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The latitudinal tilts of wealth and education in Peru: Testing them, explaining them, and reflecting on them*

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ABSTRACT

Comparisons between countries around the globe reported since 1999 reveal that nations' wealth consistently increases with distance from the Equator. Is Peru's territory exempt from this trend? This study used GPS coordinates, questionnaire data, climate files, and census information from the 2000 Peru Demographic and Health Survey, Climate Wizard, and G-Econ data sets to reconcile the contradictory national evidence and understand the role of certain geophysical and social variables. Household assets increase from north to south in the Brack ecological regions with latitudinal orientation which were studied (Desert, Puna, Yunga, Amazon), especially in rural settings, and as does women's education, except in the Amazon. Neither temperature nor fourteen other geophysical and social variables account for such effects, though women's domestic power explains them in the Yunga ecoregion. The findings can be understood through two theoretical perspectives: one, according to the evolutionary theses of Lynn, Rushton, and Kanazawa, suggests the genetic fixation of differential intellectual levels caused by an ancestral adaptation of Peruvian to various conditions of climate and altitude. The other, combining what is known about ultraviolet radiation, vitamin D, and production of sexual hormones with Zajon's confluence theory, is defined by fertility rate and the consequent intellectual home environment for the child. Both predict the increment of IQ and educational PISA scores from north to south Peru, but one points toward education and the other to family planning as human development strategies.

Keywords: latitude, wealth, education, women's power, evolutionary psychology, IQ

JEL classification: D31, I24, Z13

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Los cambios latitudinales de la riqueza y la educación en el Perú: probándolos, explicándolos y su reflejo

RESUMEN

Resultados de comparaciones reportadas entre países alrededor del globo desde 1999 indican que la riqueza de las naciones crece consistentemente con la distancia a la línea ecuatorial. ¿Está el territorio peruano exento de esta tendencia? Para reconciliar la contradictoria evidencia nacional y entender el rol de ciertos factores geofísicos y sociales, este estudio utilizó coordenadas GPS, datos de cuestionarios, archivos de clima, e información censal existentes en varias bases de datos (Encuesta Demográfica y de Salud Perú 2000, Climate Wizard, G-Econ). Los activos del hogar crecen de norte a sur en las regiones ecológicas de Brack de orientación latitudinal estudiadas (desierto, puna, yunga, Amazonía), especialmente en ámbitos rurales, y la educación de la mujer lo hace en las tres primeras. Ni la temperatura ni otras 14 variables geofísicas y sociales dan cuenta de los efectos, aunque el poder doméstico de la mujer los explica en la ecoregión Yunga. Los resultados pueden entenderse en dos perspectivas teóricas. Una, acorde con las tesis evolucionistas de Lynn, Rushton y Kanazawa, sugiere la fijación genética de niveles intelectuales diferenciales producidos por una adaptación ancestral de los peruanos a distintas condiciones de clima y altura. La otra, combinando lo que se conoce sobre radiación ultravioleta, vitamina D, y producción de hormonas sexuales con la teoría de la confluencia de Zajonc, se define por la tasa de fertilidad y consecuente ambiente intelectual hogareño para el niño. Ambas predicen el incremento del cociente intelectual y los puntajes educativos PISA del norte al sur peruanos, pero de una se desprende la educación y de la otra la planificación familiar como estrategias promotoras de desarrollo humano.

Palabras clave: latitud, riqueza, educación, poder de la mujer, psicología evolucionaria, inteligencia, radiación ultravioleta.

1. INTRODUCTION

Peruvian social sciences have prioritized historical studies and neglected geography as a major shaper of social structures and processes. The research findings presented in this article show a dependence of household wealth and women's education on latitude and, thus, demonstrate that theorizations that consider geography are needed to understand Peruvian economy and society.

1.1. Latitude and wealth

There is a remarkable consistency in the differences in wealth observed between temperate regions of the world (north of 23.45° N and south of 23.45° S) and tropical regions (between 23.45° N and 23.45° S), even within countries. Sachs (2000) reported that 28 of the 30 national economies classified as high-income by the World Bank in 2000 were in temperate ecological zones; moreover, tropical economies, which in 1820 produced wealth equivalent to 0.68 of that of temperate ones, had fallen to 0.25

by 1992 due to the higher growth rate of the latter since the early 19th century. Absolute latitude or metric distance from the Equator predicts worker productivity (Hall & Jones 1999), intensity of agricultural cultivation (Masters & McMilla,n 2000), economic growth (Cinyabuguma & Putterman, 2011), product per 1° latitude x 1° longitude cell (Nordhaus & Chen 2009), and gross domestic product per capita (Bleaney & Dimico, 2010; Gallup, 2000; Gallup, Gaviria, & Lora 2003; Lynn, 2009; Master & McMillan, 2000; McArthur & Sachs, 2001; Olsson & Hibbs, 2005; Ram, 1999; Sachs, 2000).[1] If geography affects economy consistently around the globe, wealth must therefore increase from Peru's northern (0° 02' S) to southern (18° 21' S) borders.

The evidence relevant to the validity of this hypothesis is contradictory. Upholding national conventional wisdom, G-Econ's (2011) 3-dimensional map of spatial wealth indicates a Peruvian north more economically active than Peru's south.[2] The map reflects the centralization of economic activity in Lima and important concentrations in large cities on the northern coast, the southern city of Arequipa being the exception.[3] Yet, the country's map of poverty (FONCODES 2006) suggests that welfare decays from south to north. To dispel doubts, I used PNUD Perú (2009) data to calculate the correlation between absolute latitude and monthly family income per capita over the 24 Peruvian departments and found a Pearson $r = .15$ that upholds the latitudinal hypothesis implicit in the international literature.[4] This suggests that what increases from north to south in Peru is the wealth that impinges on human development: family income per capita can be seen as an indicator of the opportunities a person has to exercise his/her freedom to attain different kinds of alternative lives (Sen, 1999).

Only one study has thoroughly explored the relationships between wealth and geography, including latitude in Peru (Escobal & Torero, 2003). In it (Table 8, column 1), latitude did not show significant effects on wellbeing; however, another geographic variable, altitude, emerged with a significant and large negative impact on per capita expenditure growth. Altitude is expected to have a negative effect on income despite the positive impacts that it may have had in specific times and settings, such as during Africa's slave trade (Nunn & Puga, 2009) or in pre-hispanic Peru.[5] All else being equal,

1 Latitude is usually measured in decimal degrees, where decimals replace the minutes and seconds of the traditional geographic measurement. Northern (N) latitude is given a + sign and southern (S) latitude a – sign. Absolute latitude simply disregards the N and S signs. In the cited studies, country was the unit of analysis, except when within-country differences were targeted (Lynn, 2009; Ram, 1999) or a large part of the globe was divided into 1° latitude and 1° longitude cells (Masters & McMillan, 2000; Nordhaus & Chen, 2009).

2 The economic indicator is product per grid cell of 1° latitude and 1° longitude.

3 Lima is at a latitudinal center of the Peruvian coast.

4 The data came from the Peru Human Development Report (PNUD Peru, 2009). Departments have officially been known as "regions" since 2002, when budgetary and electoral autonomy were granted to them. Their original name is retained in this article to avoid confusion with natural or ecological regions.

5 The greatest accomplishments of pre-Hispanic Peru in terms of state formation—the Wari and Inca states—were achieved at high altitude (Bonavia, 1991).

on rugged terrain it is more difficult to construct buildings, roads, bridges and other infrastructure; agriculture and irrigation are also more difficult, and trade is more costly. West longitude emerged with smaller, but significant, negative coefficients, a finding that can be understood as an effect of the East-West location of Peru's three natural regions. The Peruvian coast, with the highest negative longitude, is richer because it does not suffer the altitude of the highlands or the tropical climate of the Amazon forest, in addition to having the advantages provided by the access to cheap transport afforded by maritime waterways (Mellinger, Sachs, & Gallup 1999). Escobal and Torero (2000, 2003) probably failed to detect the effects of meridionality on Peruvian wealth because in all of their econometric models, latitude was entered together with the other geographic variables (longitude, altitude, soil slope, soil depth, igneous rock, metamorphic rock, temperature). Altitude increases from north to south in Peru and longitude does not function as orthogonal to latitude, either; as the Pacific littoral increases its distance from the Equator, it diminishes its West longitude. Hence, the effects of latitude could have been hidden by the multicolinearity. More importantly, the selection of per capita expenditure as main dependent variable may have introduced important measurement error and bias. Research has shown that expenditure-based indicators are frequently affected by seasonality and other short-term fluctuations in economic wellbeing (Filmer & Pritchett, 2001). For these reasons, scientists have developed methods to estimate household wealth or permanent income using information on the ownership of selected assets or on the use of certain services that correlate with permanent income (Ferguson, Tandon, Gadikou, & Murray, 2003). While there is a strong overall correlation between expenditures and the asset-based measures, the correlation is much weaker among the worst-off (Klassen 2000). In addition, using provinces (N = 190) as units of analysis may have added further error.

I overcame these weaknesses in an analysis of data from the Peru 2004-2008 Continuous Demographic and Health Survey concerning the relationship between latitude and women's control of economic decisions at home (León, 2011b). Instead of working at national scale, I performed independent latitude analyses for coast, highlands, and Amazon forest while disregarding longitude. Rather than focusing on expenditures, the study relied on household assets, and the latitude measurements pertained to 1,409 survey clusters. The findings uphold the hypothesis implicit in the international literature: negative bivariate correlations between South latitude and household wealth emerged at each cell of a matrix formed by three levels of urbanization (city, town, rural setting) and the three natural regions, eight of them significant; the *r*s ranged from -.03 through -.30. Yet, the correlations could have been spurious, plausibly determined by third variables. For example, the study was oblivious to the number of household members; if household size increased from north to south, this variable might have caused the observed latitude-wealth *r*'s.

1.2. Theory

There are two major explanations for latitude's effects on wealth in economics literature; one entails climate and the other, culture and institutions.

