Abstract

This paper summarizes inequalities in PC ownership using data from the US Consumer Expenditure Survey (CE) and the British General Household Survey (GHS) for the period 1984-98. Between 1988 and 1994, British households were more likely than US households to own a personal computer (PC). After 1994, however, US PC ownership rates accelerated rapidly, pushing the United States ahead of Britain. Differences in computer ownership rates are however much larger *within* the two countries, measured by income, education, age, family status, and race. Both the United States and Britain show large and growing inequality in PC ownership over the 1980s and 1990s. Analysis of ownership patterns of four other household consumer durables suggests that there may be significant limitations to relying solely on the market to eradicate PC inequality quickly.

Key words: Inequality, Personal Computers
JEL Classification Number: J6

Acknowledgements

John Schmitt is a Research Associate, Economic Policy Institute, Washington, DC. Jonathan Wadsworth is affiliated to Royal Holloway College, University of London and the Centre for Economic Performance, London School of Economics.

Address for correspondence: Jonathan Wadsworth
Centre for Economic Performance
London School of Economics
London WC2A 2AE
Tel: +44 (0207) 955 7063
E-Mail: jschmitt@epinet.org
j.wadsworth@lse.ac.uk

Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

© John Schmitt and Jonathan Wadsworth, submitted November 2001

ISBN 0 7530 1924 8

Individual copy price: £5

Give PC's a Chance: Personal Computer Ownership and the Digital Divide in the United States and Great Britain

John Schmitt and Jonathan Wadsworth

April 2002

1. Introduction 1

2. The Data 3
   2.1 US Consumer Expenditure Survey 3
   2.2 British General Household Survey 3

3. Differences in Average PC Ownership Rates 4

4. Differences in the Distributions of PC Ownership 5

5. Lessons from Ownership Patterns for Other Consumer Durables 12

6. Conclusions 16

Tables 17
Figures 27
Appendix 36
References 41

The Centre for Economic Performance is financed by the Economic and Social Research Council

1. Introduction

Personal computers (PCs) have become emblematic of the "new economy", the series of economic developments that, especially since the middle of the 1990s, have been both praised for raising labour productivity and widely blamed for widening economic inequality. To date, research on PCs has generally taken two directions. The first has analysed the impact of the use of PCs in the workplace on the employment and wages of workers, especially on the potentially different impact PCs might have on workers with different educational backgrounds.[1] The second strand of PC research has concentrated on the distribution of PC ownership – the "digital divide" – across households, with by far the greatest attention on the situation in the 1990s.[2]

In this paper, we build on this earlier "digital divide" research by adding two comparative components. First, we compare the diffusion pattern of PC ownership, concentrating on the level of, and changes in, household PC inequality in the United States in the 1980s and 1990s and in Great Britain over the same period. The analysis of Britain is valuable on its own terms, since little research has examined PC inequality there. The comparison is also interesting because the United States and Great Britain are the two advanced capitalist economies that experienced the largest rise in income inequality over the last two decades. The second comparative component of the paper is between the pattern of household adoption of PCs and those of other consumer durables (video cassette recorders, microwave ovens, motor vehicles, and washing machines). The comparison of diffusion dynamics by income potentially has much to say about current and future trends in PC inequality.

We draw several conclusions from our analysis. First, from 1988 though 1994, Britain had a higher PC ownership rate than the United States. After the mid-1990s, the United States overtook Britain, but the gap remained relatively small, especially considering substantially lower household incomes and substantially higher prices for PCs in Britain.

---

[1] See, for example, Autor, Katz, and Kruerg (1998); Berman, Bound, and Griliches (1994); Berman, Bound, and Machin (1998); Katz and Autor (1999); Krueger (1993), and Machin and Van Reenan (1998), among others. For the view that PCs have not had a major impact on inequality in the 1980s and 1990s, see: DiNardo and Pischke (1997); Handel (1999); Howell (1999) and Mishel and Bernstein (1994).

[2] See, for example, Kominski and Newburger (1999), National Telecommunications and Information Administration (1999; 2000), and US Bureau of the Census (1988; 1991; 1999). DeNew and Schmidt (2001), have undertaken an analysis of the diffusion pattern of PC's at the workplace in Germany over a similar period to ours, though their focus is not explicitly on inequality of ownership.

Second, patterns of PC inequality within the two countries are very similar. In both countries, large PC-ownership gaps exist across income, education, age, family type, and even racial categories. In general, inequality in the "new economy" appears to closely track that of the old economy.

Third, inequality of PC ownership increased almost continuously in both countries in the 1980s and 1990s. In 1988, US households in the top income quintile were 18.7 percentage points more likely to own a computer than were households in the bottom quintile. By 1998, the gap had risen to 48.6 percentage points. Over the same period, the gap between the top and bottom in Britain grew from 21.8 to 45.8 percentage points.

Fourth, differences in computer ownership *within* the two countries are much larger than differences *between* the two countries. We estimate that by 1998, Britain was about 1.7 "years behind" the United States with respect to the rate of computer ownership. In that same year, using the same measure, in the United States, the bottom income quintile was 10 years behind the top income quintile, while in Britain, the bottom income quintile was more than 14 years behind the top.

Fifth, comparisons of the diffusion patterns of PCs with those of other consumer durables argue that PC inequality could get worse before it gets better and that a significant degree of PC inequality is likely to remain in both countries even in the long run. In the short- and medium-term, the highest income quintiles in the United States and Great Britain show no signs of having reached PC "saturation", suggesting that ownership rates may continue to grow for these groups, raising the potential for widening ownership gaps between the top and the bottom in both countries. In the long run, the diffusion patterns of other consumer durables emphasize that markets for more expensive consumer durables typically reach "saturation" at a level where a significant minority of the population has not "adopted" the new technology. These same diffusion patterns also show stable long-run gaps in adoption rates across income quintiles.

The paper proceeds as follows. The second section describes the US Consumer Expenditure and the British General Household Survey data sets analysed here. The third section compares the *average* rate of PC ownership between the two countries from 1988 through 1998. The fourth section analyses differences between the two countries in the *distributions* of PC ownership over the same period. The fifth section contrasts the diffusion of PC ownership in the 1980s and 1990s with the ownership rates of four other consumer durables. The final section concludes with some observations on the implications of the findings for public policy and future research.

2. The Data

The main dataset for this analysis pools household-level information from the US Consumer Expenditure survey (CE) and the British General Household Survey (GHS) for the years 1984-98. The combined dataset provides information on PC ownership, ownership of other consumer durables, and detailed household characteristics including income, education, age, race, and family type that are consistent both across countries and over time for the longest possible period currently available.

