Research Article

Ethnic Digital Exclusion in Brazil: National and Regional Data from 2001 to 2004

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Abstract

This article presents an analysis of computer ownership and Internet access in Brazil from 2001 to 2004. Using a linear regression model to relate income and the probability of computer ownership and home Internet access, we show that African descents are 7% less likely to own a computer and 5% less likely to have home Internet access than are families of other ethnicities with the same total family income per capita. Likewise, if an African-descent family already owns a computer, there is still a 7% less probability of that family having Internet access from home. These gaps are reduced, but do not disappear when one adds education level or the presence of a child at home in the analysis. Regional differences for the 2004 data show that whether African descents make up the majority of the population is not statistically significant as a factor to explain the gap differences.

1. Introduction

According to Fuchs (2009),

> [T]he digital divide refers to unequal patterns of material access to, usage capabilities of, and benefits from computer-based information and communication technologies that are caused by certain stratification processes that produce classes of winners and losers of the information society. (p. 46)

Thus, the study of the digital inequalities involves two dimensions. The first is that of access, the values of which, in Fuchs's view, are material access, usage capabilities, and benefits. This dimension is layered in terms of importance with benefits considered the most important value. If one determines that two groups derive the same or equivalent benefit from using computer-based information and communications technologies, it is less important to establish if the two groups have the same or similar capabilities and almost unimportant to ascertain if they have different material access to these technologies. The access dimension is also layered in terms of causality—to reap the benefits of ICT, one needs the capabilities, and to develop one's capabilities, one needs material access. Of course, there is no determinism in this relation; that is, equal access does not necessarily equate to the same capabilities, but the lack of access will certainly determine the lack of capabilities. Other authors see the access dimension in different terms. For example, van Dijk (2005) sees it in terms of motivational access, physical access, skill access, and usage access. These concepts are not exactly similar to those of Fuchs, but they are also layered in terms of causality and importance. Warschauer (2004) sees the

access dimension in terms of physical, digital, human, and societal accesses.

The second dimension is that of stratification, or which groups or variables will be used to analyze the divide or inequalities. Researchers, including Hargittai (1999) and Fuchs (2009), among others, have compared countries among themselves and within a single country, researchers have compared groups according to standard demographic classifications, including income, age, gender, education, ethnicity, employment status and occupation, geographic region (especially the urban/rural dichotomy), family structure, and so on (Mossberger et al., 2003; Fairlie, 2004; van Dijk, 2005).

This article examines the access dimension in terms of material access and, in particular, a simpler form of material access—that of computer ownership and Internet access at home. Access to a computer and Internet from home is not the only form of material access. A person may have access to computers at school, at work, at paid or free Internet cafés, at a friend's or relative's home, or more recently, through mobile telephone services. But computer ownership is somewhat special among these other forms of material access for several reasons. First, computer ownership (and Internet access at home) was the first form of material access adopted in both scientific and public policy views of the "digital divide." Most of the published research still measures this form of access. Second, computer ownership seems to allow for a more autonomous use of the computer, and theoretically this should foster speedier development of the skills to better use these technologies. The third reason is a practical one: Computer ownership and Internet access from home are easy to define and easy to measure, as many countries regularly collect such data as part of their household surveys.

Our research on the stratification dimension concerns itself mainly with income and ethnicity. Income has been clearly recognized as a key factor to computer ownership (Hoffman & Novak, 1998). Families can decide to own a computer and obtain Internet access if they have enough disposable income to pay for these products and services, and if the perceived gains from such acquisitions are higher than the costs. Clearly, family income is the central aspect of the equation, but it is the second part, ethnicity, that interests us. There is a cultural component to how families perceive the benefits of owning computers and having Internet access, even to whether they consider such an acquisition. This perceived benefit can be seen as one of the aspects of van Dijk's motivational access; if one does not see the benefit to owning a computer, one has little motivation to purchase one. Different groups perceive these benefits of different form. For example, more educated families or those with young children tend to see more benefits and thus will be more likely to own computers than will families with the same disposable income, but who are less educated or who do not have young children (van Dijk, 2005).

Digital divide research that factors in ethnicity found it to be a significant source of inequalities regarding computer ownership (Hoffman & Novak, 1998; Wilson et al., 2003; Fairlie, 2004) and use of the Internet (Alvarez, 2003; Spooner & Rainie, 2000). Clearly, ethnicity carries/causes a strong cultural component (Nagel, 1994), but we are surprised that ethnic-related culture also defines preferences regarding computers and the Internet.