1.2.1. Climate

Agricultural yields for all major crops are lower in tropical than temperate ecological zones because high temperature and humidity cause organic matter in the soil to break down quickly, robbing the soil of nutrients as well as the structure needed to absorb fertilizers and slow down erosion. Moreover, whereas the winter frost of temperate regions kills pathogens and parasites, the lack of freezing temperatures in the tropics facilitates the growth of a greater number of agricultural and animal pests. On the same basis, human tropical diseases such as malaria are endemic and reduce agricultural labor productivity (Gallup & Sachs, 2000). The effects of tropical climate on disease environment and of the latter on economic development are well-established (Bhattacharyya, 2009; Bloom & Sachs, 1998; Carstensen & Gundlach, 2006; Gallup, Sachs, & Mellinger, 1999; Sachs 2003; Sachs & Melaney, 2002). Hence, tropical eco-zones as measured by the Koeppen-Geiger climate classification system, as well as temperature and/or yearly number of days of frost as continuous variables, predict investment in farm inputs (Masters & Wiebe, 2000), intensity of cultivation (Masters & McMillan, 2000), agricultural labor productivity (Gutierrez, 2002), general labor productivity (Gallup, Sachs, & Mellinger, 1999), product per 1° latitude x 1° longitude cell (Nordhaus, 2006; Nordhaus, Azam, Corderi, Hood, Makarova Victor, Mohammed, Miltner & Weiss, 2006; Nordhaus & Chenm, 2009), economic growth (Gallup, Sachs, & Mellingerm, 1999; Masters & McMillan, 2000), and/or average income (Bhattacharyya 2009; Bleaney & Dimico 2010; Gallup, Sachs, & Mellinger 1999; McArthur & Sachs 2001; Olsson & Hibbs, 2005; Sachs, 2000). It follows that, if latitude determines wealth in Peru, the relationship could be attributable to temperature. This variable, however, did not significantly contribute to welfare in the Escobal and Torero (2003, Table 8, column 1) study.

Temperature is distributed in Peru in a way that moderates its latitudinal condition as a tropical country. Since the Humboldt Current cools the Pacific coast and the parallel Andes extend the cold eastwards as an effect of altitude, only the climate in the underpopulated Amazon forest equals that of equatorial Africa. Furthermore, the western (colder) and eastern (warmer) slopes of the Andes present specific ecological characteristics that differentiate them from each other and from the Puna, the region of highest altitude. Thus, whether the expected latitude-wealth relationship has different levels of strength across Peruvian ecologies may be a question with potential empirical value. Similar is the case of urbanization level; temperature may have a stronger impact on agriculture than on urban life, and consequently, urbanization can also be expected to moderate the expected latitude-wealth relationship.

1.2.2. Culture and institutions

Hall and Jones (1999) interpreted the relationship between absolute latitude and output per worker as an effect of the worldwide spread of good institutions and government policies from Western Europe. Others (e.g., Acemoglu, Johnson, & Robinson, 2001; Easterly & Levine, 2002; Rodrik, Subramanian, & Trebbi 2004) have challenged the climate interpretation of latitude's effects on wealth, considering geography as a mere proxy for "good" culture (technology, interpersonal trust, social ethics, individualism) and institutions (rule of law, property rights, openness to trade; see Nunn 2009). Discrete historical *facts* are specific to time and place and thus look scientifically trivial to me. For example, free-city formation in Northern Italy in the Middle Ages (Guiso, Sapienza, & Zingales, 2008) or ancient immigration from Northern Africa (Lynn 2009), regarded as causes of the current latitudinal gradient of wealth observed in Italy, cannot explain the similar gradients seen in Brazil (PNUD Brasil, 2005), China (Démurger, Sachs, Woo, Bao, Chang, & Mellinger 2002), the United States (Ram, 1999), or Western Europe as a whole (as evidenced in the current financial crisis of the Eurozone). More compelling is the evidence entailing historical *variables*, such as the time of technology adoption (Comin, Easterly, & Gong, 2008), or interactions between geography and history. According to Diamond (1997), the north's technological advantage stems from the complex specialized societies which arose wherever crops and animals were domesticated earlier and in more varieties. Eurasia not only had the largest endowments, but the domestication of plants and animals quickly spread east and west because when in either direction, the length of the day does not change and the climate is generally not drastically different. However, this is not true when moving north or south. Hence, for continents with a north-south orientation, such as the Americas or Africa, domestication or technological advance tended not to spread as quickly as in Eurasia. A notable study by Olsson and Hibbs (2005) shows that, indeed, differences in initial biogeographic conditions and in geography largely account for the different timings of the Neolithic transition from a nomadic hunter-gatherer lifestyle to sedentary agriculture, and that such timings explain the hundred-fold differences in wealth existing between nations today.[6] Nonetheless, the Olsson-Hibbs study also demonstrates that the effects of biogeography and geography on present differences in prosperity, being partly mediated by the quality of present-day institutions, are in part independent of institutional quality. Nordhaus and Chen's (2009) findings from a study of economic product over 27,442 geographic cells point to analogous conclusions from the opposite angle; they found that climate and other geophysical variables only explained 50% of the gross product variance attributable

[6] Important reversals of fortune, however, have been seen. It took Europeans one millennium to catch up with Arab technology and 1,5 additional millennia to surpass it (Comin, Easterly, & Gong, 2008). Similar is the case of China, whose economic development circa 1500 AD was comparable to that of Europe's (Frank, 1998).

to latitude around the globe. In particular, the case of Sub-Saharan Africa challenged the climate explanation, for similar tropical regions of the world exhibited greater product.

I surmise that one or several unnoticed latitudinal covariates fill the vacuum. For example, the singular situation of Sub-Saharan African underdevelopment vis-à-vis other tropical zones can be accounted for by Portuguese immigration into northern Brazil; British immigration into Northern Australia; South India's location at the crossroads of the ancient world, linking the Mediterranean and the Far East, and similar historical influences from the north on tropical spaces. Data regarding where the ancestors of a population were circa 1500 AD—specifically, if they lived in regions with longer histories of organized states—improves prediction of current wealth, the explanation being that the culture and institutions brought by immigrants are reflected in contemporary wealth differentials within countries (Putterman & Weil, 2010). In Latin America (Gonzales, 1994) and, specifically, Peru (Valdivia, Benavides, & Torero, 2007), descendants of Spaniards are richer than indigenous peoples or afrodescendants.[7]

Yet, to account for the expected latitude-wealth relationship in Peru in the cultural perspective, the "good" culture and institutions brought by Spaniards and presently fed by globalization would have to be more prevalent in southern than northern Peru. Actually, to the extent that language is an indicator of culture, the opposite seems to be true. Quechua has many speakers in southern Peru and significant percentages in the country's central departments, but is virtually a dead language in northern Peru, whereas Aymara prevails only in the Lake Titicaca region (south) and Amazonian languages are spoken by very few (Knapp, 1987).

1.3. Other relevant factors

1.3.1. Education

The distribution of aboriginal languages in Peru has important implications; if European culture is less pervasive in southern than northern environments in this country, then schooling, a potent acculturation tool, can be assumed to play different roles along latitude. Native Spanish speakers receive the European culture mainly through their families, although schooling obviously reinforces such learning; in contrast, schooling may be the fundamental vehicle of acquisition of European culture for native speakers of an aboriginal language. Assuming that social progress is valued by indigenous populations and that they understand the instrumentality of schooling in this regard, formal education should be relatively more appreciated by indigenous than non-indigenous populations. Given the well-known schooling-wealth relationship that exists within (Pal, 2004) and

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7 Putterman (Brown University 2011) calculates for Peru 45% of Amerindians, 37% of mestizos, 15% of European-descended, and 1% of afrodescendants. The mestizo population, in turn, would descend from Amerindians (52%), Europeans (35%), and Africans (13%).

between countries (Rindermann, 2008), a positive relationship can be expected between absolute latitude and education in Peru. Also, given the previous rationale, and since indigenous populations are concentrated in the Peruvian highlands, the latitude-education relationship can be expected to be greater in this region *vis-à-vis* other regions.

The schooling-income association has already been demonstrated at national level (Escobal, 2001; Ruggeri Laderchi, 1999). As for the influence of absolute latitude on schooling in Peru, I calculated an $r = .34$ (N = 24) using PNUD Perú's (2009) educational index.[8] Since the *r* I found with income using PNUD data only reached .15, latitude could be hypothesized to affect education to a greater extent than it does wealth. However, among the findings I reported for the region x urbanization matrix referred to earlier (León, 2011*b*) is the fact that the eight negative *r*'s between South latitude and women's years of education were generally weaker than the ones I found for wealth. Again, household size was not controlled; the *r*'s could have been spurious.

1.3.2. Women's domestic power

Considering the relationship that may exist between gender equality and economic development (World Bank, 2012), recent findings showing a strong dependence of women's domestic power on latitude in Peru are of particular relevance to the topic of this article. Analyses of data from Peruvian national samples collected at different points in time have revealed that women's control of economic decisions within the household (León, 2011*b*) or, more generally, women's domestic power (León, 2012*a*), increase along meridionality. Average standard power scores increased from northern to central to southern Peru in all of Brack's (1983) major ecological regions, even though 15 sociodemographic variables were held constant; the linear trend was especially strong in the Yunga (.012, .238, .517 means) and Amazon (-.043, .108, .525 means; León 2012*a*). Such findings are consistent with the expected latitude-wealth and latitude-education links in that the three relationships have to do with human development. Poverty and ignorance (Sen, 1999), as well as women's disempowerment (Malhotra, Schuler, & Boender, 2002), are fundamental barriers to human development. Women's domestic power could account for the expected latitude-wealth relationship. Given their greater domestic power along meridionality, southern Peruvian women are probably more effective at contributing to family wealth, whereas their northern counterparts, kept within the limits of reproduction and child care, are less effective. Powerful women can not only contribute to wealth by working for pay or helping their husbands in the production of goods or services; they can also help husbands make economic decisions that have positive impacts on household wealth (World Bank, 2012).That is, wealth may increase from northern to southern Peru because gender equality increases from north to south in this country.

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8 The PNUD index combines years of education with expected years of education.

1.4. Study objectives

In the research described below, I sought to resolve the contradiction between my finding of systematic impacts of latitude on household wealth in Peru (León, 2011*a*) and the failure of Escobal and Torero (2000, 2003) to detect any significant effects of latitude on wellbeing. Secondly, climate and culture provide a number of hypotheses relevant to the relationships between latitude, wealth, and education in the Peruvian setting that require testing; new knowledge generated in this perspective might widen the focus of Peruvian studies. Thirdly, the link observed between latitude and women's domestic power in Peru (León, 2011*b*, 2012*a*) could account for the expected latitude-wealth and latitude-education relationships and, thus, help to understand the economic impacts of meridionality.

Therefore, the following hypotheses were submitted to empirical scrutiny:

1. The relationship between latitude and household assets remains significant when household size and other relevant variables are set constant.
2. Temperature explains the latitude-wealth relationship.
3. Ecology and level of urbanization moderate the influence of latitude on wealth.
4. Education is affected by latitude as in hypotheses 1, 2, and 3.
5. The latitude-education relationship is greater in the highlands than in other regions.
6. Women's domestic power accounts for the latitude-wealth and latitude-education relationships.