2.1. US Consumer Expenditure Survey

The source of almost all data for the United States is the annual CE survey for 1984-98. The CE surveys collect detailed, nationally representative information on household characteristics and consumer expenditures from approximately 5,000 households each quarter.[3] The CE also asks households if they have a variety of household "appliances," including a "computer, not solely for games"[4] (from 1987 only), a washing machine, a microwave oven (from 1987), and a "video tape recorder, video disc player, or video cassette recorder" (from 1987). Separately, the CE asks households if they own "vehicles not used exclusively for business."

2.2. British General Household Survey

The source of almost all British data is the GHS, a nationally representative survey of about 8,000 households. We analyse annual GHS data for 1984-96 and for the last three quarters of 1998 and the first quarter of 1999 (referred to in the text as 1998).[5] The computer-ownership

[3] Households participate in the survey for five consecutive quarters. We use responses from the households' fifth quarter in the survey. Beginning in 1999, the CE sample was expanded to about 7,000 households. The data analyzed here include household responses collected in the first quarter of 1999 referring to expenditures made in 1998.

[4] The exact question reads: "Does your C[onsumer] U[nit] have any of the following appliances?" If the household answers "yes", with respect to any of the appliances, the interviewer then asks: "How many?" and "Was this (Were any of these) 1. Purchased for own use? 2. Included with own house? 3. Received as a gift? 4. Included with rental unit? 5. Rented separately?" To avoid problems associated with the phase-in of the computer question and to take advantage of the generally higher-quality responses associated with the interviews from households' fifth quarter in the survey, we have excluded 1987 from the computer analysis.

[5] The GHS was not undertaken in 1997.

question in the GHS, which was first asked in 1984, is almost identical to the question in the US CE survey. The GHS asks respondents: "Does your household have any of the following items" including an option for "Home computer (exclude video games)." As with the US CE survey, the GHS inventory also includes washing machines, microwave ovens, and video cassette recorders. The GHS separately asks households about their ownership of cars and vans.

All other personal and household characteristics are made consistent across both data sets. Income data in both datasets have been equivalised by dividing gross monthly household income by the square root of the number of individuals living in the household.

3. Differences in Average PC Ownership Rates

Table 1 and Figure 1 show the average PC ownership rates in the United States and Great Britain from 1984 through 1998. The most striking feature of the data is that, from 1988 through 1994, Britain had a higher PC ownership rate than did the United States. In 1988, 17.2% of British households owned a computer, compared to just 10.2% of households in the United States.[6] The United States overtook Britain sometime in 1995, when ownership rates in both countries had reached about 25%.[7] From 1995 on, PC ownership rates accelerated in both countries, but growth was especially strong in the United States. By 1998, about 41% of US households and 34% of British households had a PC.[8]

[6] We were initially concerned that these results might reflect idiosyncratic features of the measurement of PC ownership in the CE and GHS surveys. Estimates of PC ownership rates from separate sources, however, give almost identical rates to those presented here. While these other sources do not provide annual figures on PC ownership for the full period available from the CE and GHS surveys, these alternative data sets do provide independent confirmation of our general findings. Figure A1 in the appendix compares annual data for the United States from the CE with data from the Current Population Survey (CPS) for 1984, 1989, 1993, 1994, 1997, and 1998. The CPS and CE data track each other closely. Figure A2 compares British ownership rates from the GHS for 1984-98 with rates from the British Household Panel Survey (BHPS) for 1991-98. The GHS and BHPS estimates of ownership rates are also close to each other. The conclusion that Britain led the United States with respect to PC ownership does not appear to be an artefact of the data sets we have chosen to analyse.

[7] PC ownership in the United States accelerated rapidly at about the same time (1995-96) that individual access to the internet through private internet service providers also started to become widespread. A slower development of private ISPs in Britain may help to explain the relatively slow growth in PC ownership in Britain after 1995.

[8] Data from a supplement to the US Current Population Survey in August 2000 suggests that about 51% of US households owned a computer at that time.

International comparisons of technology sometimes refer to how many "years behind" one country trails another. Table 1 uses the national PC ownership rates to calculate one measure of the number of years that Britain lags "behind" the United States with respect to PC ownership. We take the PC ownership rate in Britain in a given year and calculate how many years earlier the United States achieved the same ownership rate.[9] In the table, "years behind" has a negative sign if Britain is "behind" the United States and a positive sign if Britain is "ahead". By this measure, in the middle of the 1980s, Britain was about four years *ahead* of the United States. The British lead, however, eroded steadily through 1994-1995; by 1998, Britain had fallen about 1.7 years behind the United States.

The early British lead in PC ownership, and even the relatively narrow US-British gap in ownership rates at the end of 1990s, are especially remarkable given the substantial differences in incomes and computer prices in the two countries. In 1998, GDP per capita in Britain was, on a market-exchange-rate basis, about 26% below, and, on a purchasing-power-parity basis, about 34% below that of the United States.[10] At the same time, a common rule of thumb holds that a PC costs the same number of pounds in Britain as it would cost dollars in the United States. If true, this rule implies that at the end of the 1990s, PCs were about 50% more expensive in Britain than they were in the United States. Given lower incomes and higher prices in Britain, high British rates of PC ownership suggest that "tastes" for computers may be significantly greater in Britain than they are in the United States. (We return to the impact of national income differences on PC ownership rates below.)

4. Differences in the Distributions of PC Ownership

The average ownership rates in the preceding analysis mask important disparities within the United States and Britain with respect to income, education, age, family type, race, and other household characteristics. In this section, we analyse differences in the distribution of PC ownership within the two countries. The available data suggest that the pattern of PC-ownership inequality is broadly similar in the United States and Great Britain. In both

[9] When the rate in Britain falls between the US rates in consecutive years, we use linear interpolation to calculate a fraction of a year.

[10] Mishel, Bernstein, and Schmitt (2001), Tables 7.1 and 7.2.

countries, PC-ownership inequality is closely linked to inequality in the "old economy", including education, age, family type, and race.

Table 2 presents several basic indicators of the inequality of PC ownership for the United States and Great Britain in the years 1988 (the first year where data are available for both countries), 1994 (the year when the United States first reached the average British PC ownership rate), and 1998 (the last year in our sample). The first line of the table shows the "income concentration ratios" derived from the cumulative PC ownership rates by income centiles graphed in Figures 2A and 2B. These concentration ratios, which are similar in spirit to Gini coefficients,[11] show PC-ownership inequality falling in the United States between 1988 and 1994 and, then falling further, but only slightly, between 1994 and 1998. The corresponding data for Britain show a declining concentration ratio between 1988 and 1994, followed by a sharp rise in concentration between 1994 and 1998, to a level above the original level of 1988. Figure 2A contrasts the general rise in ownership across all income centiles in the United States, with the steeper rises amongst the upper income centiles in Britain over time. By 1998, the degree of inequality, at least as measured by the concentration ratio, appeared to be about the same in the United States (0.282) and Great Britain (0.285).