In very segregated societies, more of the culture is ethnically related, because the ethnic groups exchange little among themselves. The results discussed so far (and further examined in section 1.3) refer to the United States. Our goal, however, is to understand if the ethnic cultural component related to computer ownership and Internet access is also present in a less segregated society such as Brazil.

We have organized this article as follows: In section 1.1 we briefly discuss ethnicity in Brazil; section 1.2 presents a brief explanation of the Brazilian Household Sample Survey (PNAD), whose data we used; section 1.3 presents in detail the relevant research in digital inequalities related to ethnicity; section 1.4 defines explicitly the presuppositions, goals, and contribution of this research. Section 2 presents the details of the data and methods. Section 3.1 presents the national results and 3.2 a regional analysis. Section 4 discusses these results.

First, a note on this article's use of nomenclature: We will use the term *African descent* to refer to persons of the *preto* (black or negro) and *moreno* (brown or tanned) ethnic groups. That term has been used recently in Brazilian social movements by some participants within these ethnic communities to refer to themselves. We prefer it to "African-Brazilian" (Johnson, 1998), which we find too U.S.-centric, and to "black" (Telles, 2002; Bailey & Telles, 2006), which some readers may find offensive. We

will use the terms *white, Asian descent,* and *native,* respectively, to describe persons of the *branco* (white), *amarelo* (yellow), and *indigena* (native or indigenous) ethnic groups. We will also use *ethnicity* rather than *race,* although the latter term is more commonly used in the Brazilian literature on ethnicity (Htun, 2004; Bailey & Telles, 2006).

1.1 Ethnicity in Brazil

Brazil was the last country in the Americas to abolish slavery, in 1888, after receiving more than 4 million Africans as slaves over a period of three centuries (Heringer et al., 1989). If there have never been legal forms of segregation, nevertheless, the ethnic inequalities in Brazil are very high. There is a broad consensus that ethnic relations in Brazil have a distinct history and share characteristics with those of most other countries, including the U.S. Most authors agree that the concept of race in Brazil is more closely attuned to "appearance" than to "ancestry" and thus differ strongly from the American "one-drop rule" view. Many authors have discussed the similarities and differences of ethnic relations in Brazil and the U.S. (Degler, 1971; Skidmore, 2003; Andrews, 1992).

There are two main views on ethnic relations in Brazil (Motta, 2000). The first is mainly attributed to Freyre (1960), but it is also present in the work of Harris (1956) and Degler (1971). In essence, this view states that ethnic identities are less important in Brazilian society, and that miscegenation and mobility have created the category of moreno (brown or tanned) that epitomizes the ethnic ambiguity in Brazil. The three cited authors disagree on the causes of the ethnic ambiguity and their consequences. For example, Freyre used terms like *racial democracy* to point out the harmonious ethnic relations in Brazil. For his part, Harris did not claim that discrimination was absent in Brazil, but that it could be attributed more to class than to ethnicity. Degler proposed that the possibility of social mobility and inclusion of the moreno group, even if not "true in reality," is part of the Brazilian perception on ethnic relations, and it defuses the ethnic tensions. The international acceptance of the "racial democracy" view in the 1950s resulted in a series of UNESCO-funded ethnic research projects in Brazil (Wagley, 1952).

The second view, represented by the work of Hasenbalg (1979), does not see much difference between the *preto* and *moreno* categories, but instead of making historical or anthropological arguments, he shows that the two groups have similar demographic characteristics, and both of them compare negatively to whites. For example, using census data and statistical analysis, Halsenbalg showed that African descents in Brazil have fewer educational opportunities than whites, and even when they achieve equal educational levels, their salaries are lower. He attributed the inequalities to subtle forms of discrimination and racism. This is the approach followed more recently in ethnic studies in Brazil by Henriques (2001), Santos (2005), Campante et al. (2004), Telles (2004), and Bailey and Telles (2006).

Brazilian population survey questions ask respondents to classify themselves into one of five ethnic groups: *branco, moreno, preto, amarelo,* or *indigena.* The 2000 full population census determined that the proportion of the population in each of those groups is 53.8%, 39.1%, 6.2%, 0.5%, and 0.4%, respectively.

Regardless of the different views on ethnic relations, it is clear that, despite there not being (and never have been) institutionalized forms of segregation in Brazil, there are marked inequalities regarding ethnic groups. In 1996, fully 10.9% of white adults had 12 or more years of formal education, whereas only 2.4% of African-descent adults had that many years of formal education. Conversely, 11.8% of white adults and 26.2% of African-descent adults had no or less than one year of formal education (Heringer, 2002).