2. METHODOLOGY

2.1. Data

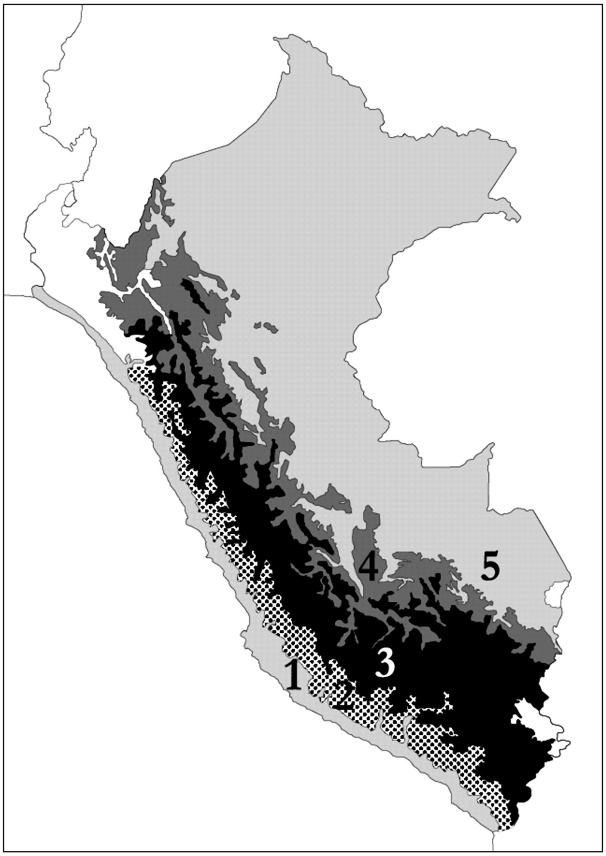
Data from five data sets were integrated. The Climate Wizard (2011), a website developed by Cris Zganjar (The Nature Conservancy), Evan Girvetz (The University of Washington), and George Raber (The University of Southern Mississippi), contributed temperature data. The Geographically Based Economy Data (G-Econ 2011), a website developed by William Nordhaus (Yale University) and Xi Chen (Quinnipiac University), was the source of population density data. All the other study variables were supplied by three data sets from the Peru 2000 Demographic and Health Survey (DHS). This survey, and not the Peru Continuous 2004-2008 DHS, was selected because it maximizes time contiguity with the Escobal and Torero (2000) study and G-Econ data for Peru.

The Peru 2000 survey (INEI, Macro International, USAID, & UNICEF 2001) was part of DHS international initiative, whose standard methodology across countries entails a multiphasic and stratified sample design and weights specially calculated to provide estimates of the variables of interest with national and sub-national representation. The sampling phases entailed the selection of population clusters and households within them, the stratification was urban-rural, and the representativeness reached the department level. Complete interviews were obtained from 88% of the occupied households. Eligible subjects within households were all women of fertile age, i.e., 15-49 years old, and the rate of individual responses was 95%. Three data sets from this survey—the *Geographic Positioning System* (GPS), *Wealth Index*, and *Individual Recode* data sets—were merged. They, respectively, had clusters (N = 1,409), households (N = 28,900), and women (N = 27,843) as cases.

The sample was segmented considering Brack's (1983) ecological system, based on the application of standard geographic concepts from the international literature to the Peruvian context. Zamora's more recent (1996) 18-ecoregion system was discarded owing to its extreme fragmentation of the territory. I compared the coordinates (latitude, longitude, altitude) for each sampling cluster of the Peru 2000 DHS with a giantography of Brack's ecoregions (Ministerio del Ambiente, 2011) to decide the classification of each cluster into one of the five latitudinally-oriented ecoregions presented on Figure 1 or its exclusion from the study.

- The Pacific coast Desert is 40 to 100 km wide and entails an altitudinal range from 1 through 1,000 meters above sea level (m.a.s.l.); this is a highly urbanized region irrigated by 40 small rivers, fed by Andean glaciers and rainfall, and corresponds to Pulgar Vidal's (1938) *Chala*.
- The *Sierra* steppe is equivalent to Pulgar Vidal's M*aritime Yunga* and Zamora's (1996) Meridional Andes; all of these terms refer to the western slopes of the Andean mountains (from 1,000 through 3,800 m.a.s.l.). The Chicama valley in the department of La Libertad is the dividing line between the *sierra* steppe and the more northerly Andes slopes (Brack's Dry Equatorial Forest).
- Brack's *Puna* or Andean plateau covers high-altitude territories from Cutervo National Park (3,200 m.a.s.l) in the northern department of Cajamarca through the glaciers at 5,200 m.a.s.l. in the southern department of Tacna. It encompasses several of Pulgar Vidal's and Zamora's regions, including the Quechua subregion, i.e., inter-Andean valleys where cities like Cajamarca (2,750 m.a.s.l.) and Huaraz (2,645 m.a.s.l.) are located.
- Brack's *Yunga* region—Pulgar Vidal's Fluvial Yunga—entails the eastern slopes of the Andes, from 600 through 3,500 m.a.s.l. This humid tropical zone loses continuity in Peru's north due to the crossing of the equatorial dry forest from the departments of Piura and Lambayeque into the Marañón river.
- The Hot Tropical Amazon Forest encompasses the largest Peruvian ecoregion, the low jungle, from 50 through 600 m.a.s.l.

Figure 1. Ecoregions of the study: desert (1), steppe (2), puna (3), yunga (4), and Amazon (5)



Source: Ministerio del Ambiente 2011.

The other non-maritime ecoregions of Peru (Pacific Tropical Forest, Equatorial Dry Forest, the *Páramo*, and the Palm Savanna) were ignored given their scarce latitudinal relevance. Table 1 exhibits sample sizes computed per latitude level per ecoregion. Considering the small number of cases in various key cells of the steppe, I discarded this ecoregion from further analyses.

2.2. Study variables

2.2.1. Independent variable

- Absolute latitude. The GPS was instrumented by DHS through the Garmin Etrex tool (Montana & Spencer, 2004). The information refers to the centroid of the cluster and is given in decimal degrees. All households and women within a cluster received the same score.

2.2.2. Dependent variable

- Household wealth score (HWS). DHS builds a wealth variable in each country. Household items considered include source of water for drinking (pump/well, open source, etc.); type of toilet facilities (flush, latrine, etc.); source of lighting (electric, etc.); and main floor, window, and roof materials. Other assets considered include radio, television, refrigerator, bicycle, motorcycle, and car. Filmed and Pritchett (2001) describe the use of principal component analysis to obtain HWSs on the basis of such inputs. Implementing this methodology, DHS produces a standardized score with mean = 0 and standard deviation = 1.
- Women's literacy/education (WLE). DHS asks women, "Have you ever attended school?" and, "How many years of schooling did you complete?" The total number of years required to complete the highest year of studies indicated by the interviewee—including university years—is calculated. Women who respond "Primary instruction" or less are given a card with a sentence and asked to read it. To translate educational attainment into a normally distributed single score that in the end was found to be skewed, I combined the two variables and produced the following scale: 0 = unable to read (N = 2,973). 1 = reads part or the complete sentence and has 0-4 years of schooling (N = 3,324). 2 = literate and has 5-9 years of schooling (N = 9,233). 3 = has 10-11 years of schooling (N = 6,830). 4 = has 12-14 years of schooling (N = 3,135). 5 = has 15-17 years of schooling (N = 2,242).

2.2.3. Covariates

- Temperature. The measurements selected from the Climate Wizard are annual averages in Celsius degrees per cell of 0.5º latitude and 0.5º longitude, i.e., 55.52 square kilometers, over the past 50 years. The coordinates of each cluster of the study were examined and compared to the geographic cells of the Climate Wizard data matrix to decide assignment of a temperature score. A few clusters on the international frontiers of the Amazon region lacking information were assigned the value of the nearest Peruvian cluster.
- West longitude. The nature and treatment of this variable were similar to those of latitude; the negative sign was maintained.
- Altitude. This measurement, in m.a.s.l., was obtained from the GPS data set and pertains to the cluster, too.
- Urbanization. DHS classified as urban or rural the cluster to which the woman's household belonged. This classification was defined by INEI's criterion, according to which an urban center has at least 100 households contiguously grouped and/or is a district capítal. The codes used were 1 (Rural) and 2 (Urban).

- Population density. This variable contextualizes the cluster. G-Econ (2011) provides population information per 1° latitude x 1° longitude grid cell as of 1990. The conversion of administrative-based information—INEI's (1991) census data per province—into grid cell data is described by Deichmann, Balk, and Yetman (2001). The coordinates of each cluster were examined to decide its correspondence to a specific G-Econ cell and the indicated population was assigned. A few clusters in Madre de Dios and Puno on the frontier with Bolivia lacked G-Econ's information; the population for the closest Peruvian grid cell was assigned in these cases.
- Spanish as mother tongue. Women were asked, "What language or mother tongue did you learn in your childhood?" Responses were coded originally as 1 = Spanish, 2 = Quechua, 3 = Aymara, 4 = Other indigenous language, and 5 = Foreign language. They were recoded as Spanish = 1 and any indigenous language = 0; foreign language (less than 0.1% of the cases) was ignored.
- Household size. The total number of household members (adults and children) was obtained from the *Individual Recode*.
- Household head. From the *Individual Recode*, this variable was recoded 1 = Female, 0 = Male.
- Age. The woman's age was calculated considering her birth date and the date of the interview.

DHS asks two questions ("What is your month and year of birth?" and "How old were you on your last birthday?") and corrects inconsistencies where possible.

- Work. The woman was asked whether she worked at the time of the interview and whether she had worked in the past 12 months. ("As you know, some women work for a payment in cash or in kind. Others sell things, run small businesses, or work family land or in family concerns. Are you currently employed in any of these activities? Have you worked in the past 12 months?") Her responses were coded 0 = did not work and 1 = worked and/or is working now, regardless of whether she received payment or not and the type of payment.
- Born in place. The woman was asked how long she had lived continuously at the interview location. Responses were coded Always = 1 and Not always, Inconsistent, or Does not know = 0.
- Number of living children. This is DHS's sum of responses concerning the number of male children residing in the household, male children residing outside the household, female children residing in the household, and female children residing outside the household.