The second and third lines of Table 2 report the share of all computers owned by the richest and the poorest deciles of equivalised household income.[12] In the United States, the share of all computers owned by the top income decile fell from 21.7% in 1988 to 18.5% in 1998; over the same period, the share owned by the bottom decile rose slightly, from 6.2% to 6.9% of all PCs. By contrast, in Britain, the share of all computers owned by the top decile grew steadily from 17.0% in 1988 to 20.1% in 1998, while the share of PCs owned by the bottom decile grew from 3.0% in 1988 to 5.5% in 1998.[13]

The concentration ratios and the data on ownership rates presented in Table 2, however, provide only limited insight into the PC-ownership distributions in the two

[11] The concentration ratio can be negative, depending on ownership patterns across income centiles, but it remains true that the closer the (absolute) value is to zero, the smaller the degree of (relative) inequality.

[12] Here we assume each household reporting owning a PC owns only one PC. To the extent that multiple PC ownership is positively correlated with income, the figures in Table 2 underestimate PC concentration.

[13] Note that, in both countries, the ownership rates for the poorest decile in the last line of Table 2 are above the PC ownership rates for the poorest quintile in Table 3. This implies that the poorest decile has a higher level of PC ownership than the second decile. We believe that this reflects relatively high PC ownership rates among income-poor young people (students and recent school leavers) concentrated at the very bottom of the income distribution.

countries. Table 3 summarizes PC-ownership rates by income, education, age, family type, and racial groups in 1988, 1994, and 1998. In both countries, the general pattern of inequality in 1998 and the change in inequality over the 1988-98 period are remarkably similar.

Turning first to the general pattern of inequality in 1998, PC ownership appears to rise strongly and continuously with a household's income[14] and education level. In 1998, about 71% of US households in the top quintile owned a PC, compared to just 22% of those in the bottom quintile. In the same year, in Britain, 61% of households in the top quintile owned a PC, compared to only 15% in the bottom quintile. In both countries, by the end of the sample period, about 65% of households headed by a university graduate had a PC, compared to only 11% of those with less than a secondary-school education in the United States and 18% of those in Great Britain.

PC ownership also appears to be concentrated among "prime-age" households. In 1998, in both countries, over half of households with heads in the 40 to 54 year-old range owned a PC. Fewer than 20% of the elderly in the United States and fewer than 10% in Britain had their own PC. Younger households are also at a disadvantage in both countries, with ownership rates for households with heads between 16 and 24 years of age considerably below those of prime-age households.

PC ownership also varies in a similar way across family types in both countries. Married couple families with children were the most likely to have a PC (62% in the United States; 57% in Great Britain), followed by married couple families with no children (42% in the United States; 34% in Great Britain). Single-female households were the least likely to have their own PC (23% in the United States; 13% in Great Britain).

The only area where the similarity in ownership patterns breaks down is with respect to race and ethnicity. In the United States, whites were significantly more likely than were non-whites to own a PC. In Great Britain, which has a much smaller non-white population, however, PC ownership rates were higher for non-whites.

Changes between 1988 and 1998 in key "PC-ownership gaps" also followed very similar patterns in both countries. Table 4 uses the PC ownership rates by household characteristics in Table 3 to calculate PC-ownership "gaps", in percentage-point terms, across

[14] We use equivalent income here, dividing gross household income by the square root of the number of occupants.

groups by income, education, age, family type, and race. Table 5 reports the marginal effects from standard probit equations corresponding to the raw PC-ownership gaps in Table 4.

Despite some indication of declining inequality using the basic inequality measures presented in Table 2, these absolute PC-ownership gaps across most groups grew substantially between 1988 and 1998. In the United States, the ownership gap between the top and bottom income quintiles grew from 19 percentage points in 1988 to 49 percentage points in 1998; over the same period, the corresponding gap in Great Britain rose from 22 percentage points to 46 percentage points (see also Figures 3A, 3B, and 4A). The gap between educational levels grew by comparable levels. In 1988, the difference in PC-ownership rates between those with a university degree or more and those with less than a complete secondary-school education grew from 19 percentage points in both the United States and Great Britain to 55 percentage points in the United States and 48 percentage points in Great Britain (see also Figures 3C, 3D, and 4B).

Changes in the pattern of PC-ownership gaps by age and family type, however, differed somewhat in the two countries. In the United States, between 1988 and 1998, the ownership gap by age grew strongly for the elderly (from 15 percentage points in 1988 to 34 percentage points in 1998), and much less so for those in the 16-24 and 55-64 year-old ranges. The PC gap for 25-39 year olds, meanwhile, did not change at all. In Great Britain, over the same period, the ownership gap also rose substantially for the elderly, but it fell slightly for 55-64 year olds,[15] and was almost unchanged for 16-24 year olds. The gap for 25-39 year olds, however, rose. (See also Figures 3E, 3F, and 4C.)

Ownership gaps between married couple families with children and all other types rose substantially in the United States between 1988 and 1998. In Great Britain, however, the pattern is not well defined. Using the raw ownership rates in Table 4 (see also Figure 4D), the gap for married couple families without children fell; the gap for single males was basically unchanged; and the gaps for single females and single-parent families with children increased only slightly. However, using the coefficients from the probit equations in Table 5, which control for basic household characteristics including income, changes in gaps between married couple families and other types of families were much closer to those in the United States. The gap for married couple families without children rose slightly; the gap for single males doubled from about 10 to about 20 percentage points; and the gaps for single females and single-parents with children also increased substantially.

[15] The probit equations reported in Table 5 show a slight increase for 55 to 64 year olds.

Taken together the results from Tables 3, 4, and 5 show a distribution of PC ownership in 1998 and changes in the pattern PC inequality between 1988 and 1998 that are very similar in the United States and Great Britain. PC ownership varies across households in patterns that closely reflect the distribution of income in the "old economy": PC-ownership is heavily concentrated in households with the highest incomes and best formal educations, especially those with married, "prime-age," household heads. The same data also show a substantial rise in inequality of PC ownership between 1988 and 1998, at least as measured by PC-ownership gaps.

