This appendix consists of three parts. First, we explain the procedure for computing “net” differences in home computer access and network service use, and we present a table with “gross” and “net” differences. Second, we explain our approach to statistical tests of the significance of widening or narrowing of gaps between 1993 and 1997. Third, we present additional material, not discussed in the main body of the report, on the purposes for which individuals use home computers.

**NET DISPARITIES ACROSS SOCIOECONOMIC GROUPS**

The focus of Citizens, Computers, and Connectivity is on disparities across socioeconomic groups in their access to a home computer and their use of network services. As briefly outlined in the main text, tabulations based on raw data may lead to misleading conclusions. For example, in order to assess the impact of income on the diffusion of computers, it would be misleading only to look at disparities across income groups. Part of the gap between low- and high-income families may stem from other socioeconomic characteristics, such as educational attainment. To account for the effects of all other predictor variables of interest, we employ a multivariate regression technique. The six characteristics of interest are household income, educational attainment, race and ethnicity, age, sex, and location of residence (urban or rural).
Both outcome variables, presence of a home computer and use of network services, are binary (yes/no) variables. The use of linear regression techniques, such as ordinary least squares (OLS) or analysis of variance (ANOVA), would be inappropriate, since these do not guarantee that predicted fractions are between 0 and 1. The statistical models most commonly used to estimate binary outcomes are the logistical regression (logit) and probit models. The choice between them is largely arbitrary; we opted for the logit model (Maddala, 1983).

The procedure is as follows. First, we estimate multivariate logit models to explain, say, the presence of a home computer using the six categorical predictor variables listed above. Second, to determine net disparities by, say, sex, for each individual in the sample, we predict the probability that he or she has a home computer under the counterfactual assumption that everyone is female. That is, if everyone were female, but otherwise with the same characteristics that he or she actually has, what would be the probability that each person would have a computer? Third, we average these predicted probabilities over all individuals in the sample to obtain the predicted fraction of the population that would have a computer if everyone were female. This prediction is repeated under the counterfactual assumption that everyone is male, and averaged over all individuals in the sample to obtain an estimate of the fraction having a computer among males. The resulting fractions are termed net fractions, as they represent differences that are due only to sex, controlling for all other socioeconomic characteristics of interest. This procedure is repeated for the other five socioeconomic predictor variables. The same procedure is used to compute net percentages of network service users.

Table A.1 shows logit coefficient estimates of 1997 presence of a home computer (column 1) and network service use (column 3). (Columns 2 and 4 are explained below.) Positive values indicate a greater propensity to have a home computer or make use of network services. The omitted category is a non-Hispanic white male age 20 to 39 who lives in a rural area and is a high school graduate (but not a college graduate) with a household income in the bottom quartile. Note that most coefficients are highly significant, in part because of the very large sample sizes (143,129 individuals in 1993 plus 123,249 in 1997).
## Table A.1
### Logit Estimates