- Listens to radio. Women were asked whether they listened to radio and how frequently. Responses were coded Never = 0, At least once a week = 1, and Almost every day = 2
- Women's domestic power (WDP). Only data from women whose husbands were living with them were analyzed. The following DHS questionnaire items were selected: "Who usually makes decisions about (major household purchases [V743B]) (household purchases for daily needs [V743C]) (visits to your family or relatives [V743D])?"[9] The response options included: "Respondent", "Husband/partner", "Respondent and husband/partner jointly", "Someone else", and "Respondent and someone else jointly". However, there were virtually no responses involving the "Someone else" options in the sample. The egalitarian model justifying an overall domestic power score has been laid out elsewhere (León, 2012*c*). Essentially, it is posited that domestic areas vary in importance and, consequently, the measurement operations to capture women's power cannot be identical across domestic areas. For the purposes of this research, items V743C and V743D were considered to entail less important domestic areas than item V743B. Whereas women's freedom of movement may have considerable importance in countries less developed than Peru (Kishor & Subaiya 2008; León 2011*a*), this does not appear to be the case in Peru itself. Consequently, the following recodes were applied to the responses on small purchases and visits: "Husband" = 0, "Respondent and husband" = 1, and "Respondent" = 2. Under the egalitarian model (León 2012*c*), the greater importance of large purchases for the home required assigning a 0 to "Husband", a 1 to "Respondent", and a 2 to "Respondent and husband", as this would reflect the couple's egalitarian values. Then, the three recoded items' scores were averaged. The internal consistency of the power scale was satisfactory, despite the small number of items (Cronbach's α = .67).

2.3. Analytical approach

Since the design of the Peru 2000 DHS responded to the double objective of drawing a national and 24 departmental representative samples, the aggregate Peru sample under-represented some departments and over-represented others. For example, Lima's sample size (N = 3,714) was below what its demographic importance required (N = 9,117) because 3,714 cases were enough to achieve an acceptable standard error for the

[9] An item considered in my study on latitude and women's control of economic decisions at home in Peru (León 2011*b*) concerned wife's control of husband's earnings. This item posits a problem in the way to obtaining a composite power score: an important loss of cases occurred in that study, probably due to husband's unemployment and/or interviewee's reluctance to address this topic. Hence, the earnings item was substituted in the present research, as it was in León (2012*a*).

departmental estimates; Madre de Dios' sample size (N = 1,418) was greater than what corresponded to its populational significance (N = 79) because few reliable departmental estimates could be made on the basis of 79 cases. Sample weights are provided by DHS to restablish the appropriate proportions and obtain adequate estimates of national means and percentages. However, this study's hypotheses were not about means or percentages, but about relationships between variables. DHS sample weights do not apply to correlation or regression (Rutstein & Rojas, 2006). The option of weighting cases and obtaining weighted means for each dependent variable of the study at each latitude level within each ecoregion was rejected on two grounds: firstly, the only way to avoid any bias would have been to obtain *n* randomly drawn samples of equal size, one per degree of latitude per Peruvian ecoregion; weighting would not compensate for the lack of this ideal design. Secondly, third variables could not be controlled. Therefore, the analyses were performed on unweighted cases.

Moderated multiple regression (Aiken & West 1991) was replicated for each dependent variable (Y) at national scale and each selected ecoregion:

$$Y = \beta_0 + \beta_1\delta + \beta_2\pi + \beta_3\lambda + \beta_4(\delta\pi) + \beta_5(\lambda\pi) + [\beta_i\xi_j] + \varepsilon \tag{1}$$

In this equation, δ is absolute latitude; π is urbanization; λ is temperature; $(\delta\pi)$ and $(\lambda\pi)$ are the latitude x urbanization and temperature x urbanization interactions, each implemented as the simple multiplication of the two variables; and $[\beta_i\xi_j]$ is a set of covariates that includes household size, women's domestic power, and others.[10] A Type III method for calculating the reduction in error sum of squares was employed. The SPSS 19 statistical package was utilized in all the analyses.

3. RESULTS

Table 2 presents descriptive statistics for the ecoregions and the national scale. The latitude, longitude, and altitude averages are not geophysical, but geopopulational. The Desert presents the greatest levels of absolute latitude, West longitude, urbanization, population density per grid cell, Spanish as mother tongue, female heads, women's age, HWS, WLE, and WDP, as well as the lowest temperature and altitude and smallest household size and number of children. The Puna is differentiated by having the greatest altitude, proportion of women working, and number of children, as well as lowest urbanization, HWS, WLE, proportion having Spanish as mother tongue, and inmigration. The Yunga is not characterized by any extreme average. The Amazon can be described as the region with the highest temperature, youngest women, and greatest household size and immigration level, as well as lowest absolute latitude, West longitude,

[10] Interaction terms in regression models are often seen in the psychological (e.g., Overton 2001) and political science (e.g., Brambor, Roberts Clark, & Golder, 2005) literatures.

population density, females as household heads, women working, and WDP. That is, the Desert is the modern ecoregion of Peru, whereas the Puna, Yunga, and Amazon represent various forms of traditional societies. The number of cases was smaller for WDP than the other variables because unmarried, widowed, divorced, and married women not living with their husband were excluded from the analyses involving this variable. The distributions of the dependent variables significantly departed from normality according to Kolmogorov-Smirnov tests.

3.1. Household size, temperature, urbanization, and education

According to Hypothesis 1, the relationship between absolute latitude and wealth would emerge positive and significant even though household size and other relevant variables were set constant. The Pearson correlation between absolute latitude and household size emerged opposite the expected direction: $r = -.13$ at national level, $r = -.09$ in the Desert, $r = -.14$ in the Puna, $r = .00$ in the Yunga, and $r = -.20$ in the Amazon (all, excepting the Yunga, at $p < .000$, two-tailed). As shown in Table 3, household size was positively and significantly related to HWS. Yet, absolute latitude transcended the effects of this and the other covariates and significantly influenced HWS in the expected direction.

Hypothesis 2 predicted that temperature would explain the latitude-wealth relationship. Consistent with climate theory, temperature emerged negatively and significantly related to absolute latitude: $r = -.70$ at national level, $r = -.47$ in the Desert, $r = -.58$ in the Puna, $r = -.46$ in the Yunga, and $r = -.48$ in the Amazon (all at $p < .000$, two-tailed).[11] Temperature behaved as expected from climate theory when the latitudinal main effect was excluded from the regression model; that is, it negatively and significantly determined HWS. Nonetheless, Hypothesis 2 was disconfirmed by the results: like in the Nordhaus and Chen (2009) study, temperature failed to account for the latitude-wealth relationship, which maintained its significance after the effects of temperature were discounted.

Upholding Hypothesis 3, the level of urbanization significantly moderated the influence of latitude on household wealth (see Table 3). The negative sign of the latitude x urbanization interaction in the regression models that included latitude as a predictor indicates stronger effects of the geographic variable in rural than urban settings. This was registered in spite of the possible reduction of power (increased Type II Error) due to heterogeneity of the error variances (Overton 2001). As for Type I Error, the actual *p*'s were below .000; heterogeneity of error variances may have brought down significance,

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[11] The difference in relationship strength observed between national and ecoregional levels can be understood considering that the cold ecoregions (Desert, Puna) are to the south of the warmer ones (Yunga, Amazon); that is, at national scale, between-ecoregion covariance was added to the within-ecoregion covariance.

yet within the limits of the conventional .01 or .05 levels. Braumoeller (2004) might say that because the significant interaction implies that the impact of latitude on HWS varies depending on the level of urbanization, the idea of "an impact of latitude on HWS in general" would be meaningless. That is, concluding that latitude determines HWS "in general", as I have done at the beginning of this section, would be unjustified. To test this possibility, I replicated the model C regressions of Table 3 (excepting the urbanization and latitude x urbanization terms) separately for the rural and urban settings and found the following standardized regression coefficients: for HWS, Rural $\beta = .522$ ($p < .000$) and Urban $\beta = .198$ ($p < .000$), and for WLE, Rural $\beta = .174$ ($p < .000$) and Urban $\beta = .074$ ($p < .000$). That is, absolute latitude had a positive and significant influence in each setting which was stronger in rural than urban areas. When temperature substituted latitude in the model, the latitude x urbanization interaction became positive, which contradicts my earlier expectation of results showing that temperature is more relevant to agriculture than to urban life and suggests that another covariate, not temperature, is responsible for the stronger effects of latitude on wealth in rural settings.

Hypothesis 4 predicted that the previous hypotheses would also apply to education; indeed, absolute latitude determined WLE positively and significantly (see Table 3). Although the differences were not statistically significant, the observed effects of latitude on WLE emerged less strong than those on HWS. Moreover, according to the R^{2}'s, the general predictability of WLE was weaker as compared to the predictability of HWS. This suggests that literacy/education is generally less variable than wealth in Peru, which may reflect a greater success of the equalizing efforts of the State as a provider of educational services than opportunities to escape from extreme poverty. Alternatively, the nature of the WLE score, i.e., how it was constructed, could have artifactually limited its variability.

3.2. The special case of the Puna

Hypothesis 5 stated that the latitude-education relationship would be stronger in the highlands than in other regions; the results shown on Table 4 uphold this hypothesis. Significant differences in unstandardized regression coefficients were observed under model I between the Puna ($b = .275$, 95% CI = .230, .320) and the Desert ($b = .126$, 95% CI = .067, .186) and Amazon ($b = .004$, 95% CI = –.045, .052), though not the Yunga ($b = .177$, 95% CI = .107, .248).[12] The rationale for the hypothesis was that education would have a greater value for indigenous than non-indigenous populations because, to the former, it represented basic access to European culture. However, the relevance of the evidence for this rationale is challenged by the fact that Spanish as mother tongue was controlled in the analyses. The Puna presented another peculiar

[12] The differences between Desert and Amazon ($b = .004$, 95% CI = -.045, .052) and Amazon and Yunga were also significant.

characteristic: only in this ecoregion did temperature and the temperature x urbanization interaction show significant effects on WLE. It can also be noted on Table 4 that the latitude-education coefficients slightly decayed when HWS was set constant, except in the Amazon, where the relationship was insignificant across the board.

A different pattern can be seen with respect to the effects of latitude on wealth (see Table 5). To begin with, the effects of latitude were significant in the Amazon. The Puna lagged behind the Desert and Yunga, though not significantly, in terms of the latitude-HWS relationship. Only in this high-altitude ecoregion did the relationship (b = .093, 95% CI = .067, .119) decrease significantly when WLE was controlled (b = .031, 95% CI = .010, .051); that is, education was significantly relevant to wealth in the Puna alone. Moreover, only in the Puna were the effects of latitude on HWS (b = .068, 95% CI = .047, .089) significantly smaller than on WLE. And, in contrast with the case of WLE, only Desert (b = .095, 95% CI = .059, .130) and Amazon (b = .030, 95% CI = .000, .059) presented significant differences regarding effects of latitude on HWS. That is, ecology moderated the effects of latitude on education to a greater extent than on wealth.