In 2004, the average monthly income of a white adult was 415.4 reals and the average monthly income of a person of African-descent was 237.7 reals. In the city of São Paulo alone, in 1999, the unemployment rate for African-descent males was 20.9%, whereas for white males it was 13.8% (Heringer, 2002). Lopes (2005) reported that, in 2000, the life expectancy at birth for a white infant was 73.99 years compared to 67.87 years for an African descent infant.

Of course, some, if not all of these inequalities, are correlated. If African-descent persons have lower educational levels, they would likely have a higher unemployment rate and lower average income, which could also be correlated to worse health. But Santos (2005) shows that ethnic-based differences in salary still exist, even when class, education level, years on the job, region, gender, and family status

are taken into consideration. Campante et al. (2004) reached similar conclusions. But whereas Santos focused on the ethnic salary gap in terms of a neo-Marxist concept of classes, Campante et al. focused on the regional differences, especially between the Northeast (where African descents are a majority) and the Southeast (where they are not).

1.2 National Household Sample Survey

The National Household Sample Survey (PNAD), conducted by the Brazilian Institute of Geography and Statistics (IBGE), has been carried out since 1967 (and annually since 1971). The PNAD collects data in the third trimester of each year and publishes the data and analysis the following year. The PNAD questionnaires feature two components: (1) a constant component to evaluate population, education, employment, income, and household conditions and (2) a variable/periodic component to evaluate aspects such as migration, marriages, fecundity, health, nutrition, and so on. The 2004 PNAD interviewed more than 400,000 people and more than 139,000 households. Once a household is selected to be surveyed, data on all household members are collected.

1.3 Related Research

As we have noted, some research has related ethnicity and digital exclusion. Fairlie (2004) used the 2000 Current Population Survey (CPS) to measure and explain the differences in computer ownership and Internet access from home for whites, African-American, and Mexican-American adults. The aggregate data for the 2000 CPS revealed that 70.4%, 41.3%, and 33% of these three ethnic groups, respectively, had access to a home computer, and 58.9%, 29.8%, and 22.1%, respectively, had Internet access at home. Fairlie (2004) used a variety of statistical models, which included, besides ethnicity, an interval-based classification for income, sex, education, marital status, presence of children, region, central city status, employment status, and occupational category. Fairlie concluded that income, education, marital status and children, and occupation explained about 22%, 9%, 6%, and 5%, respectively, of the gap between African-Americans and whites in computer ownership. Further, he noted that education, income, and occupation explained about 24%, 22%, and 7%, respectively, of the gap between Mexican-Americans and whites in computer ownership. However, about 50% of each of the two gaps could not be attributed to the independent variables considered. His work also considers other explanations for the unexplained portions of the gap, including price differences, different schooling experiences, language barriers, and so on.

Hoffman and Novak (1998) used the 1997 Commerce Net/Nielsen Internet Demographic Study to compare the gap between white and African-American computer ownership and Internet access and use. For computer ownership, they found that income differences explained this gap. But they also determined that ethnicity was a statistically significant factor in explaining computer ownership as a function of education: "Whites are still more likely to own a home computer than African Americans at each and every education level" (Hoffman & Novak, p. 391). For students, ethnicity was also a significant factor in explaining computer ownership, even when income was taken into consideration.

Wilson et al. (2003) surveyed 522 persons in North Carolina (the year is not noted) and analyzed computer ownership and Internet access at home and at other locations. The independent variables were ethnicity, gender, urban/rural home, age, education, children, and income. The study found that for computer ownership and home access to Internet, once controlled for income and education, ethnicity was the only other independent variable that had a significant impact.

Alvarez (2003) used the 2000 and 2002 General Social Survey to analyze differences in Internet use between African-Americans and whites and found that the two ethnic groups had similar levels of Internet knowledge, skill, and navigational sophistication. Somewhat different results were reported in Spooner and Rainie (2000). In 2000, African-Americans who had access to the Internet did not go online as often as whites. The choices by the two ethnic groups of what to visit or do on the Internet also differed.

As far as the authors have been able to determine, there is no research on ethnicity and the digital divide in developing countries.