<table>
<thead>
<tr>
<th></th>
<th>Access to Home Computer</th>
<th>Use of Network Services</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>-1.4651 ***</td>
<td>-1.0032 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0258)</td>
<td>(0.0388)</td>
</tr>
<tr>
<td><strong>Second income quartile</strong></td>
<td>0.7279</td>
<td>0.0055</td>
</tr>
<tr>
<td></td>
<td>(0.0224)</td>
<td>(0.351)</td>
</tr>
<tr>
<td><strong>Third income quartile</strong></td>
<td>1.4398 ***</td>
<td>-0.1316 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0213)</td>
<td>(0.0331)</td>
</tr>
<tr>
<td><strong>Top income quartile</strong></td>
<td>2.2376 ***</td>
<td>-0.0826 *</td>
</tr>
<tr>
<td></td>
<td>(0.0230)</td>
<td>(0.0341)</td>
</tr>
<tr>
<td><strong>Income not reported</strong></td>
<td>0.7223 ***</td>
<td>0.3332 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0264)</td>
<td>(0.0429)</td>
</tr>
<tr>
<td><strong>Enrolled in school</strong></td>
<td>0.1532 ***</td>
<td>0.0925 *</td>
</tr>
<tr>
<td></td>
<td>(0.0326)</td>
<td>(0.0464)</td>
</tr>
<tr>
<td><strong>High school dropout</strong></td>
<td>-0.5159 ***</td>
<td>0.0602</td>
</tr>
<tr>
<td></td>
<td>(0.0268)</td>
<td>(0.0409)</td>
</tr>
<tr>
<td><strong>College graduate</strong></td>
<td>0.7375 ***</td>
<td>0.0309</td>
</tr>
<tr>
<td></td>
<td>(0.0190)</td>
<td>(0.0261)</td>
</tr>
<tr>
<td><strong>Hispanic</strong></td>
<td>-0.8745 ***</td>
<td>0.0941 *</td>
</tr>
<tr>
<td></td>
<td>(0.0244)</td>
<td>(0.0392)</td>
</tr>
<tr>
<td><strong>Black</strong></td>
<td>-0.9630 ***</td>
<td>0.2622 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0231)</td>
<td>(0.0344)</td>
</tr>
<tr>
<td><strong>Native American</strong></td>
<td>-0.1609 *</td>
<td>-0.4800 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0731)</td>
<td>(0.1333)</td>
</tr>
<tr>
<td><strong>Asian</strong></td>
<td>0.1654 ***</td>
<td>-0.0435</td>
</tr>
<tr>
<td></td>
<td>(0.0344)</td>
<td>(0.0494)</td>
</tr>
<tr>
<td><strong>Age 0–19</strong></td>
<td>0.2872 ***</td>
<td>-0.0928 *</td>
</tr>
<tr>
<td></td>
<td>(0.0316)</td>
<td>(0.0452)</td>
</tr>
<tr>
<td><strong>Age 40–59</strong></td>
<td>0.0104</td>
<td>0.0311</td>
</tr>
<tr>
<td></td>
<td>(0.0177)</td>
<td>(0.0249)</td>
</tr>
<tr>
<td><strong>Age 60+</strong></td>
<td>-1.0046 ***</td>
<td>0.0673 *</td>
</tr>
<tr>
<td></td>
<td>(0.0234)</td>
<td>(0.0349)</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>0.0018</td>
<td>-0.0065</td>
</tr>
<tr>
<td></td>
<td>(0.0133)</td>
<td>(0.0188)</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td>0.2179 ***</td>
<td>0.1028 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0178)</td>
<td>(0.0254)</td>
</tr>
<tr>
<td><strong>Location missing</strong></td>
<td>0.1984 ***</td>
<td>0.1107 ***</td>
</tr>
<tr>
<td></td>
<td>(0.0236)</td>
<td>(0.0325)</td>
</tr>
</tbody>
</table>

**NOTES:** Standard errors in parentheses. Significance: * = 5 percent; ** = 1 percent; *** = 0.1 percent.
We estimated similar logit equations for access to a home computer and use of network services at home or work for 1989 and 1993 and computed net rates, as explained above. For each set of predictor variables, Table A.2 shows gross and net rates of home computer penetration and use of network services.

**DID DISPARITIES BECOME SMALLER OR LARGER BETWEEN 1993 AND 1997?**

We want to determine whether the gaps between socioeconomic groups have widened or narrowed from 1993 to 1997. There are several alternative approaches. For example, we could measure the gap in home computer penetration as the percentage point penetration difference between two groups. For individuals in the lowest and highest income quartiles, 1993 home computer penetration was 7 and 55 percent, respectively, i.e., the gap was 48 percentage points. By 1997, these figures had risen to 15 and 75 percent, respectively, yielding a gap of 60 percentage points. According to this definition, the gap has widened. Alternatively, we could measure the gap as the duration necessary for the disadvantaged group to achieve the penetration level of the advantaged group. Let’s explore this definition further.