Temperature (as well as the temperature x urbanization interaction) presented a significant effect only in the Puna, too, albeit in a direction that contradicts climate theory. Pulgar Vidal (1938) noticed a substantial advantage in endowments in the Quechua subregion, i.e., the (Brack) Puna territory of lowest altitude and highest temperature, compared with higher and colder subregions of this ecoregion. Since the higher altitudes are inadequate for agriculture, the Quechua is the more heavily populated subregion of the (Brack) Puna. Nordhaus *et al.* (2006) also found that economic activity decreases under extreme cold, such as in Alaska and Siberia.

3.3. The role of women's domestic power

It was hypothesized that women's domestic power would explain the expected effects of latitude on wealth and education (Hypothesis 6). The Pearson r's between absolute latitude and domestic power were: .10 (national), .06 (Desert), .11 (Puna), .17 (Yunga), and .21 (Amazon), all at $p < .000$, two-tailed; that is, the latitude-WDP link was stronger in the warmer ecoregions. Hypothesis 6 was fully upheld only with respect to wealth in the Yunga; the latitude-HWS relationship lost its significance when WDP was set constant (see Table 6) in this ecoregion alone. The relationship also decayed in the other ecoregions, but did not lose significance. It must be noted that testing of Hypothesis 6 required a subsample of married women living with their husbands, for domestic power is measured by considering the couple. In this reduced sample (Table 6), the effects of latitude generally weakened as compared to the results observed in the whole sample of women (Table 5), except in the Puna, wherein the opposite was seen. Yet, since none of these differences were significant, they are not given further attention here, except to suggest that the smaller number of cases caused the latitude-HWS's loss of significance in the Amazon under models 1 and 2.[13] Different was the case of Desert and Puna; in these ecoregions, the latitude-wealth relationship decayed when WDP was controlled, but a strong and significant latitude-HWS link remained in place (Table 6). This can be understood in part considering my previous finding (León 2012*a*) of weaker effects of latitude on WDP in the Desert (linear trend = .069, $p < .01$) and Puna (.254, $p < .001$) than in the Yunga (.357, $p < .001$) and, especially, the Amazon (.401, $p < .001$).

Table 7 offers results pertaining to the latitude-WLE relationship. It can be seen that the relationship remains significant in Desert, Puna, and Yunga when WDP is controlled. Since neither women's domestic power nor temperature explain the relationships observed between latitude and the dependent variables, another construct is needed to make sense of the study results in these ecoregions.

4. DISCUSSION

The study's methodological limitations were significant, but do not impede substantive interpretations of the results. The main problem is one of representativeness; in the absence of conditions to implement the ideal research design (i.e., *n* randomly drawn samples of equal size, one per degree of latitude per Peruvian ecoregion), the analyses were performed on available data from 24 departmental samples integrated into a global Peru sample and then disaggregated according to ecoregion. The sub-samples were not weighted and thus remained potentially biased. Since they were not strictly representative of degrees of latitude, a number of unknown biases could have underlied the relationships observed between meridionality and the dependent variables.[14] Weighting could have restored the representativeness of the subsamples, but statisticians involved in the generation of the DHS sampling scheme advised against using the DHS weights in correlation or regression (Rutstein & Rojas, 2003). They probably considered that while there is a wide consensus in using survey weights when estimating population parameters (e.g., means, ratios), it is not clear what to do when the objective is making inferences about model parameters (e.g., regression coefficients) from samples of complex structure (Faiella, 2010; Gelman, 2007; Lohr, 2007). This was not the only limitation of the study; the distributions of wealth and education violated the linear regression assumption of normality and the presence of spatially correlated errors may have led to overestimates of the impacts of latitude on them. Measurement of some variables was primary; for example, use of lowest rather than average temperature might have produced different results. These limitations, however, far from destroy the credibility of the observed north-south phenomenon. OLS regression is robust

13 I am assuming that similar processes can be theorized for the Yunga and Amazon.

14 For example, Lima contributed a number of cases that over-represented the 12° S in the desert.

to violation of its assumptions and the observed relationships between latitude and the dependent variables did not take place in a scientific vacuum but are strengthened by their consistency with the international evidence.

4.1. Reconciling the national evidence

The findings suggest that the failure of Escobal and Torero (2000, 2003) to detect latitude as a determinant of wealth in Peru is not attributable to the multicolinearity of their geographic variables; use of temperature, longitude, and altitude as covariates did not prevent the emergence of significant latitude-wealth coefficients in the present study. The contradictory León (2011*b*) and Escobal and Torero (2000, 2003) findings can thus be reconciled considering only two factors: household assets represent the accumulation of wealth throughout the life of a family, as reflected in the observed dependence of HWS on women's age in this study (see Table 3); in contrast, the variable utilized by Escobal and Torero (2000, 2003), monthly expenditure, is not only more unreliable as a wealth indicator, but may systematically underestimate the welfare of rural populations. The second possibility is that their unit of analysis, provinces, was too gross, and the within-province latitudinal variance added considerable error in the measurement of welfare.

The paradoxical question posited by the confirmation of a consistent latitude-wealth relationship in Peru is, do southern Peruvians have a greater income than their northern compatriots? The greater wealth seen in south Peru's households might not necessarily reflect greater income. A conservative attitude toward spending expressed in investing in the household might differentiate southerners from citizens who become happier-to-spend in other pursuits as they come closer to the equatorial line. Whether southern Peruvians have a greater income *and* are more savings-oriented is an empirical question that calls for specially designed questionnaires. However, the PNUD Perú (2009) data that I analyzed clearly supports the hypothesis of greater income.

4.2. An explanation based on evolutionary Psychology

No cultural explanation of any type occurs to me that could help understand why wealth and education, regardless of current temperature and level of women's domestic power, increase from north to south in Peru's Desert and Puna, the colder and more heavily populated ecoregions of this study. The inability of contemporary covariates to provide an answer demands a look at heredity. According to evolutionary psychology, present human characteristics are in part results of evolved adaptations (Buss 2004). The relevance of evolutionary tenets to the subject of this article is made evident by the finding that the Bolivian male of towns and cities in the highlands, typically a mestizo, presents higher levels of hemoglobin than his rural Aymara counterpart at the same altitude (Beall, Worthman, Stallings, Strohl, Brittenham, & Barragán, 1992). The genes of aboriginal populations have been in Peru and Bolivia for more than 12 millennia versus just 0.5 millennia of those of Spaniard ancestry. Hence, it should not be surprising that the Sherpa of the Himalayas, who has had 30,000 years of adaptation to altitude, presented a lower level of hemoglobin than the Peruvian Quechua or Aymara (Monge, Bonavía, León-Velarde, & Arregui, 1990).

An economics historian, Landes (1998), posited that a fundamental source of wealth, the disposition to work hard, is stimulated by cold, and that the cold-work association explains international differences in welfare. Current temperature, however, may be less relevant today than it was in ancient times, when *Homo sapiens* had not yet created effective technologies to deal with it. In temperate regions of the world, the person of ten millennia ago who was unable to anticipate the winter and work hard and smartly to prevent its adverse consequences faced a greater likelihood of dying and failing to pass his/her genes into the future; tropical regions, on the other hand, are more likely to have permitted the survival and reproduction of the lazy and short-sighted along with the hard-working and smart. Thus, Rushton (2000), Lynn and Vanhanen (2006), and Kanazawa (2008) have explained the international latitude-wealth relationship by considering an evolutionary dependence of human intelligence, as measured by IQ, on low temperature.[15] If the less smart died more easily in temperate regions, average intelligence increased in such regions at a greater rate than in tropical zones and, in the end, generated better technology and greater wealth. Templer and Arikawa (2006) and Rindermann (2007, 2008) have produced strong evidence upholding this concept, based not only on IQ measurements, but also on PISA and other educational proficiency test scores. The evidence is starting to attract the attention of mainstream scientists despite the political incorrectness of the rationale.[16] The tensions between the Nature and Nurture standpoints ameliorate when it is realized that heredity may be responsible for half the variance in human traits and culture for the other half. Thus, ancestral cold may be the unnoticed covariate of latitude theorized earlier to explain the Nordhaus and Chen's (2009) latitude-temperature gap and needed to account for the HWS and WLE findings of this study in the Desert and Puna. The latitude-education link that was predicted by considering the instrumental value of education for indigenous populations could have also been predicted from evolutionary psychology: more intelligent families are more likely to seek a greater education for their children.

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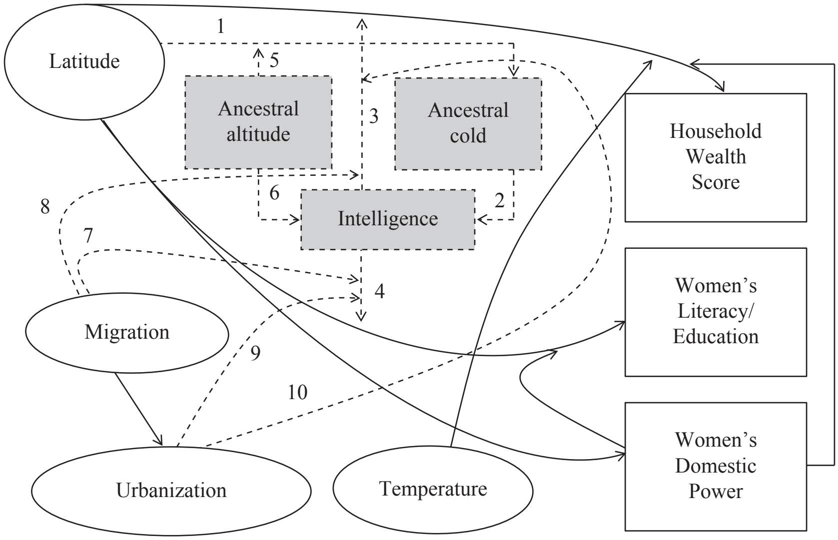
15 Actually, Kanazawa (2008) considers evolutionary novelty. Cold would be an instance of evolutionary novelty.

16 See the debate to which volume 21 of the *European Journal of Personality* was dedicated four years ago.

Figure 2. Explaining the effects of latitude on wealth in the desert and puna and on women's education in the desert, puna, and yunga



In the model depicted in Figure 2, drawn to guide an evolutionary interpretation of the study results, solid lines represent empirical findings and dotted lines refer to theorized links.