1.4 This Research

There is a general methodological problem regarding research on computer ownership and home Internet access, in that these characteristics are

household properties, meaning that it is usually the household that has a computer, and clearly, it is the household that has an Internet connection. Furthermore, in most research, including ours, the data come from household surveys; that is, even if computers are owned by one or more members of the household, they show up as computers present in the household. However, the other variables of interest are *not* solely properties of a household: Age, gender, ethnicity, and occupation are characteristics of individuals; the presence of children can be a characteristic of families or households; and income can be a characteristic of individuals, families, and households. Therefore, a researcher has to prioritize one of the levels involved (household, family, or individuals) and map the properties of the other levels onto the one that is selected. There are always problems and presuppositions to each mapping. For example, if the researcher prioritizes individuals (as most do), the usual mapping is to say that an individual owns a computer and has Internet access if the household does. However, a particular individual may be a household servant or rent a room in the household, and therefore, may not have access to the computer and the Internet, thus contradicting the mapping algorithm that assigns computer ownership to that person. Or the individual may be a family son who earns minimum wage while attending night school and uses the computer/Internet, but who did not make the decision to buy the computer and did not purchase it with his own money. There are similar problems with older relatives, children, and so on.

In this article, we decided to prioritize the family level; that is, we transferred the relevant characteristics to families. To map households to families, we considered only single-family households and removed from the data all non-relatives living in the household. (The PNAD data classify households into single family or multigroups, and in the case of single family, classify the inhabitants as family-related or not.) Considering only single-family households, including people living by themselves, we simply transfer computer ownership and Internet access from the household to the family. We also consider the disposable income of the family to be the total household income divided by the number of family members. But the other variables characteristic of individuals are not so easily transferable to families; families do not have age, occupation, gender, and so on. Regarding ethnicity, we use the following mapping: If all members of the family are of the same ethnic group, we attribute it to the family; otherwise, we consider the family as multiethnic and remove it from analysis.

This article analyzes computer ownership and Internet access for single family households in which family members are of the same ethnic group, using total family income per capita and ethnicity as independent variables. Regarding the ethnic groups, we follow the modern approach in Brazilian ethnic research of grouping people who are self-declared *preto* and *moreno* into the single ethnic group of African descent. Finally, we only analyze the African-descent/non-African-descent frontier; the separate analysis of the Asian descent and indigenous ethnic groups did not have statistical significance, given the low proportions of these groups in the Brazilian population.

This research makes several contributions. It is the first research we are aware of that deals with a developing country in which the concept of ethnicity is more diverse than that of the U.S.; where African descents are not a minority of the population; where there has never been institutionalized segregation; and where ethnic tensions are, at least on the surface, less intense than in some other countries, despite there being significant ethnic inequalities as previously noted. Second, this is the first research that performs the analysis at the family level.

Our analysis uses all national data collected for 2001 to 2004 regarding the ethnic gap in computer ownership and Internet access. We also analyze the gaps for each of the Brazilian states for 2004, which have different proportions of African descent, to explore the relative importance of minority status in this ethnic gap.

2. Method

2.1 Data

The PNAD survey collects, among other things, data on each household regarding the presence of computers, Internet access, and total household income. For each inhabitant of the household, PNAD collects data such as age and race.

As discussed, we are interested in whether families decide to own computers or to have Internet access. As noted earlier, disposable income is probably the most important factor in this decision. Also, we are interested in the cultural aspects carried by ethnicity regarding these decisions. Thus, to evaluate

Table 1. Number of households after POS-processing for each year.

Year	Number of households included	Multiethnic households (excluded)	Multifamily households (excluded)	Maximum income
2001	69,069	22,456	7,865	2,300
2002	69,275	25,236	8,173	2,500
2003	71,244	25,260	7,886	2,666
2004	76,404	25,613	8,490	3,200

this, we made the following decisions regarding data:

- We eliminated all households that were not single family.
- We used the family total income divided by the number of persons in the family as the family's disposable income.
- We discarded all multiethnic families; that is, we discarded the households in which not all family members were African descent, or white, or Asian descent, or indigenous.
- We eliminated all households in which there was missing information regarding the variables of interests of this research: total family income, number of family members, ethnicity of each family member, ownership of computers, and Internet access in the household
- We eliminated the top 2% of higher-income families, as these families were responsible for very high residual errors in the linear regression, given that the income for each of these families was hundreds of times larger than the average income.

Table 1 shows the number of households included in our analysis after the elimination procedure just described, the number of multiethnic households (excluded from our data), and the proportion of African-descent population in the included data.