The concentration ratio measures of PC inequality in Table 2 show declining PC inequality in the United States and a modest increase in PC inequality in Great Britain between 1988 and 1998. The PC-ownership gaps in Tables 4 and 5, however, suggest substantial increases in PC inequality in both countries over the same period. Our view is that the percentage-point gap, rather than the concentration ratio, is the most meaningful measure of inequality in this context. An example using the British data helps to illustrate this point. The PC ownership rate for households in the bottom quintile roughly tripled between 1988 and 1998 (from about 5% to about 15%). Meanwhile, the share of households with a computer in the top quintile more than doubled (from just over 25% to just over 60%). Since ownership rates tripled at the bottom but not at the top, the gap, measured in relative terms, declined between 1988 and 1998. In percentage-point terms, however, the gap between the top and bottom grew from about 20 percentage points in 1988 to about 50 percentage points in 1998. In 1988, when 75% of households in the top quintile still didn't have a PC, the 95% of households in the bottom quintile that didn't have a PC either were probably at less of a social and economic disadvantage than were the 85-90% of households at the bottom that didn't have a PC in 1998, when 60% of those at the top did own a PC.

As a separate check on the trend in inequality in PC ownership, Table 6 reports the results from probit equations of PC ownership. The dependent variable takes the value one if the household owns a computer and zero otherwise. The explanatory variables in the regression are the natural log of household equivalent income; and binary variables for three education levels; four age groups; five family types in the United States and four in Great Britain; and three racial and ethnic categories in the United States and one in Great Britain. Table 6 reports the marginal effect of the natural log of equivalised household income for each country from each annual probit regression. We can interpret the income coefficient in

these regressions as a measure of PC-ownership inequality by income (controlling for other characteristics of the regression). A higher coefficient indicates that PC ownership is more responsive to income in a particular cross-section. The results in Table 6 are consistent with the conclusion reached by the PC-ownership gap analysis: PC inequality appears to have increased substantially between 1988 and 1998 in both countries. In both countries, the responsiveness of PC ownership to income more than doubled between 1988 and 1998. In the United States, the income coefficient increased from 0.020 (with a standard error of 0.004) in 1988 to 0.051 (standard error: 0.007) in 1998; in Great Britain, from 0.061 (0.006) to 0.147 (0.009). By this measure, at least, PC inequality appears to be much larger in Great Britain than it is in the United States.

Three additional features

The data summarized in Tables 3, 4, and 5 and Figures 3 and 4 also point to several other important features of the international PC distributions. First, the British lead in PC ownership disappeared first at the top of the income distribution and later worked its way down the entire income distribution. Table 7 demonstrates this point most clearly. The table shows national "years behind" measures by income quintile, comparing the top income quintile in Britain with the top quintile in the United States, the middle quintile in Britain with the middle quintile in the United States, and the bottom quintile in Britain with the bottom quintile in the United States. The top quintile in Britain first fell behind the top quintile in the United States in 1991, at a time when the middle quintile in Britain still had a substantial lead (4 years) over the middle quintile in the United States. In the same year, the bottom quintiles in both countries had the same PC ownership rates. While the United States surpassed Great Britain with respect to average ownership rates sometime between 1994 and 1995, it wasn't until the following year that the middle and lower income quintiles in the United States overtook their British counterparts.

Second, the strong relationship between household income and PC ownership evident in Tables 3, 4, and 5 and Figures 3 and 4 reinforces the observation made in the preceding section that the early British lead in PC ownership – and even the relatively small British deficit between 1994 and 1998 – are particularly impressive given the lower average incomes and higher PC unit prices in Britain. While we do not have access to internationally comparable, quality-adjusted, PC prices, we do have accurate information on household

incomes. In Table 8, we examine the impact of international income differences on average PC ownership rates.

As a first step, we fit probit equations for PC ownership along the lines of those in Table 6, for each country for each year in the sample, using the log of equivalised household income levels among the regressors.[16] We then assigned all households in the British sample the (generally higher) income that they would have received if they had been in the corresponding centile of the US distribution in the same year.[17] In a similar way, we assigned to all US households the (generally lower) income that they would have received if they had been in the corresponding centile of the British distribution in the same year. Finally, we returned to the probit equations for each country to predict the estimated counterfactual share of each country's PC ownership if the sample had its original characteristics and corresponding domestic propensity to own a PC (the estimated domestic coefficient on the log of household income), but its assigned "foreign" income.

The results in Table 8 show that international differences in income had a modest effect on the international gap in PC ownership. In 1998, the actual PC ownership gap was 7.9 percentage points. If households in both countries had had the US income distribution, however, our analysis suggests that the gap would have been only 6.6 percentage points; if both countries had had British incomes, the gap would have been about 7.0 percentage points. Thus, depending on the income base used, 11-16% of the ownership gap reflected the generally lower incomes in Great Britain.

The third and probably most important additional feature of the international PC distributions is that the differences in PC ownership rates *within* each country are far larger than the differences *between* the two countries. In Table 1, we reported a simple estimate of the number of years that Britain "trailed behind" the United States (about 1.7 years). Table 9 calculates the same statistic for the top, middle, and bottom income quintiles within the two countries. According to these calculations, in 1998, the bottom quintile in the United States was about 10 "years behind" the top quintile, while in Britain, the bottom trailed more than 14 years behind the top.[18]

---

[16] The only difference is that in Table 8 we used regular income not log income in order to retain observations with negative and zero income for the year.

[17] We convert the US dollar income to sterling using average market exchange rates in each period.

[18] The "years behind" index used here is only defined for years where the "trailing" group has an ownership rate as least as high as at least one earlier year for the "leading" group. For example, the "years behind" index that relates the bottom US quintile to the top US quintile is not defined in 1997 because the ownership rate for the

5. Lessons from Ownership Patterns for Other Consumer Durables

A large literature exists on the general pattern of adoption of new products over time (summarised for example in Rogers, 1995, or Stoneman, 1995). One of the major empirical regularities of this literature is that the diffusion rate (the average use or ownership rate) follows an S-shaped or sigmoid pattern over time, with adoption growing only slowly at first, then accelerating rapidly for a relatively short period, and then returning to slow or even no growth as the market reaches "saturation". Two other recurring features of diffusion studies are also potentially relevant to the discussion of PC inequality. The first is that diffusion rates generally reach their peak below one, that is, before every potential adopter has adopted the technology. In 1998, for example, 6% of US households still did not have a telephone. The second feature is that different income groups typically "peak" at different adoption rates. In the case of telephones, for example, in 1998, 99% of households with yearly incomes of $75,000 or more had a telephone, while only 89% of those with annual incomes of $10,000 to $15,000 did.[19]

All three of these recurring findings of the diffusion literature – the S-shaped diffusion pattern; the existence of a potentially sizeable portion of long-run non-adopters; and differences across income groups in long-run peak adoption rates – have important implications for future trends in PC inequality. The S-shaped diffusion pattern implies that inequality measured as percentage-point "ownership gaps" will typically grow through the first and second parts of the S-shaped curve (the initial period of slow growth and the second period of rapid diffusion) because the "haves" will be opening up an ever-widening gulf with the "have-nots". Only when the market nears saturation and the "have-nots" begin to catch up, will ownership gaps begin to close. An examination of the diffusion graph for PC ownership may therefore provide important clues about trends in PC inequality in the short- and medium-run.