- Ancestral cold. The evolutionary significance of this variable has already been addressed and is represented by links 1-2 in the model. This factor could explain the latitude-wealth (link 3) and latitude-education (link 4) findings of the study in the Desert and Puna. Taking into account average temperature in Peru, the Desert is colder than the Puna. However, the Puna has a higher seasonal variance, as well as that between day and night. Whereas Desert temperature, though infrequently, may reach 0 ºC in the highest latitudes of Peru (i.e., Tacna), the Puna temperature may descend below 0 ºC in the night as an effect of altitude, reaching -9 ºC in Cusco and, occasionally, even -24 ºC in Puno (south). Since the northern Puna is not as high above sea level as the southern part, this latitude x altitude interaction determines an important north-south risk differential for human survival (link 5), announced by national newspapers each time they report children dying of cold in Puno (south), but not in Cajamarca (north). That the cold of the Peruvian Desert at the highest latitudes was intense enough to create a differential north-south survival risk, too, is a likely possibility.
- Ancestral altitude. According to Kanazawa (2010), general intelligence (*g*), i.e., the ability to reason deductively or inductively, think abstractly, use analogies, synthesize information, and apply it to new domains, is useful to solve

evolutionarily novel problems. These are the problems which were not present in the Sub-Saharan Africa savanna, i.e., the environment in which *Homo sapiens* as is known today lived over dozens of thousands of years prior to migrating and populating the rest of the world. In that interval, the human brain completed the development of abilities to automatically solve recurrent physical and social problems posited by human life in that habitat; for example, emotional or social intelligence. When *Homo sapiens* left that environment and faced evolutionarily new problems (e.g., soils lacking naturally growing food, altitude, freezing temperatures, etc.), abstract intelligence became more relevant to survival; that is, the new environments challenged humans and favored the survival and reproduction of the more *g*-intelligent individuals. Whereas cold has attracted most of the attention of evolutionary psychologists, altitude has been overlooked. This is also the case in economics; consider Nunn and Puga's (2009) finding that terrain ruggedness is positively related to economic development in Africa and their attribution of this relationship to the difficulties ruggedness posed to Europeans for the slave trade. That is, the devastation of African societies would have been diminished by rugged terrains. An alternative interpretation could consider that terrain ruggedness represented an evolutionarily novel situation that facilitated the survival and reproduction of those Africans able enough to make the most of that soil, thus improving their average *g* in the long term. In Peru, the agricultural terraces designed by the Incas for slopes greater than 6 degrees, which make agriculture impossible according to FAO (1993), speak of an ingenuity that helped survive and reproduce those endowed with the talent to initiate such a type of cultivation in Andean soil (link 6); this, of course, was later disseminated culturally. Hence, the Puna, due to the latitude x altitude interaction, may be the Peruvian ecoregion with the greatest latitudinal variance in IQ.[17]

- Migration. This variable is required to account for the finding of a significant latitude-education relationship in the Yunga, even though the effects of women's domestic power were discounted (link 7). Internal migration in Peru, especially in modern times, has been translongitudinal rather than translatitudinal. That is, people from the Cusco and Puno Punas have tended to migrate into the Cusco and Puno Yungas (south), and similar has been the case of Junín and Pasco in central Peru and Cajamarca in northern Peru. Hence, the latitude-intelligence

[17] It is possible that the Desert posited evolutionarily novel challenges to *Homo sapiens sapiens*'s survival when the El Niño climatic phenomenon destroyed its naturally food-producing valleys and, later, after they had invented agriculture, their crops. But the sea, and plenty of food, was there as an evolutionary novel opportunity for survival that the more intelligent Peruvians took advantage of. In contrast, the Amazon did not offer such opportunities. Consequently, the pre-Hispanic cultures of the Peruvian coast were considerably more developed than the Amazon's.

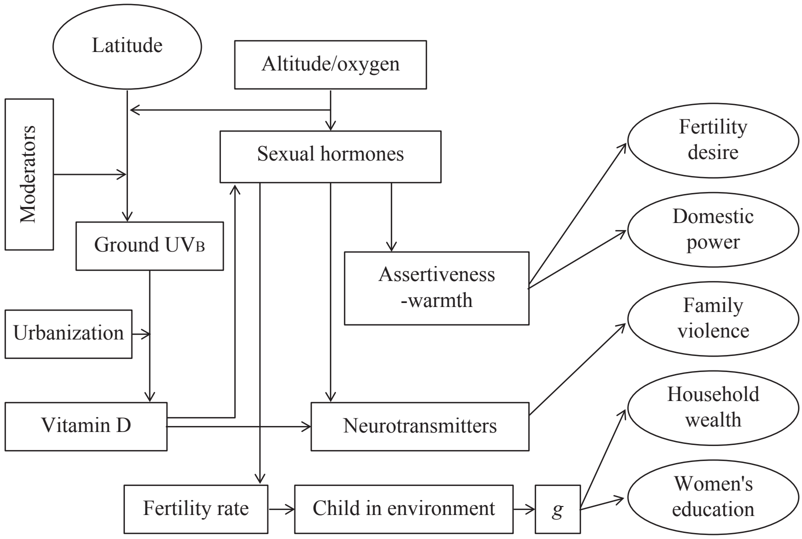
relationship theoretically generated in the Puna could have been transferred into the Yunga via migration. This hypothesis can be tested by comparison with the farther Amazon, in which no trace of latitude-education dependence was seen. Rindermann (2007) demonstrated that PISA scores are actually measures of *g*. The PISA scores collected by Peru's Ministry of Education can be analyzed to establish whether they increase from north to south in the Yunga, but not in the Amazon. Moreover, migration may have also strengthened the latitude-education and latitude-wealth relationships in the Desert (links 7-8), for westward migration from the Puna has been rather frequent; e.g., from Puno into Tacna and Moquegua (southern Peru), from Ayacucho and Junin into Ica and Lima (central Peru); and from Cajamarca into Lambayeque and La Libertad (northern Peru). That is, the latitude-wealth and latitude-education relationships observed in the Desert may have been transferred from, or, at least, reinforced by, migration from the Puna.

- Urbanization. Another characteristic of migration is that it generally takes place from rural to urban settings, which may help understand the recurring finding of greater effects of latitude on wealth in rural than urban environments of Peru in this study; such effects are not explained by current temperature. Consider the questionnaire responses of women born in the same place in which they were interviewed and where their ancestors lived over millennia versus the responses of women whose ancestors or who they themselves migrated translatitudinally over the past few centuries or years. Since migration tends to take place from rural to urban settings, rather than the other way around, people of towns and cities are more likely to be heterogeneous in the impact of ancestral cold on their genes than populations of rural areas. Therefore, there was probably more error in capturing effects of ancestral cold in urban settings in this study (links 9-10).

4.3. An explanation based on ultraviolet radiation and sexual hormones

An alternative interpretation considers the relationship between latitude and ultraviolet B (UV) radiation (see Figure 3). This component of sunlight decays from the Equator through the north and south poles as an effect of the rotational axis of Earth. For example, on May 29, 2012, it reached 13.4 in Quito, 8.8 in La Paz, 4.7 in Asunción, and 2.8 in Buenos Aires (TuTiempo.net 2012). Whereas infrared radiation affects temperature, UV radiation largely constitutes the main source of vitamin D in humans through a process of synthesis in skin and retina. (Dietary sources include oily fish and cod-liver oil.) At high latitudes, vitamin D is fabricated by the body in the summer and stored as fat for use in winter. A comparative advantage of UV radiation with respect to the evolutionary framework is that it parsimoniously explains a number of Peruvian findings in addition to accounting for the latitude-IQ covariance.

Figure 3. A UVB radiation theory of latitude's effects on fertility desire, domestic power, family violence, household wealth, and women's education in Peru



- The vitamin D hormone system controls the expression of more than 200 genes and the proteins they produce. Its regulatory role in the synthesis of sexual hormones has been demonstrated and attributed to the maintenance of the homeostasis of calcium (Kinuta, Tanaka, Moriwake, Aya, Kato, & Seino, 2000). Hence, vitamin D and human testosterone are closely related and vary together seasonally (Wehr, Pitz, Boehm, März & Obermayer-Pietsch, 2009). The production of testosterone and oestrogen declines from November through April in the northern hemisphere, i.e., during winter, and begins to increase continually in spring and summer (van Anders *et al.* 2006). This directly influences the rate of human conceptions (Cummings, 2007). Therefore, the greater and more continual exposure to UV radiation near the equatorial line explains my finding of a quarter of a century ago in the archaeological collections examined by Kauffmann-Doig (1979): a greater number of pre-Columbian ceramics with explicit sexual contents stemming from northern than southern Peru (León, 1986).
- Social norms widen or restrict the range of permissible behaviours according to the person's gender (Kabeer, 2001; Mason, 1998; Sen, 1999), while women's age, educational level, and work for cash strengthen their domestic power, and the age difference with their husbands weakens their autonomous decisions (Kishor & Subaiya, 2008). Since these factors were held constant in a study of latitude's effects on Peruvian women's economic control of their household environment, I attributed the observed latitude-dependent residual power to assertiveness,

a component of extraversion (Eysenck & Eysenck, 1985; Goldberg, 1973) which is stronger among males than females regardless of culture (Costa, Terracciano, & McCrae 2001) (see León, 2011b). Since sexual hormones make men more masculine and dominant and women more feminine and timid (McLean & Anderson, 2009), women's assertiveness can be expected to decrease with closeness to the Equator. Moreover, couples can be expected to be more egalitarian far from the equatorial line and more power-asymmetric near it. The latitudinal distribution of women's domestic power in Peru is consistent with this prediction (León, 2011b, 2012a). In psychological quarters, Costa and McCrae (1992) have regarded assertiveness and warmth as opposite poles of a single dimension. The finding of an increased desire for children by Peruvian women as they reside closer to the Equator (León, 1984, 1986, 2011a, 2012b), i.e., opposite to the latitude-domestic power relationship, is consistent with this concept, for desire for children can be equated with warmth (see Figure 3).

- Vitamin D has important effects on neurotransmitters such as dopamine and serotonin (Cass, Smith, & Peters 2006), while testosterone increases the production of dopamine among males (Hull, Muschamps, & Sato 2004); hence, vitamin D is a prime suspect of being a regulator of mood. Vitamin D seems to be part of the dynamics of seasonal affective disorder, a syndrome attributed to a deficit of exposure to sunlight in winter which is treated with light therapy (Rosenthal *et al.*, 1984; Gloth *et al.*, 2007). Related to it is the northern depression, highly prevalent in Scandinavian countries, excepting Iceland (Magnusson *et al.,* 2000). The deficit of UV radiation near the Artic accounts for the northern depression, and the exception can be attributed to the high rate of consumption of vitamin D-rich fish by Icelanders (FAO, 2006). In an extensive literature review on the vitamin D-depression link, Bertone-Johnson (2009) came to the conclusion that the epidemiological studies have produced mixed results, but high doses of supplemental vitamin D may improve mild depressive symptoms. Hence, I have recently interpreted the increased use of alcohol, tobacco, and coca leaf observed from north to south Peru 25 years ago (León 1987) as an expression of human efforts to deal with affective disorders caused by decreased exposure to UV radiation and the consequent deficit of vitamin D (León 2012a). This rationale led to the prediction of a positive relationship between family violence and absolute latitude which I confirmed in Peru, with the exception of the Amazon forest (León 2012b).