2.2 Analysis

To model computer ownership and Internet access from home, as discussed, we used the following linear equations:

$$\text{COMP} = \alpha_1 \times \text{INCOME} + \alpha_2 \times \text{AD} + \alpha_3 \quad (1)$$

$$\text{INTERNET} = \beta_1 \times \text{INCOME} + \beta_2 \times \text{AD} + \beta_3 \quad (2)$$

Variable COMP is *1* for families that own computers and *0* otherwise; INCOME is the total family income per capita; AD is *1* for families of African descent and *0* otherwise; and INTERNET is *1* for families that have Internet access from home. The coefficient α_2 is termed the *Computer Ethnic Probability Gap* (or CEPG), which can be viewed as how much more probable it is that an African-descent family would own a computer in comparison to a non-African-descent family with the same income. If the CEPG is negative, it indicates that an African descent family would be less likely to own a computer than would a non-African descent family with the same income.

Similar reasoning can be applied for the linear regression approximation to having Internet access from home, and the relevant coefficient β_2 is termed the *Internet Ethnic Probability Gap* (IEPG). Finally, we define a *Conditional Internet Ethnic Probability Gap* (CIEPG) as the coefficient of the Internet linear equation, when applied only to the families that already have computers. The CIEPG measures the increase or decrease in probability that an African-descent family would have Internet access, given that it already has a computer, in comparison to the probability of other African-descent families with the same disposable income. All statistical calculations were made using the statistical free software R.[1]

3. Results

3.1 National Results

Table 2 illustrates the ethnic probability gap for computers and for Internet use for the years 2001 to 2004. All results are statistically significant at the confidence level of 95%. Appendix A lists the statistical analysis of the coefficients of the OLS regression as reported by the R software program.

1. http://www.r-project.org

Table 2. Ethnic probability gap (2001 to 2004).

Year	Computer	Internet	Conditional Internet
2001	−0.054	−0.029	−0.040
2002	−0.066	−0.043	−0.076
2003	−0.070	−0.047	−0.062
2004	−0.076	−0.052	−0.069

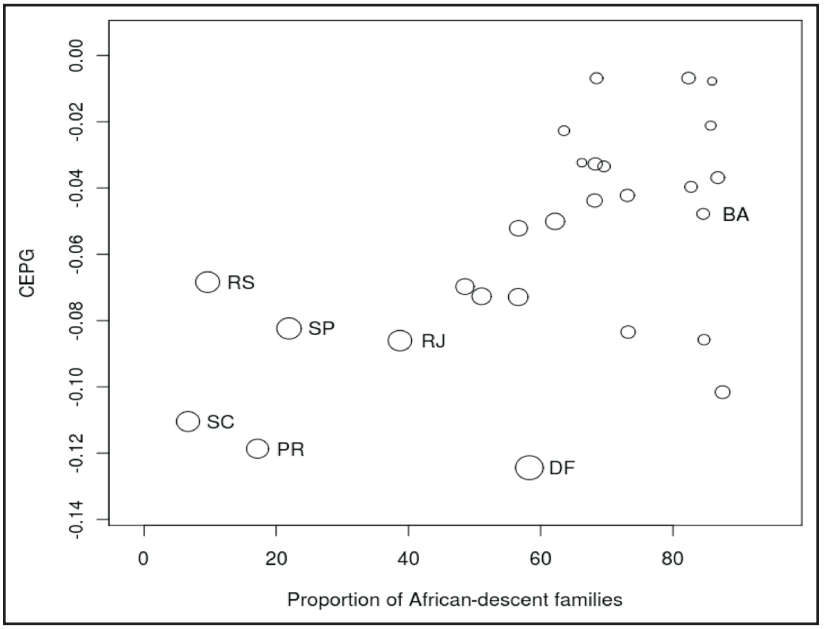

Figure 1. State CEPG as a function of the proportion of African descents for 2004. The size of the circle is proportional to the state average income.

3.2 Regional Results

We used the 2004 PNAD to calculate the CEPG and the IEPG for each of the 27 Brazilian states. Figure 1 shows the CEPG with the proportion of African descents in the state population. The radii of the circles in the figure are proportional to the state average household income. It also shows that in states where African descents are not a minority, the CEPG is closer to zero, but those are also the poorer states. Figure 1 displays the abbreviations of the richest states: RS (Rio Grande do Sul), SC (Santa Catarina), and PR (Parana) from the southern region; SP (São Paulo) and RJ (Rio de Janeiro) from the southeast region; and DF (Brasilia) from the midwest. It also shows BA (Bahia) from the northeast, one of the states with the largest proportion of African-descent families and the center of African-descent culture and social movements in Brazil.