The likelihood that PC diffusion will reach a long-run maximum below complete saturation suggests that society will need to prepare for having a portion of the population that – by choice or because of limited options – may not be able to participate fully in PC

---

lowest quintile in that year (19.0%) was below the lowest observed ownership rate for the top quintile in the CE data (22.3% in 1988). The British figure for 1998 is, technically, not defined, but we know that it must be at least 14 years since the ownership rate for the lowest quintile in 1998 (14.8%) is lower than the rate for the top quintile in 1984 (17.3%).

society. The social implications will vary significantly depending on whether the group is small or large and whether it is made up largely of households that have "opted out" (such as those who today have chosen not to own a television) or those who have been excluded for reasons of income, price, or technological preparation (such as, presumably, many of those today without a car). Comparing PC diffusion rates with those of other consumer durables and, particularly, comparing PC diffusion rates by income with diffusion rates by income for other consumer durables may provide some clues about the share of the long-run population that might end up without PCs.

In this section, we compare diffusion rates for PCs to those of four other consumer durables: two new and relatively inexpensive high-technology durables (video cassette recorders and microwave ovens); and two "mature" and relatively expensive consumer durables (washing machines and vehicles). We first compare the national ownership rates and then examine differences in diffusion rates within countries by income quintiles.

Recall that Figure 1, which graphs the diffusion pattern of PCs in Britain and in the United States, showed little evidence of the typical sigmoid diffusion pattern over the period examined here.[20] If anything, the figure shows an inverse sigmoid pattern. Figure 5 shows ownership rates of each of the four consumer durables for both countries for the period 1984 to 1998. The first two products – VCRs[21] (Figure 5A) and microwaves (Figure 5B) – are relatively recent inventions, from around the same period as the PC; Like PCs, both draw on "high technology"; unlike PC's, both these products underwent rapid price declines in the 1980s, transforming themselves from luxury to mass consumption goods. In 1984, fewer than one in four British households owned a VCR and, in 1988, fewer than half of US households did. By 1998, however, over 80% of households in both countries owned a VCR. By 1998, though, the diffusion pattern for VCRs still showed no signs that it had reached "saturation" (repeated annual observations at or near the same diffusion rate as, for example, in the pattern for vehicle ownership in the United States in Figure 5C). Neither national VCR diffusion pattern demonstrates the characteristic S-shape, but this may be due to the lack of

[19] Data for telephone diffusion taken from National Telecommunications and Information Administration (1999), Charts I-1 and I-3.

[20] DeNew and Schmidt also observe an inverse sigmoid pattern of diffusion of PC's at the workplace in Germany.

[21] We do not distinguish here between households that own and households that rent consumer durables. For computers, renting is negligible in both countries. For VCRs, however, "hire" and "hire-purchase" arrangements are common in Britain.

data for the earliest stages of diffusion. Figure 5A presents data on diffusion only for part of the second and the beginning of third of the three-stage diffusion process.

Microwave ovens followed a broadly similar pattern, with rapid adoption in both countries between the mid-1980s and the late 1990s. As with VCRs, neither country appears to have reached "saturation" by 1998, though the rate of growth in diffusion appears to have decelerated in the United States. Once again, the diffusion patterns do not take an S-shape, probably because of the lack of data on earlier years.

The second two products – vehicles and clothes washing machines – are "mature" goods that have been on the market for decades, but remain expensive relative to typical household incomes. Over the full 1984-1998 period, vehicle ownership rates in the United States were basically flat at about 85-90% of all households; over the same period, US washing machine ownership rates were also basically unchanged at about 70%. Meanwhile, in Great Britain, diffusion rates grew slowly, but steadily, for both consumer durables. (We'll see below that the rise was due, almost entirely, to increases in ownership rates for households in the lower quintiles of the British income distribution.) None of these "mature" products show an S-shaped diffusion path over time. In these cases, we are almost certainly looking at only the third stage of the diffusion process (or, in the case of Britain, at the end of the second stage), where long-run "saturation" has been reached. To the extent that the markets for these consumer durables have in fact "peaked", the diffusion patterns here are potentially instructive about long-run characteristics of the PC market. In 1998, about 15% of US households and about 30% of British households did not have a car (or a truck). In the same year, over 10% of British household and around 30% of US households did not have a washing machine. While using vehicles or washing machines to predict the future of PCs is a risky proposition, that a large share (10-30%) of households in both countries do not own cars or washing machines, despite both products' long life span, suggests the possibility that PC diffusion could stabilize at a point where a sizeable minority of households are left without home access to a PC.

Figure 6 displays ownership rates of the same four consumer durables for the top and bottom income quintiles in each country (Figures 3A and 3B show corresponding PC ownership rates by income quintile for the United States and Great Britain). The most striking feature of Figure 6 is that none of the four products shows the widening ownership gap evident for PCs in Figures 3A and 3B. For VCRs, the ownership gap between the top and the bottom quintile narrowed considerably over the 1990s. The top quintile in both countries appears to have reached a saturation point at above a 90% ownership rate, while the

share of the lowest-quintile households with VCRs rose steadily throughout the entire period. A similar pattern holds for microwave ovens. The top quintile in both countries appears to be close to saturation at high rates of adoption, while ownership rates continue to grow among those in the bottom quintile. In the case of both of these "high-tech" consumer durables, ownership gaps such as those presented in Tables 4 and 5 decreased substantially in the 1990s, in strong contrast to the steep rise in gaps for PCs in both countries.

For vehicles, the ownership gap by income was flat in the United States and fell in Great Britain. In the United States, the lowest quintile appeared to have reached "saturation" at a level (60-70%) well below that of the top quintile (about 95%). In Britain, the top quintile had vehicle ownership rates that were nearly identical to those of the United States. The bottom quintile in Great Britain, however, saw its vehicle ownership rise during the 1990s from very low levels in the 1980s, helping to narrow the ownership gap by income. Washing machines show a similar pattern across the two countries. The US gap was largely unchanged over the 1990s, reflecting what appears to be "saturation" at very different ownership rates for households in the top (80-90%) and bottom (about 50%) quintiles. The British gap, however, narrowed significantly over the period, with the top quintile holding almost steady at over 90% and the bottom quintile growing from just over 50% in 1984 to over 70% in 1998.