Figure A.1 shows a stylized home computer penetration model. The penetration rate of new technologies tends to follow a logistic pattern, and we assume that home computers and network use are no exception. Any individual jumps discretely from 0 (no home computer) to 1 (home computer), but population groups as a whole tend to move along the curve from zero penetration to some asymptote, which may or may not be 100 percent. Consider individuals in the lowest income quartile who move from 7 percent in 1993 (Q193) to 15 percent in 1997 (Q197), while those in the top quartile move from 55 percent (Q493) to 75 percent (Q497). During the same time period, the percentage point gap grew from 48 to 60 percent, but did the gap really widen? The growth rate in the lower part of the curve is lower than just above the center, so equal-paced movement to the right implies a widening percentage point differential. If equal-paced growth continues, though, the shape of the curve ensures that the penetration rates will converge.
<table>
<thead>
<tr>
<th></th>
<th>Home Computer</th>
<th>Network Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom quartile</td>
<td>5.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Second quartile</td>
<td>9.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Third quartile</td>
<td>18.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Top quartile</td>
<td>35.0</td>
<td>28.7</td>
</tr>
<tr>
<td>Educational attainment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school dropout</td>
<td>6.1</td>
<td>11.4</td>
</tr>
<tr>
<td>High school graduate</td>
<td>14.3</td>
<td>16.1</td>
</tr>
<tr>
<td>College graduate</td>
<td>31.9</td>
<td>26.5</td>
</tr>
<tr>
<td>Race and ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>7.7</td>
<td>10.3</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>20.2</td>
<td>19.1</td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>8.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Native American</td>
<td>7.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Asian</td>
<td>24.1</td>
<td>20.0</td>
</tr>
<tr>
<td>Age category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-19</td>
<td>21.5</td>
<td>23.5</td>
</tr>
<tr>
<td>20-39</td>
<td>17.5</td>
<td>16.2</td>
</tr>
<tr>
<td>40-59</td>
<td>22.1</td>
<td>18.5</td>
</tr>
<tr>
<td>60+</td>
<td>5.5</td>
<td>7.7</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18.9</td>
<td>18.1</td>
</tr>
<tr>
<td>Female</td>
<td>16.6</td>
<td>17.3</td>
</tr>
<tr>
<td>Location of residence</td>
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<td></td>
</tr>
<tr>
<td>Rural</td>
<td>13.2</td>
<td>15.5</td>
</tr>
<tr>
<td>Urban</td>
<td>19.0</td>
<td>18.1</td>
</tr>
</tbody>
</table>

Table A.2
Gross and Net Percentages of People Who Have Access to a Home Computer and Use Network Services at Home or Work
Our multivariate logit models follow this penetration model. Column 1 of Table A.1 indicates that the 1997 logit-propensity to have a home computer of the top quartile exceeds that of the bottom quartile (omitted category) by 2.2376, i.e., the horizontal distance between Q497 and Q197 is 2.2376; it is significantly different from zero at 0.1 percent. We estimated the same model using 1993 data; the estimates in column 2 are the difference between 1993 and 1997 coefficient estimates.\(^1\) In other words, estimates for 1993 are the sum of columns 1 and 2. The propensity to have a home computer in 1993 was 2.2376 - 0.0826 = 2.1550 larger for the top income quartile than for the bottom. We present the 1993 incremental (marginal) coefficients, rather than the actual coefficients, because doing so enables us to determine whether the change in the relative propensity was significant. For both home computer presence and use of network

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\(^1\)To be precise, we estimated both columns simultaneously on pooled 1993 and 1997 data, where column 1 coefficients applied to all data and column 2 to 1993 data only.
services, we find that the gap widened between 1993 and 1997. The wider gap for access to a home computer is significant at 5 percent; the increased gap for use of network services was insignificant. In either case, the gap did not widen substantially.

One way to interpret the horizontal axis is in terms of the period by which one group lags another. Note that the change in the Constant coefficient of column 2 is –1.0032, i.e., the population as a whole moved 1.0032 units to the right between 1993 and 1997. This corresponds to the population-weighted average distance between groups' positions in 1993 and 1997, i.e., the average of Q197 – Q193, Q497 – Q493, and so on for the other quartiles. If the population keeps moving to the right at 1.0032 units every four years, the 1993 bottom quartile may be said to lag behind the top quartile by (1997 – 1993)*2.1550/1.0032 = 8.6 years; by 1997, this lag had increased to 8.9 years. The time gap in use of network services is much shorter: At the rate of adoption experienced between 1993 and 1997, the bottom income quartile may be expected to achieve usage rates equal to those of the top income quartile in just 2.1 years. Thus interpreted, the coefficient estimates in Table A.1, columns 2 and 4, are direct measures of narrowing or widening of gaps. Table 1 on page 29 summarizes changes in gaps from 1993 to 1997 using these data. Only differences that are significant at a 5 percent confidence level or better are recorded as changes.