Figure 1 seems to indicate that the CEPG decreases in absolute value with the increase of the African-descent proportion. But the CEPG also decreases with the decrease of the average income. The linear regression on the CEPG, as a function of the African descents proportion and of the average state income, shows that the only significant relation is with the mean income (see appendix A.4). That is, for poorer states, the differences regarding computers between the white and the African-descent ethnic groups diminishes. The same is true for the IEPG.

3.3 Other Socioeconomic Variables for 2004

We performed the same analysis (as described in section 2.2) for 2004, but added the educational level of the family, which is defined as the maximum number of years of education possessed by any of the family members, and whether the family had a child 10 years old or less. The resulting CEPG is displayed in Table 3. Appendixes A.5 and A.6 illustrate the full statistical analysis.

4. Discussion

This article shows that there is an ethnic gap in computer ownership in Brazil which is independent

Table 3. CEPG for 2004 with added socioeconomic variables.

Only income	Income and education	Income, education, and child
−0.076	−0.054	−0.054

of income and education, and more specifically, that African-descent families are less likely to own a computer and to access the Internet from home than are white families. The results in this article refer to families, but the gap remains when the analysis is performed at the individual level (results of which are not presented in this article). What are the possible explanations for this ethnic gap phenomenon?

One explanation could be that ethnicity, as collected by the PNAD survey, really stands for other socioeconomic variables, and that the inclusion of these variables will "explain away" the ethnic gap. In 2004, only 6.2% of African-descent families had computers, compared to 23.1% of non-African-descent families. By including income, the ethnic gap from African-descent families to non-African-descent families dropped from 16.9% to 7.6%. By factoring education on top of income, the gap shrank even further, from 7.6% to 5.4%. Then is it not the case that by including other socioeconomic variables, the gap would reduce to zero? This view would claim that there is no intrinsic ethnic gap, and that ethnicity is so strongly correlated to other socioeconomic variables (due to segregation, oppression, history, and other reasons) that when all these variables are taken into consideration, the gap will disappear. We do not believe this hypothesis to be true. Other researchers (Hoffman & Novak, 1998; Alvarez, 2003; Wilson et al., 2003; Fairlie, 2004) have found that an ethnic gap remains, even when other socioeconomic variables are considered. Our experiments with adding the presence of children in the family show that there seems to be a limit as to how much the gap reduces. Further research in this line should add other socioeconomic variables, such as the type of work performed by the head of the household, but we do not believe that these variables will explain away the gap.

A second possible explanation admits that the ethnic gap is real, and that, indeed, African-descent families are less likely to own computers due to their ethnicity, but that is not necessarily an issue regarding computers alone but the consumption of goods in general. It may be that African-descent families have consumer values that make them less likely to be early adopters of some technology; that is, only after they perceive a relatively large number of adopters among their peers will they adopt that technology. A prosaic reason to be a late adopter is that they may feel insecure about their job/income stability and may feel uncomfortable making large consumer expenses.

A third explanation might claim there is something different or special about computers that may not initially appeal to African-descent families. They would be late adopters of computers because ownership of computers is particularly less interesting to them. Again, the explanation can be prosaic: Because one's friends and their families do not have computers (and Internet access), there is less incentive to own one. In fact, a survey of Internet users in 2005 CETIC.br (2005) discovered that different forms of communication (email, social networking Web sites, and blogs) comprise the most common uses of the Internet in Brazil. If one belongs to a community that does not use Internet, there is little incentive to start using it, and that may be the case for the African-descent families. The large values of the CIEG may be further evidence toward this network effect; even when they already have computers, African-descent families are less likely to have Internet access than are non-African-descent families.

We do not support the first possible explanation, and we have no data that would lead us to choose either of the latter two explanations. Further research on consumer habits and expenditures of African-descent families may provide evidence in favor of or against the second hypothesis. Qualitative research on opinions of African-descent families toward computer ownership and Internet use may provide evidence to support the third hypothesis.

There is an important limitation to this research: We are using computer ownership and Internet access from home as a proxy for the physical access metric discussed in the Introduction. But that is an incomplete proxy, in that members of African

descent families may be accessing computers and the Internet in other places, such as public and free Internet cafes, school, work, via mobile phones, and so on. Our research has not evaluated these alternatives. Research on Brazilian *telecentros* (free Internet cafés) that collected statistical data on users (Albuquerque, 2005; Selaimen, 2004) included no ethnic variables that could be used to start evaluating whether African descents use telecentros in higher proportion to compensate for their lower access to computers at home. Mobile phone access to the Internet seems important for some countries, especially Japan, Korea, and Finland (Ishii, 2003), even in the period in question, from 2001 to 2004. However, we could not find public data on the number of mobile Internet users in Brazil during this period, or how they were ethnically divided. Nevertheless, we believe mobile Internet access was probably not an important form of access during the period in question, as 3G mobile phone technologies were not introduced in Brazil until 2004.