To summarize the lessons from other consumer durables, the diffusion patterns across income groups for both VCRs and microwaves make clear that, in general, though not always, a reduction in the ownership gap will take place only after the "leading" group reaches "saturation." Thereafter, continued diffusion among the "lagging" group works to lower the ownership gap. In the case of both VCRs and microwaves, the top income quintiles reached saturation rapidly. Subsequent growth in overall ownership rates for the two products was therefore concentrated almost entirely in lower income quintiles, driving down inequality. In the case of PCs, however, the diffusion patterns for top income quintiles in both countries, through 1998, shows no signs of saturation, suggesting that ownership inequality is likely to get worse, at least in the short-term, before it gets better. The diffusion patterns for the two "mature" and relatively expensive goods – vehicles and washing machines – demonstrate, at most, only a modest tendency toward convergence by income over time (see Figures 6C and 6D), and only in Great Britain. A key feature of the ownership rates for vehicles and washing machines is the large and persistent gap in ownership rates across income quintiles. The experience of both the "mature" goods suggests that lower-

income groups can reach "saturation" at ownership levels well below those of higher-income groups, locking in inequality over the long run.

6. Conclusions

Data for the United States and Great Britain for 1984-1998 establish that household PC inequality was high and, by most measures, increasing over the period in both countries. An analysis of the diffusion patterns for PCs and other consumer durables suggest that PC inequality is likely to get worse before it gets better and, moreover, that a significant degree of inequality is likely to persist even in the long-run.

Our findings recommend at least two areas for future research. The first is to attempt to measure the social and economic impact of household PC inequality. PC inequality will be less of a concern if it is not linked to poor social or economic outcomes for households without PCs. One particularly important question is whether children in households without PCs perform worse in school or, later, in the labour market, than do children whose households do have a PC. A second important area of investigation concerns the extent to which public and private communal access to PCs through schools, libraries, community computer centres, or work, is a reasonable substitute for household PC ownership.

Table 1
PC ownership rates

	Share of households owning computer (%)		"Years behind"
Year	United States	Great Britain	GB-US
1984	--	8.2	--
1985	--	12.6	3.7
1986	--	16.1	4.5
1987	--	17.1	4.1
1988	10.2	17.2	3.1
1989	13.8	18.6	2.6
1990	15.5	19.5	2.0
1991	16.9	20.3	1.3
1992	19.6	22.8	1.4
1993	22.1	23.2	0.6
1994	23.9	24.5	0.2
1995	26.8	25.5	-0.5
1996	32.9	26.6	-1.1
1997	35.3	--	--
1998	41.3	33.7	-1.7

Source: Authors' analysis of CE data for the United States and GHS data for Britain.

Notes: Years behind measure includes a linear interpolation term. See text for details.

Table 2
Basic measures of PC ownership inequality

	United States			Britain		
	1988	1994	1998	1988	1994	1998
Concentration ratio	0.314	0.284	0.282	0.272	0.251	0.285
Percent of all computers owned by:						
Richest decile	21.7	21.4	18.5	17.0	19.0	20.1
Poorest decile	6.2	5.0	6.9	3.0	7.8	5.5
Ownership rates (%):						
Richest 10%	23.5	54.8	76.7	29.2	46.6	67.8
5th to 9th decile	14.4	32.2	51.8	23.9	31.9	45.2
Poorest decile	6.8	12.7	28.1	5.1	19.1	18.7

Source: Authors' calculations using CE data for the United States and GHS data for Britain.

Table 3
PC ownership rates by household characteristics
(Percent)

	United States			Great Britain		
	1988	1994	1998	1988	1994	1998
(a) All	10.2	23.9	41.3	17.2	24.5	33.7
(b) Equiv. Inc. Quint.						
Top	22.3	46.3	70.9	26.4	43.1	60.6
Fourth	13.4	30.9	53.5	24.6	32.0	45.4
Third	6.9	21.4	37.9	21.4	21.3	29.9
Second	5.0	11.6	22.8	9.1	12.6	17.9
Bottom	3.6	10.2	22.3	4.6	13.4	14.8
(c) Education level						
University graduate	21.8	45.2	65.9	32.9	51.8	65.2
Upper secondary	12.3	29.7	49.1	30.5	41.2	52.7
Lower secondary	6.7	15.2	29.2	22.2	27.4	32.3
Less than secondary	2.4	5.9	10.8	14.1	15.1	17.5
(d) Age						
65+	2.7	9.8	18.7	2.4	3.8	9.9
55-64	5.8	22.8	37.8	7.4	16.0	28.4
40-54	17.3	34.5	52.8	31.7	41.6	50.7
25-39	11.8	25.8	47.3	26.8	32.3	42.4
16-24	8.9	19.2	40.6	11.6	20.7	29.9
(e) Family type						
MCF no kids	7.5	23.3	42.1	10.7	21.7	33.5
MCF kids	19.3	37.7	61.6	41.9	47.6	57.3
Single male	10.3	18.2	34.6	9.5	15.8	24.7
Single female	4.0	10.4	23.1	2.2	5.0	12.7
Single kids	6.9	16.8	28.5	21.3	24.5	29.8
(f) Race						
White	10.7	26.3	45.2	17.2	28.5	33.2
Not white	8.1	14.7	28.5	14.9	24.3	43.9
Black	6.1	12.8	25.0	n.a.	n.a.	n.a.
Hispanic	7.5	11.0	24.3	n.a.	n.a.	n.a.
Other	17.1	32.5	47.3	n.a.	n.a.	n.a.

Source: Authors' analysis of CE data for the United States and GHS data for Britain.

Table 4

PC ownership gaps by household characteristics

(Percentage-point difference)

	United States			Britain		
	1988	1994	1998	1988	1994	1998
(a) Equiv. Inc. Quint.						
(Relative to top)						
Top	0.0	0.0	0.0	0.0	0.0	0.0
Fourth	-8.9	-15.4	-17.4	-1.8	-11.1	-15.2
Third	-15.4	-24.9	-33.0	-5.0	-21.8	-30.7
Second	-17.3	-34.7	-48.1	-17.3	-30.5	-42.7
Bottom	-18.7	-36.1	-48.6	-21.8	-29.7	-45.8
(b) Education level						
(Relative to graduate)						
University graduate	0.0	0.0	0.0	0.0	0.0	0.0
Upper secondary	-9.5	-15.5	-16.8	-2.4	-10.6	-12.5
Lower secondary	-15.1	-30.0	-36.7	-10.7	-24.4	-32.9
Less than secondary	-19.4	-39.3	-55.1	-18.8	-36.7	-47.7
(c) Age						
(Relative to 40-54)						
65+	-14.6	-24.7	-34.1	-29.3	-37.8	-40.8
55-64	-11.5	-11.7	-15.0	-24.3	-25.6	-22.3
40-54	0.0	0.0	0.0	0.0	0.0	0.0
25-39	-5.5	-8.7	-5.5	-4.9	-9.3	-8.3
16-24	-8.4	-15.3	-12.2	-20.1	-20.9	-20.8
(d) Family type						
(Relative to MCF kids)						
MCF no kids	-11.8	-14.4	-19.5	-31.2	-25.9	-23.8
MCF kids	0.0	0.0	0.0	0.0	0.0	0.0
Single male	-9.0	-19.5	-27.0	-32.4	-31.8	-32.6
Single female	-15.3	-27.3	-38.5	-39.7	-42.6	-44.6
Single kids	-12.4	-20.9	-33.1	-20.6	-23.1	-27.5
(e) Race						
(Relative to whites)						
Whites	0.0	0.0	0.0	0.0	0.0	0.0
Not white	-2.6	-11.6	-16.7	-2.3	-4.2	10.7
Black	-4.6	-13.5	-20.2	n.a.	n.a.	n.a.
Hispanic	-3.2	-15.3	-20.9	n.a.	n.a.	n.a.
Other	6.4	6.2	2.1	n.a.	n.a.	n.a.