THE USE OF HOME COMPUTERS

We conclude with extensive tabulations of various dimensions of home computer access and use. For individuals with a home computer, Table A.3 shows the average age of the (newest) computer in years. Overall, the stock of home computers in the United States is, on average, just two years and three months old. About one out of four computerized households has more than one computer. For each individual age 3 or older living in a household with a computer, the CPS asks whether that individual uses the computer directly. Overall, 71.2 percent of those with a home computer use the computer directly.
### Table A.3

**Computer Use at Home (percent)**

<table>
<thead>
<tr>
<th>Have more than one comp. in household</th>
<th>Among Those with a Home Computer</th>
<th>Among Those Who Directly Use the Home Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.24</td>
<td>24.8</td>
<td>71.2</td>
</tr>
<tr>
<td>60.9</td>
<td>40.0</td>
<td>35.9</td>
</tr>
</tbody>
</table>

#### Sex

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.19</td>
<td>2.22</td>
</tr>
<tr>
<td>Est. average of newest comp. (yrs)</td>
<td>26.2</td>
<td>24.2</td>
</tr>
<tr>
<td>Use comp. for any purpose</td>
<td>72.0</td>
<td>70.3</td>
</tr>
<tr>
<td>Have word processing</td>
<td>57.0</td>
<td>64.9</td>
</tr>
<tr>
<td>Book-</td>
<td>42.3</td>
<td>37.3</td>
</tr>
<tr>
<td>keep., finance, taxes, household records</td>
<td>39.1</td>
<td>33.9</td>
</tr>
<tr>
<td>Desktop pub., newsletters</td>
<td>16.3</td>
<td>17.1</td>
</tr>
<tr>
<td>Games</td>
<td>66.4</td>
<td>58.5</td>
</tr>
<tr>
<td>Graphic design</td>
<td>24.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Databases</td>
<td>27.4</td>
<td>21.2</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>30.2</td>
<td>23.1</td>
</tr>
<tr>
<td>Internet, other on-line service</td>
<td>47.9</td>
<td>38.0</td>
</tr>
<tr>
<td>Connect to comp. at school</td>
<td>12.9</td>
<td>8.3</td>
</tr>
<tr>
<td>Work at home</td>
<td>35.0</td>
<td>28.2</td>
</tr>
<tr>
<td>School assignments</td>
<td>28.5</td>
<td>31.3</td>
</tr>
<tr>
<td>Learning to use comp.</td>
<td>19.3</td>
<td>20.3</td>
</tr>
<tr>
<td>Total Use comp. $+/days per week</td>
<td>37.7</td>
<td>29.9</td>
</tr>
</tbody>
</table>