The main contribution of this research is the realization that the ethnic gap (discovered by others) in American society, where African Americans are a minority and are/were segregated, and thus form a more cohesive culture, is also in place in Brazil, where African-descent families are not a minority, and where segregation is/was less pronounced. Table 1 shows that the number of multiethnic families, which are a significant proportion of families with a single ethnicity, is a strong indication of how less segregated Brazil is.

This work also points out opportunities for further research. The main question still to be answered is why do these ethnic probability gaps exist? We believe that the further exploration of the two hypotheses we formulated could prove to be interesting lines of research. The results of regional differences also deserve further analysis, as there are large differences in the CEPG across different states. Though we have shown that the variations in mean income better explain these differences, we cannot yet state that the proportion of African-descent families to other ethnic groups is not a component in the explanation of these state differences. An interesting follow-up analysis could be to compare states with similar mean income but different CEPG for other explanatory variables, such as segregation level.

Finally, the results of this article may have practical implications to actions that could mitigate the digital divide within the country. If the third hypothesis we posed is correct—that there is resistance on the part of African-descent families in Brazil to owning computers and having Internet access from home—then understanding the source of this resistance may speed the introduction of computers to these families. ■

Appendix A: Statistical Analysis of the Ethnic Probability Gap Coefficients

A.1 Computer Ethnic Probability Gap

2001

Coefficients:

	Estimate	Std. Error	t value	Pr(>ltl)
(Intercept)	1.860e-02	1.927e-03	9.654	<2e-16 ***
income	3.800e-04	3.041e-06	124.957	<2e-16 ***
ad	−5.448e-02	2.244e-03	-24.281	<2e-16 ***

Signif. codes:0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2808 on 69066 degrees of freedom.
Multiple R-squared: 0.2218, Adjusted R-squared: 0.2218.
F-statistic: 9843 on 2 and 69066 DF, p-value: <2.2e-16.

2002

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	3.172e-02	2.023e-03	15.68	<2e-16 ***
income	3.711e-04	2.856e-06	129.95	<2e-16 ***
ad	−6.618e-02	2.354e-03	−28.12	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2968 on 69687 degrees of freedom
Multiple R-squared: 0.2359, Adjusted R-squared: 0.2359
F-statistic: 1.076e+04 on 2 and 69687 DF, p-value: <2.2e-16

2003

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	3.669e-02	2.120e-03	17.31	<2e-16 ***
income	3.533e-04	2.766e-06	127.73	<2e-16 ***
ad	−7.026e-02	2.384e-03	−29.47	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3039 on 71564 degrees of freedom.
Multiple R-squared: 0.2302, Adjusted R-squared: 0.2301.
F-statistic: 1.07e+04 on 2 and 71564 DF, p-value: <2.2e-16.

2004

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	4.271e-02	2.134e-03	20.01	<2e-16 ***
income	3.393e-04	2.558e-06	132.65	<2e-16 ***
ad	−7.603e-02	2.377e-03	−31.99	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3114 on 75164 degrees of freedom.
Multiple R-squared: 0.2351, Adjusted R-squared: 0.235.
F-statistic: 1.155e+04 on 2 and 75164 DF, p-value: <2.2e-16.

A.2 Internet Ethnic Probability Gap

2001

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	−9.221e-03	1.629e-03	−5.662	1.50e-08 ***
income	3.119e-04	2.570e-06	121.384	< 2e-16 ***
ad	−2.928e-02	1.896e-03	−15.441	< 2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2373 on 69066 degrees of freedom.
Multiple R-squared: 0.203, Adjusted R-squared: 0.203.
F-statistic: 8796 on 2 and 69066 DF, p-value: <2.2e-16.

2002

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	8.231e-04	1.757e-03	0.468	0.64
income	3.210e-04	2.481e-06	129.397	<2e-16 ***
ad	−4.304e-02	2.045e-03	−21.051	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

Residual standard error: 0.2579 on 69687 degrees of freedom.
Multiple R-squared: 0.2264, Adjusted R-squared: 0.2264.
F-statistic: 1.02e+04 on 2 and 69687 DF, p-value: <2.2e-16.