Source: Authors' analysis of CE data for the United States and GHS data for Britain.

Table 5
Probability of PC ownership, probit equations
(Marginal probabilities)

	United States			Britain		
	1988	1994	1998	1988	1994	1998
(a) Equiv. Inc. Quint.						
(Relative to top)						
Fourth	-0.029**	-0.074**	-0.128**	-0.023*	-0.053**	-0.118**
	(0.008)	(0.016)	(0.023)	(0.009)	(0.011)	(0.015)
Third	-0.055**	-0.110**	-0.211**	-0.036**	-0.104**	-0.203**
	(0.007)	(0.015)	(0.022)	(0.010)	(0.011)	(0.013)
Second	-0.053**	-0.159**	-0.268**	-0.073**	-0.121**	-0.240**
	(0.008)	(0.015)	(0.022)	(0.009)	(0.011)	(0.014)
Bottom	-0.064**	-0.150**	-0.248**	-0.108**	-0.138**	-0.271**
	(0.008)	(0.016)	(0.024)	(0.009)	(0.011)	(0.014)
(b) Education level						
(Relative to graduate)						
Upper secondary	-0.035**	-0.064**	-0.110**	0.004	-0.004	0.029#
	(0.008)	(0.015)	(0.021)	(0.013)	(0.014)	(0.017)
Lower secondary	-0.065**	-0.179**	-0.267**	-0.026*	-0.066**	-0.093*
	(0.008)	(0.013)	(0.019)	(0.010)	(0.011)	(0.015)
Less than secondary	-0.082**	-0.211**	-0.376**	-0.050**	-0.121**	-0.171**
	(0.008)	(0.013)	(0.017)	(0.010)	(0.010)	(0.015)
(c) Age						
(Relative to 40-54)						
65+	-0.052**	-0.073**	-0.161**	-0.128**	-0.234**	-0.249**
	(0.010)	(0.019)	(0.024)	(0.010)	(0.010)	(0.015)
55-64	-0.034**	-0.026	-0.046	-0.076**	-0.100**	-0.088**
	(0.010)	(0.022)	(0.029)	(0.008)	(0.011)	(0.017)
25-39	-0.028**	-0.049**	-0.034	-0.050**	-0.081**	-0.093**
	(0.008)	(0.015)	(0.021)	(0.007)	(0.009)	(0.013)
16-24	-0.001#	0.004	0.077*	-0.061**	-0.072**	-0.055#
	(0.015)	(0.028)	(0.034)	(0.010)	(0.016)	(0.030)
(d) Family type						
(Relative to MCF kids)						
MCF no kids	-0.054**	-0.105**	-0.159**	-0.140**	-0.137**	-0.159**
	(0.008)	(0.016)	(0.024)	(0.009)	(0.011)	(0.015)
Single male	-0.035**	-0.141**	-0.246**	-0.103**	-0.140**	-0.203**
	(0.008)	(0.014)	(0.021)	(0.006)	(0.009)	(0.013)
Single female	-0.065**	-0.172**	-0.303**	-0.154**	-0.211**	-0.263**
	(0.007)	(0.013)	(0.020)	(0.007)	(0.009)	(0.013)
Single kids	-0.038**	-0.071**	-0.197**	-0.022**	-0.066**	-0.086**
	(0.010)	(0.022)	(0.029)	(0.013)	(0.014)	(0.021)

(continued)

Table 5 (continued)
Probability of PC ownership
(Marginal probabilities)

	United States			Britain		
	1988	1994	1998	1988	1994	1998
(e) Race						
(Relative to whites)						
Not white	--	--	--	-0.047**	-0.010	0.076**
				(0.014)	(0.019)	(0.027)
Black	-0.007	-0.083**	-0.129**	--	--	--
	(0.014)	(0.019)	(0.026)			
Hispanic	-0.007	-0.097**	-0.132**	--	--	--
	(0.022)	(0.020)	(0.028)			
Other	0.007	-0.014	-0.037	--	--	--
	(0.022)	(0.035)	(0.041)			
Pseudo R-squared	0.157	0.183	0.219	0.233	0.205	0.207
Sample size	4,479	4,253	4,408	7,114	8,515	7,529

Source: Authors' analysis of CE data for the United States and GHS data for Britain.

Note: The dependent variable takes the value one if the household owns a computer, zero otherwise. For means of the dependent variables, see Table 1; for means of the independent variables, see Appendix Table 1. Equations estimated using probit. Coefficients are the change in probability of owning a computer associated with a discrete change from 0 to 1 in the value of the independent variable. The excluded group are households in the top equivalent income quintile, with university education or more, in married couple families with children, where the first householder is white and between 40 and and 54 years old. Standard errors are in parentheses; # indicates significance at the 10% level; *, at the 5% level; **, 1% level.

Table 6
Responsiveness of PC ownership rates to income

	United States	Great Britain
1988	0.020	0.061
	(0.004)	(0.006)
1989	0.011	0.056
	(0.004)	(0.006)
1990	0.030	0.066
	(0.005)	(0.007)
1991	0.020	0.077
	(0.005)	(0.010)
1992	0.041	0.072
	(0.006)	(0.006)
1993	0.037	0.048
	(0.006)	(0.005)
1994	0.048	0.050
	(0.006)	(0.006)
1995	0.030	0.068
	(0.006)	(0.008)
1996	0.044	0.098
	(0.009)	(0.007)
1997	0.047	--
	(0.007)	--
1998	0.051	0.147
	(0.007)	(0.009)

Source: Authors' analysis of CE data for the United States and GHS data for Great Britain.

Notes: Marginal effects of the natural log of equivalent income, evaluated at the sample mean of equivalent income in each year in each country, from a probit regression of a binary computer ownership variable against the natural log of income, 3 education level categories, 4 age groups, family types (5 in the United States, 4 in Great Britain) and racial/ethnic categories (3 in the United States, 1 in Great Britain). Standard errors shown in parentheses below each coefficient. All coefficients statistically significant at, at least the 1% level. GHS data not available for 1997.