- The duration of vitamin D production depends not only on latitude, season, and exposure time, but also on total ozone, clouds, aerosols, surface reflectivity and altitude (Engelsen, Brustad, Asknes, & Lund, 2007). Given the presence of the cold Humboldt Current along the Peruvian coast and consequent cloudiness most of the year, I hypothesized and confirmed greater rates of family violence in the Pacific Desert than the Amazon forest of Peru after controlling for a number of social and demographic factors (León, 2012b). The other Peruvian regions with a latitudinal orientation are affected by high altitude. This variable potentiates UV radiation but, on the other hand, has negative effects on sexuality due to the associated deficit of oxygen. Exposure to high altitude reduces spermatogenesis (Gasco, Rubio, Chung, Villegas, & Gonzales, 2003) and plasma testosterone (Gonzales, Kaneku, & Góñez 1992). Similar effects probably occur with respect to levels of estrogen, for menarchy is delayed (Gonzales & Ortíz, 1994) and menopause takes place earlier (Gonzales & Villena, 1997) in comparison to lower altitudes. Thus, altitude has a place among the moderators of the latitude-surface UV relationship, but also as a direct influence on the synthesis of sexual hormones. The surface UV-vitamin D relationship, in turn, is moderated by urbanization, a variable associated with increased life under a roof and, hence, diminished exposure to UV radiation. As expected, urban populations of Peru present greater levels of women's domestic power (León 2011, 2012a, 2012b) and family violence (León, 2012b) than rural populations under conditions approximating *ceteris paribus*.

- UV radiation also provides an alternative explanation for the latitude-IQ link addressed by evolutionary psychologists: the lower levels of testosterone and oestrogen at higher latitudes can be expected to cause a diminished absolute fertility and greater birth-spacing. Larger household sizes were observed from south to north in this study. According to Zajonc and Markus' (1975) confluence theory, small families produce more intelligent children than large families; the theory states that the child's intellectual development depends on the cumulative effects of the intellectual home environment, which consists primarily of the siblings' and parents' mental age. The intellectual environment for a child is impoverished by the existence or addition of siblings, and the impact is greater at earlier ages (Zajonc & Bargh, 1980). Although different results are obtained from aggregate and individual data (Zajonc & Mullally, 1997; Wichman *et al*., 2006), the confluence theory holds under rigorous scrutiny (Zajonc & Sulloway, 2007).

4.4. Further research and suggested ways out of underdevelopment

The two theoretical frameworks used in the interpretation of the study's results are capable of generating specific and testable hypotheses. IQ and PISA scores increase from north to south in all major ecoregions of Peru, excepting the Amazon. The latitude-IQ and latitude-PISA relationships are stronger in rural than urban habitats, excepting the Amazon. The latitudinal variance of IQ and PISA scores is greater in the Puna than in any other ecoregion. Women's assertiveness as a personality trait increases from north to south in all ecoregions of Peru. Interest in sex and reproduction increases from south to north in all ecoregions of Peru. Women's assertiveness as a personality trait is stronger in the Desert and Puna than in the Yunga and Amazon. Interest in sex and reproduction is stronger in the Yunga and Amazon than in the Desert and Puna.

On more practical grounds, Sachs (2000) suggested possible ways out of underdevelopment attributable to geography, but his vision only encompassed the challenges posed by current temperature. The evolutionary framework of Lynn (2009), Rushton (2000), and Kanazawa (2008) suggests that similar efforts are needed to address the challenges posed by ancentral variables. Social scientists from tropical countries should imagine ways to overcome the negative effects of ancient factors on intellectual performance, rather than focusing exclusively on modern evils. This will demand a certain dosis of optimism concerning the immutability of latitude's effects. In the case of Peru, education is clearly more relevant than the technological solutions proposed by Sachs (2000) for Africa. Fortunately, there is research showing that mental abilities are improvable over the lifetime of individuals. Brinch and Galloway (2011) took advantage of the natural experiment created in Norway when an extra two years of schooling beyond the seventh grade began to be required; effects on IQ were substantial at age 19. Each year of schooling adds a significant amount to IQ (Ceci, 1991; Ceci & Williams, 2007; Feng, Spence & Pratt, 2007; Hansen, Heckman & Mullen, 2004; Winship & Korenman, 1997). This quantitative factor, in turn, may be synergic with an education that places its focus on the development of intellectual abilities, creativity, and moral strength by students rather than mere accumulation of knowledge (Sternberg & the Rainbow Project Collaborators, 2005). Quality of teaching in kindergarten has a measurable impact on academic success and life outcomes (Chetty, Friedman, Hilger, Saez, Schanzenbach & Yagan, 2010). Nisbett, Aronson, Blair, Dickens, Flynn, Halpern & Turkheimer (2012) recently reported an enhanced schooling program that affected IQ. This was a year-long program teaching a variety of reasoning skills to seventh-grade children in Venezuela (Herrnstein, Nickerson, Sanchez & Swets, 1986). The program had a very substantial effect on the individual reasoning skills taught and had a 0.4 standard deviation effect on intellectual ability as measured by typical tests. There has been no exact replication of this study, although Sanz de Acedo Lizarraga, Ugarte, Iriarte, & Sanz de Acedo Baquedano (2003) devised an extensive educational intervention that used the Herrnstein *et al.* (1986) materials. Sanz de Acedo Lizarraga *et al.* found substantial increases in several measures of intelligence, including the Culture Fair Intelligence Test (Cattell, 1973).

The Zajonc component of the UV radiation framework, in turn, implies that family planning programs, by reducing family size and thus improving the intellectual environment for the child at home, are probably causing positive intellectual outcomes all over the world. Unfortunately, family planning has had a sad history in Peru.

President Fujimori's regime (1990-2000) regarded family planning as a key tool for socioeconomic development. A law passed in 1995 made sterilization services available to women on a voluntary basis[18] and the Ministry of Health was instructed to be prepared. Expecting an overwhelming demand for sterilization services and seeking effectiveness, "…, the National Family Planning Program demand[ed] that all [public sector] providers… provide[d] contraceptive protection to a specified number of couples each month" (León, Monge, García, Zumarán & Ríos, 2001). Providers most likely felt implicitly induced to exert pressure on women to use contraception and this probably added to the motivation of well-intentioned health professionals preoccupied with the reproductive risk of women who had already had an unhealthy number of births. I frequently interacted with medical professionals who thought that women showing reproductive risk needed contraception whether they liked it or not. Moreover, given the poor quality of Peru's sterilization demand data and calculations, the Ministry was unable to validly establish when and where the explosive demand had already been met and pressure on its workers was no longer justified. Cases of poor-quality sterilization services that even led to deaths were documented and, in 1997, human rights groups, religious activists and feminists severely criticized providers in the Ministry of Health for coercing clients to accept long-acting methods. Addressing the U. S. Senate's concern about possible use of American aid funds by coercive programs, the Population Council conducted exhaustive research on the quality of family planning care at Peru´s national level. A need to supply Ministry of Health providers with new technical tools to assure quality services was identified (León, 1999) and a Balanced Counseling Strategy to strengthen the rigor of service delivery was devised and tested (León, Ríos, Zumarán & Bratt, 2003; León, Ríos & Zumarán, 2005). Yet, the conservative Toledo government which followed (2001-2006) virtually dismantled the national family planning program and subsequent governments have chosen to maintain a low profile in this area.

Zajonc's confluence theory strongly suggests that family planning should, again, become a national priority, this time as a strategy for enhancing the intelligence of future generations of Peruvians in addition to preventing teen pregnancy and attending to women's rights to access effective contraception. Not only lessons learned from past mistakes, but also improved tools which assure adequate service delivery (León, Brambila, De la Cruz, García Colindres, Morales & Vásquez, 2005; León, Vernon, Martin & Bruce, 2008) are now available.

[18] Previously, this contraceptive method was available to women only under extreme health conditions.

Table 1. Number of cases for Peruvian sample and five of Brack's ecoregions, per level of latitude

Latitude level	Peru[1]	Ecoregions				
		Desert	Steppe	Puna	Yunga	Amazon
2° 00' 01" - 4° 00' 00"	1,776					715
4° 00' 01" - 6° 00' 00"	2,487				564	374
6° 00' 01" - 8° 00' 00"	3,498	950	68	357	1,141	586
8° 00' 01" - 10° 00' 00"	3,609	804	297	708	686	1,054
10° 00' 01" - 12° 00' 00"	2,823	414	60	1,316	385	213
12° 00' 01" - 14° 00' 00"	8,013	3,232	75	2,821	1,018	1,009
14° 00' 01" - 16° 00' 00"	2,260	504	152	1,564	40	
16° 00' 01" - 18° 00' 00"	2,704	872	1,464	368		
18° 00' 01" – m°re	520	520				

[1] Includes all of Brack's land ecoregions (Desert, Steppe, Puna, Yunga, Amazon, Dry Equatorial Forest, Pacific Tropical Forest, High Plateau Páramo, and Palm Tree Savanna).

Table 2. Means for study variables, at national scale and per ecoregion

Variables	Peru[1]	Ecoregions			
		Desert	Puna	Yunga	Amazon
Household Wealth Score	.196	.987	-.406	-.212	-.112
Women's Literacy/Education	2.38	2.94	1.87	2.06	2.28
Absolute latitude	10.75	12.12	12.61	9.18	8.22
W longitude	-75.43	-76.38	-73.98	-76.21	-73.38
Temperature	15.77	10.64	13.78	20.13	25.85
Altitude	1,503,73	202.66	3,619.93	1,889.67	215.44
Urban setting	.613	.915	.314	.466	.652
Population density (at 1^0 x 1^0 cell)	246,315	602,663	93,731	56,960	14,519
Spanish as mother tongue	.868	.996	.610	.893	.939
Household size	5.75	5.55	5.75	5.92	6.04
Female head	.180	.207	.174	.160	.155
Born in place	.554	.566	.617	.501	.434
Woman work	.652	.633	.741	.657	.591
Woman age	29.41	29.65	29.52	28.95	28.80
Number of children	2.11	1.57	2.49	2.37	2.43
Listens to radio	2.19	2.33	2.07	2.20	1.99
(Lowest N)	(27,737)	(7,854)	(7,151)	(3,825)	(3,818)
Women's Domestic Power	1.25	1.36	1.24	1.14	1.13
(N)	(15,465)	(3,809)	(4,217)	(2,271)	(2,461)

[1] Encompasses nine Eco regions, including the Pacific Tropical Forest, Equatorial Dry Forest, Páramo, and Palm Savanna.