2003

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	5.168e-03	1.868e-03	2.767	0.00566 **
income	3.114e-04	2.438e-06	127.744	<2e-16 ***
ad	−4.732e-02	2.101e-03	−22.520	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2678 on 71564 degrees of freedom.
Multiple R-squared: 0.222, Adjusted R-squared: 0.2219.
F-statistic: 1.021e+04 on 2 and 71564 DF, p-value: <2.2e-16.

2004

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	8.121e-03	1.885e-03	4.308	1.65e-05 ***
income	3.030e-04	2.259e-06	134.106	<2e-16 ***
ad	−5.250e-02	2.100e-03	−25.007	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2751 on 75164 degrees of freedom.
Multiple R-squared: 0.2305, Adjusted R-squared: 0.2305.
F-statistic: 1.126e+04 on 2 and 75164 DF, p-value: <2.2e-16.

A.3 Conditional Internet Ethnic Probability Gap

2001

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	4.894e-01	9.863e-03	49.615	<2e-16 ***
income	2.345e-04	9.876e-06	23.740	<2e-16 ***
ad	−4.020e-02	1.403e-02	−2.866	0.00417 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4538 on 7900 degrees of freedom.
Multiple R-squared: 0.07086, Adjusted R-squared: 0.07063.
F-statistic: 301.2 on 2 and 7900 DF, p-value: <2.2e-16.

2002

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	0.5598989	0.0085461	65.515	<2e-16 ***
income	0.0001957	0.0000078	25.086	<2e-16 ***
ad	−0.0757665	0.0120371	−6.294	3.23e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4353 on 9266 degrees of freedom.
Multiple R-squared: 0.07252, Adjusted R-squared: 0.07232.
F-statistic: 362.2 on 2 and 9266 DF, p-value: <2.2e-16.

2003

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	5.942e-01	8.165e-03	72.768	<2e-16 ***
income	1.739e-04	7.127e-06	24.398	<2e-16 ***
ad	−6.287e-02	1.096e-02	−5.735	1.00e-08 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4261 on 9973 degrees of freedom.
Multiple R-squared: 0.06416, Adjusted R-squared: 0.06397.
F-statistic: 341.9 on 2 and 9973 DF, p-value: <2.2e-16.

2004

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	5.992e-01	7.587e-03	78.967	<2e-16 ***
income	1.658e-04	6.184e-06	26.815	<2e-16 ***
ad	−6.962e-02	9.919e-03	−7.019	2.37e-12 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4222 on 11196 degrees of freedom.
Multiple R-squared: 0.06881, Adjusted R-squared: 0.06864.
F-statistic: 413.7 on 2 and 11196 DF, p-value: <2.2e-16.

A.4 CEPG, Mean Income, and Proportion of Population of African Descent

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	4.350e-02	4.062e-02	1.071	0.294806
meanIncome	−2.458e-04	6.383e-05	−3.852	0.000766 ***
propAD	−1.610e-02	3.087e-02	−0.522	0.606674

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02311 on 24 degrees of freedom.
Multiple R-squared: 0.5714, Adjusted R-squared: 0.5357.
F-statistic: 16 on 2 and 24 DF, p-value: 3.843e-05.

A.5 Computer Ethnic Gap with Education Level 2004

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	−1.560e-01	3.109e-03	−50.17	<2e-16 ***
income	2.513e-04	2.640e-06	95.18	<2e-16 ***
AD	−5.422e-02	2.291e-03	−23.66	<2e-16 ***
Education	2.387e-02	2.811e-04	84.92	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2975 on 74883 degrees of freedom.
Multiple R-squared: 0.3016, Adjusted R-squared: 0.3016.
F-statistic: 1.078e+04 on 3 and 74883 DF, p-value: <2.2e-16.

A.6 Computer Ethnic Gap with Education and Presence of Children 2004

Coefficients:

	Estimate	Std. Error	t value	Pr(<ltl)
(Intercept)	−1.608e-01	3.199e-03	−50.263	<2e-16 ***
income	2.561e-04	2.742e-06	93.365	<2e-16 ***
AD	−5.464e-02	2.291e-03	23.845	<2e-16 ***
Education	2.360e-02	2.843e-04	83.024	<2e-16 ***
Child	1.496e-02	2.344e-03	6.383	1.74e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2974 on 74882 degrees of freedom.
Multiple R-squared: 0.302, Adjusted R-squared: 0.302.
F-statistic: 8101 on 4 and 74882 DF, p-value: <2.2e-16.

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