#### Age category

<table>
<thead>
<tr>
<th></th>
<th>0-19</th>
<th>20-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
<th>60+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.13</td>
<td>2.02</td>
<td>2.11</td>
<td>2.25</td>
<td>2.45</td>
<td>2.82</td>
</tr>
<tr>
<td>Est. average of newest comp. (yrs)</td>
<td>24.8</td>
<td>22.6</td>
<td>23.8</td>
<td>28.9</td>
<td>28.1</td>
<td>21.4</td>
</tr>
<tr>
<td>Use comp. for any purpose</td>
<td>71.6</td>
<td>75.8</td>
<td>76.3</td>
<td>72.1</td>
<td>65.7</td>
<td>54.1</td>
</tr>
<tr>
<td>Have word processing</td>
<td>41.6</td>
<td>71.3</td>
<td>68.7</td>
<td>71.4</td>
<td>73.4</td>
<td>88.1</td>
</tr>
<tr>
<td>Book-</td>
<td>5.6</td>
<td>35.1</td>
<td>48.3</td>
<td>46.5</td>
<td>48.2</td>
<td>49.3</td>
</tr>
<tr>
<td>keep., finance, taxes, household records</td>
<td>20.5</td>
<td>47.9</td>
<td>45.7</td>
<td>43.9</td>
<td>44.3</td>
<td>36.5</td>
</tr>
<tr>
<td>Desktop pub., newsletters</td>
<td>8.9</td>
<td>16.3</td>
<td>19.3</td>
<td>18.9</td>
<td>18.0</td>
<td>13.4</td>
</tr>
<tr>
<td>Games</td>
<td>81.0</td>
<td>59.6</td>
<td>58.3</td>
<td>50.4</td>
<td>43.7</td>
<td>46.4</td>
</tr>
<tr>
<td>Graphic design</td>
<td>18.4</td>
<td>24.0</td>
<td>27.7</td>
<td>27.3</td>
<td>25.8</td>
<td>20.8</td>
</tr>
<tr>
<td>Databases</td>
<td>9.3</td>
<td>23.0</td>
<td>27.0</td>
<td>28.0</td>
<td>30.3</td>
<td>24.3</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>9.4</td>
<td>26.4</td>
<td>31.1</td>
<td>30.8</td>
<td>30.7</td>
<td>24.1</td>
</tr>
<tr>
<td>Internet, other on-line service</td>
<td>34.7</td>
<td>48.3</td>
<td>45.6</td>
<td>44.3</td>
<td>42.5</td>
<td>33.9</td>
</tr>
<tr>
<td>Connect to comp. at school</td>
<td>2.7</td>
<td>17.2</td>
<td>15.8</td>
<td>14.9</td>
<td>13.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Work at home</td>
<td>7.1</td>
<td>26.4</td>
<td>39.2</td>
<td>39.2</td>
<td>41.2</td>
<td>22.8</td>
</tr>
<tr>
<td>School assignments</td>
<td>57.3</td>
<td>36.1</td>
<td>19.3</td>
<td>19.2</td>
<td>8.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Learning to use comp.</td>
<td>23.6</td>
<td>17.5</td>
<td>18.9</td>
<td>17.4</td>
<td>17.3</td>
<td>17.7</td>
</tr>
<tr>
<td>Total Use comp. $+/days per week</td>
<td>29.3</td>
<td>38.6</td>
<td>35.0</td>
<td>34.7</td>
<td>36.6</td>
<td>39.1</td>
</tr>
</tbody>
</table>

#### Education

<table>
<thead>
<tr>
<th></th>
<th>&lt;High school</th>
<th>HS graduate</th>
<th>College grad.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.19</td>
<td>2.23</td>
<td>2.25</td>
</tr>
<tr>
<td>Est. average of newest comp. (yrs)</td>
<td>23.2</td>
<td>21.4</td>
<td>31.2</td>
</tr>
<tr>
<td>Use comp. for any purpose</td>
<td>69.2</td>
<td>66.7</td>
<td>82.5</td>
</tr>
<tr>
<td>Have word processing</td>
<td>58.0</td>
<td>65.5</td>
<td>79.0</td>
</tr>
<tr>
<td>Book-</td>
<td>8.9</td>
<td>40.3</td>
<td>49.1</td>
</tr>
<tr>
<td>keep., finance, taxes, household records</td>
<td>25.9</td>
<td>39.0</td>
<td>52.8</td>
</tr>
<tr>
<td>Desktop pub., newsletters</td>
<td>8.1</td>
<td>15.0</td>
<td>21.6</td>
</tr>
<tr>
<td>Games</td>
<td>69.7</td>
<td>58.3</td>
<td>46.4</td>
</tr>
<tr>
<td>Graphic design</td>
<td>19.7</td>
<td>25.0</td>
<td>27.4</td>
</tr>
<tr>
<td>Databases</td>
<td>8.5</td>
<td>22.1</td>
<td>32.4</td>
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<tr>
<td>Spreadsheets</td>
<td>31.5</td>
<td>23.9</td>
<td>36.2</td>
</tr>
<tr>
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### Table A.3 (continued)

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</table>
For those who use a computer at home, the CPS then asks how often and for what purposes the individual uses the computer. The most common use, at 62.8 percent, is to play games, followed closely by word processing. Other popular uses are bookkeeping or keeping track of finances, taxes, or household records; connecting to the Internet; sending e-mail; working at home; and doing school assignments. Home computers appear to be used quite intensively: about one out of three home computer users reports using it at least five days per week. Three out of four use it at least two days per week (not shown in the table).