Table 3. Standardized coefficients from OLS regressions of Household Wealth Score and Women's Literacy/Education on latitude and 14 covariates (A), temperature and 14 covariates (B), and latitude, temperature, and 14 covariates (C) in Peru[1]

Variables	Household Wealth Score			Women's Literacy/Education		
	A	B	C	A	B	C
Absolute latitude	.329***		.324***	.227***		.227***
Temperature		-.179***	-.009		-.117***	.001
Urbanization	.646***	.320***	.636***	.348***	.127***	.349***
Absolute latitude x urbanization	-.186***	.198***	-.178***	-.193***	.070***	-.194***
Temperature x urbanization	-.092***	.078***	-.082***	.001	.112***	-.001
W longitude	-.079***	-.039***	-.079***	-.001	.027**	-.001
Altitude	-.151***	-.146***	-.152***	-.033***	-.030***	-.033***
Population density	.102***	.115***	.102***	.031***	.040***	.031***
Spanish as mother tongue	.103***	.082***	.102***	.218***	.204***	.218***
Household size	.057***	.054***	.057***	.018***	.016**	.018***
Woman head of household	-.040***	-.040***	-.040***	-.005	-.005	-.005
Age	.200***	.201***	.200***	.188***	.189***	.188***
Work	.002	.003	.002	.042***	.043***	.042***
Born in place	.020***	.020***	.020***	.052***	.052***	.052***
Number of children	-.252***	-.255***	-.252***	-.413***	-.415***	-.413***
Listens to radio	.099***	.097***	.099***	.125***	.123***	.125***
R^2	.663	.659	.663	.401	.399	.401
(N)	(25,329)	(25,329)	(25,329)	(25,230)	(25,230)	(25,230)

[1] All non-maritime ecoregions included. In this and the following tables, the intercept is omitted despite its inclusion in the equations.

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 4. Standardized coefficients from OLS regressions of Women's Literacy/ Education on absolute latitude and 14 variables (I) and on absolute latitude, 14 variables, and Household Wealth Score (II), per ecoregion

Variables	Desert		Puna		Yunga		Amazon	
	I	II	I	II	I	II	I	II
Absolute latitude	.377***	.236**	.469***	.396***	.392***	.266***	.010	-.031
Temperature	.119	.110	-.036	-.069*	.055	.053	-.045	-.054
Urbanization	.180**	.002	.671***	.369***	.528***	.220***	-.306	-.750
Abs. lat. x urbanization	-.116	.027	-.551***	-.469***	-.264**	-.154	.039	.109
Temp. x urbanization	-.041	-.011	.070	.132**	-.111	-.122	.483	.698
W longitude	-.207***	-.261***	-.109***	-.100**	-.143**	-.119*	.020	.011
Altitude	.024	.058***	-.022*	-.024**	-.012	-.007	-.044*	-.093***
Population density	.001	-.058***	.024*	.023*	-.026	-.042*	.004	.025
Spanish	.068***	.054***	.298***	.229***	.205***	.146***	.078***	.064***
Household size	.011	-.032**	.031**	.009	.021	.005	-.006	-.015
Head of household	-.040***	-.010	.014	.022*	.001	.018	.019	.028*
Age	.336***	.230***	.039**	-.020	.197***	.111***	.274***	.171***
Work	.049***	.056**	.036***	.037***	.022	.014	.104***	.088***
Born in place	.127***	.117***	-.013	-.013	.054***	.048***	.055***	.043***
Number of children	-.508***	-.377***	-.319***	-.247***	-.435***	-.327***	-.491***	-.356***
Listens to radio	.082***	.056***	.148***	.100***	.151***	.104***	.152***	.087***
HWS		.327***		.342***		.417***		.377***
R^2	.232	.300	.441	.490	.380	.455	.323	.390
(N)	(7,832)	(7,832)	(7,137)	(7,137)	(3,814)	(3,814)	(3,908)	(3,908)

*p < .05, **p < .01, ***p < .001.

Table 5. Standardized coefficients from OLS regressions of Household Wealth Score on absolute latitude and 14 variables (I) and on absolute latitude, 14 variables, and Women's Literacy/Education (II), per ecoregion

Variables	Desert		Puna		Yunga		Amazon	
	I	II	I	II	I	II	I	II
Absolute latitude	.429***	.331***	.210***	.095**	.301***	.188**	.104***	.105*
Temperature	.029	-.004	.096***	.106***	.005	-.009	.025	.035
Urbanization	.546***	.497***	.872***	.710***	.736***	.585***	1.187**	1.259***
Abs. lat. x urbanization	-.440***	-.407***	-.231***	-.100	-.264***	-.187**	-.181**	-.194***
Temp. x urbanization	-.091	-.079	-.179***	-.198***	.029	.045**	-.056***	-.699*
W longitude	.170***	.222***	-.027	.000	-.054	.059	-.582***	.018
Altitude	-.103***	-.111***	.007***	.013	-.012	-.015	.024	.142***
Population density	.184***	.183***	.003	-.004	.038*	-.008	.132***	-.057***
Spanish	.043***	.025**	.204***	.127***	.141***	.081***	.036**	.016
Household size	.132***	.129***	.065***	.057***	.038***	.032**	.023	.025*
Head of household	-.092***	-.080***	-.025**	-.027***	-.039***	-.040***	-.023*	-.027*
Age	.324***	.234***	.174***	.163***	.207***	.148***	.275***	.202***
Work	-.022*	-.035***	-.004	-.013	.019	.013	.040***	.014
Born in place	.031***	-.004	-.001	.002	.015	-.002	.032**	.018
Number of children	-.400***	-.263***	-.209***	-.127***	-.258***	-.130***	-.357***	-.228***
Listens to radio	.079***	.056***	.139***	.101***	.113***	.069***	.174***	.134***
WLE		.270***		.256***		.292***		.262***
R^2	.364	.421	.582	.619	.564	.617	.530	.577
(N)	(7,856)	(7,823)	(7,161)	(7,137)	(3,824)	(3,814)	(3,933)	(3,908)

*p < .05, **p < .01, ***p < .001.

Table 6. Standardized coefficients from OLS regressions of Household Wealth Score on absolute latitude and 14 variables (1) and on absolute latitude, 14 variables, and Women's Domestic Power (2), per ecoregion

Variables	Desert		Puna		Yunga		Amazon	
	I	II	I	II	I	II	I	II
Absolute latitude	.241*	.224*	.307***	.254***	.224**	.132	.075	.036
Temperature	-.073	-.072	.079*	.082*	-.054	-.023	.028	.033
Urbanization	.470***	.461***	.907***	.881***	.642***	.582***	1.179**	1.162**
Abs. lat. x urbanization	-.284*	-.272*	-.320***	-.385***	-.207*	-.111	-.118	-.084
Temp. x urbanization	.014	.014	-.152**	-.165***	.064	.041	-.621	-.644
W longitude	.194**	.200**	-.098**	-.079*	-.002	.003	.033	.026
Altitude	-.092***	-.091***	.019	.021*	-.013	-.004	.119***	.115***
Population density	.140***	.142***	-.003	.005	.044*	.047*	-.045**	-.043**
Spanish	.053***	.053***	.212***	.198***	.132	.138***	.037*	.026
Household size	.203***	.205***	.088***	.091***	.075***	.080***	.045**	.052***
Head of household	-.024*	-.025*	-.011	-.010	-.024	-.027	-.017	-.018
Age	.418***	.414***	.212***	.208***	.249***	.241***	.308***	.298***
Work	-.004	-.003	.028**	.026*	.053***	.042**	.063***	.058***
Born in place	.070***	.069***	.003	.005	.023	.022	.029*	.032*
Number of children	-.392***	-.386***	-.237***	-.235***	-.284***	-.280***	-.340***	-.341***
Listens to radio	.085***	.086***	.146***	.139***	.124***	.123***	.174***	.174***
WDP		.028*		.065***		.114***		.069***
R^2	.428	.430	.587	.590	.566	.577	.556	.558
(N)	(3,826)	(3,797)	(4,287)	(4,209)	(2,297)	(2,267)	(2,510)	(2,451)

*p < .05, **p < .01, ***p < .001.

Table 7. Standardized coefficients from OLS regressions of Women's Literacy/ Education on absolute latitude and 14 variables (1) and on absolute latitude, 14 variables, and Women's Domestic Power (2), per ecoregion

Variables	Desert		Puna		Yunga		Amazon	
	I	II	I	II	I	II	I	II
Absolute latitude	.308**	.284*	.517***	.464***	.398***	.307**	-.010	-.055
Temperature	-.017	-.014	-.063	-.062	.030	.072	.019	.052
Urbanization	.127	.120	.686***	.652***	.544***	.506***	.203	.365
Abs. lat. x urbanization	-.038	-.023	-.572***	-.529***	-.237*	-.158	.057	.083
Temp. x urbanization	.097	.090	.092	.081	-.125	-.161	-.023	-.235
W longitude	-.217**	-.205**	-.139**	-.130**	-.173**	-.160*	.031	.012
Altitude	.002	.001	-.024+	-.021	-.030	-.018	-.040	-.052*
Population density	.007	.008	.018	.020	.-.031	-.025	.006	.007
Spanish	.087***	.087***	.304***	.290***	.212***	.200***	.086***	.064***
Household size	.051***	.052***	.057***	.062***	.045*	.047*	-.004	-.002
Head of household	-.022	-.018	.040***	.037**	.001	-.003	.009	.013
Age	.194***	.189***	-.008	-.015	.111***	.101***	.170***	.144***
Work	.048***	.049***	.043***	.045***	.044*	.032	.109***	.095***
Born in place	.161***	.161***	-.014	-.012	.070***	.067***	.077***	.078***
Number of children	-.453***	-.450***	-.268***	-.266***	-.387***	-.380***	-.394***	-.383***
Listens to radio	.099***	.097***	.141***	.135***	.144***	.141***	.156***	.146***
WDP		.028+		.082***		.117***		.141***
R^2	.264	.264	.420	.427	.362	.373	.309	.323
(N)	(3,807)	(3,778)	(4,273)	(4,196)	(2,290)	(2,260)	(2,488)	(2,430)

+ $p < .06$, *$p < .05$, **$p < .01$, ***$p < .001$.

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