Table 7
"Years behind" by income quintiles, between countries

	Income quintile		
	GB Top-US Top	GB Middle - US Middle	GB Bottom - US Bottom
1988	0.9	6.1	0.3
1989	0.4	5.0	--
1990	0.3	4.1	0.0
1991	-0.4	4.0	0.0
1992	-0.7	3.2	0.5
1993	-0.6	1.4	2.3
1994	-1.5	0.0	1.2
1995	-1.3	0.5	0.1
1996	-1.7	-0.5	-1.6
1997	--	--	--
1998	-1.8	-1.5	-2.6

Source: Authors' calculations using CE data for the United States and GHS data for Britain.

Notes: Years behind measure includes a linear interpolation term. See text for details.

Table 8
Effect of national income differences on PC ownership rates

	Ownership rates (%)				Ownership differential GB-US in percentage points with income from:		
Country:	United States		Great Britain				
Income:	US	GB	US	GB	Own	US	GB
1988	10.2	9.5	18.2	17.2	7.0	8.0	7.7
1989	13.7	12.8	19.8	18.6	4.9	6.1	5.8
1990	15.6	15.2	20.0	19.5	3.9	4.4	4.3
1991	16.9	16.6	20.6	20.3	3.4	3.7	3.7
1992	20.0	19.5	23.2	22.8	2.8	3.2	3.3
1993	22.6	20.7	25.1	23.2	0.6	2.5	2.5
1994	24.3	22.1	26.3	24.5	0.2	2.0	2.4
1995	27.0	25.7	26.7	25.4	-1.6	-0.3	-0.3
1996	33.7	32.0	28.9	26.6	-7.1	-4.8	-5.4
1997	--	--	--	--	--	--	--
1998	41.6	40.7	35.0	33.7	-7.9	-6.6	-7.0

Source: Authors' analysis of CE data for the United States and GHS data for Great Britain.

Notes: Ownership rates for the United States here differ slightly from those in Table 1 because this table excludes observations where reported income is incomplete.

Table 9
"Years behind" by income quintiles, within countries

	Percent owning PCs			"Years behind"		
	Top	Middle	Bottom	Top-Bot	Top-Mid	Mid-Bot
(a) United States						
1988	22.3	6.9	3.6	--	--	--
1989	26.9	9.6	7.6	--	--	--
1990	30.3	13.1	6.6	--	--	--
1991	34.0	11.6	8.8	--	--	-2.3
1992	41.5	15.7	9.3	--	--	-3.1
1993	44.5	18.7	10.5	--	--	-3.7
1994	46.3	21.4	10.2	--	--	-4.8
1995	53.8	22.2	11.9	--	-7.0	-3.9
1996	59.8	27.3	19.0	--	-6.9	-2.9
1997	64.0	32.1	19.0	--	-6.5	-3.9
1998	70.9	37.9	22.3	-10.0	-6.5	-3.0
(b) Great Britain						
1984	17.3	7.6	2.1	--	--	--
1985	22.1	14.0	3.2	--	--	--
1986	24.3	19.0	4.6	--	-1.6	--
1987	28.1	19.5	5.3	--	-2.5	--
1988	26.4	21.4	4.6	--	-3.1	--
1989	28.1	21.3	6.3	--	-4.2	--
1990	31.5	21.4	6.5	--	-5.1	--
1991	32.6	22.4	8.7	--	-5.9	-6.8
1992	36.5	23.2	9.9	--	-6.5	-7.6
1993	38.1	21.7	14.2	--	-8.1	-8.0
1994	43.1	21.3	13.4	--	-9.2	-9.1
1995	45.7	22.7	12.9	--	-9.7	-10.2
1996	48.3	24.5	10.9	--	-9.9	-11.5
1997	--	--	--	--	--	--
1998	60.7	29.9	14.8	-14+	-8.5	-12.8

Source: Authors' calculations using CE data for the United States and GHS data for Britain.

Notes: Years behind measure includes a linear interpolation term. See text for details.

Figure 1

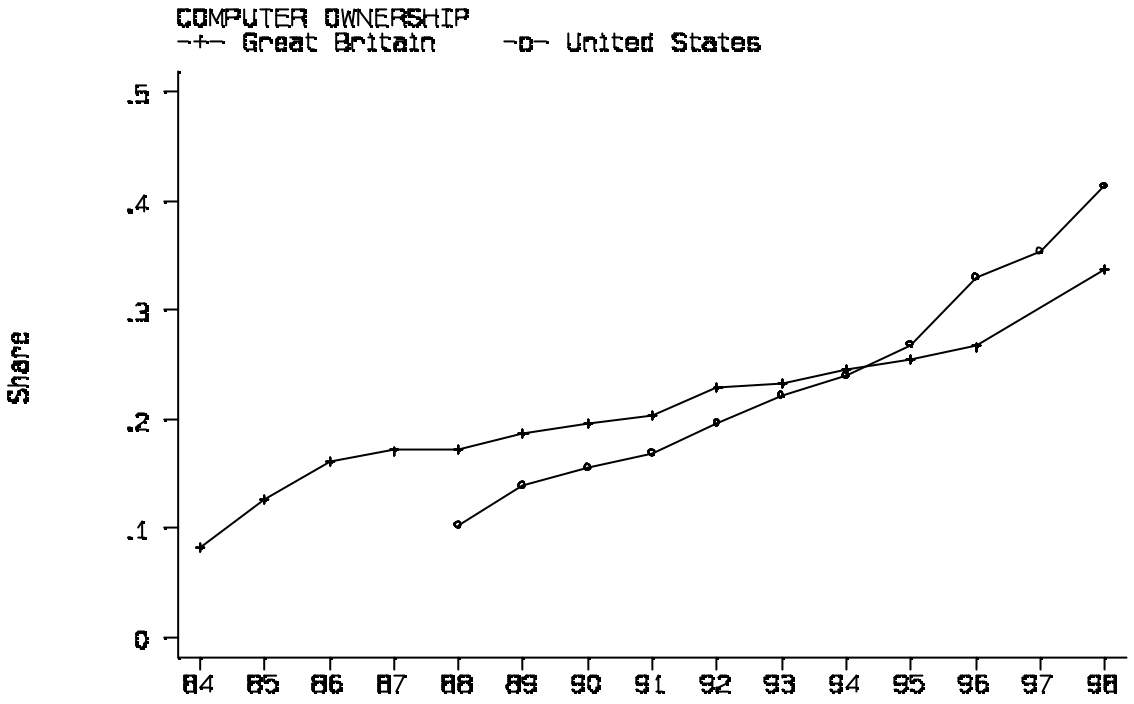
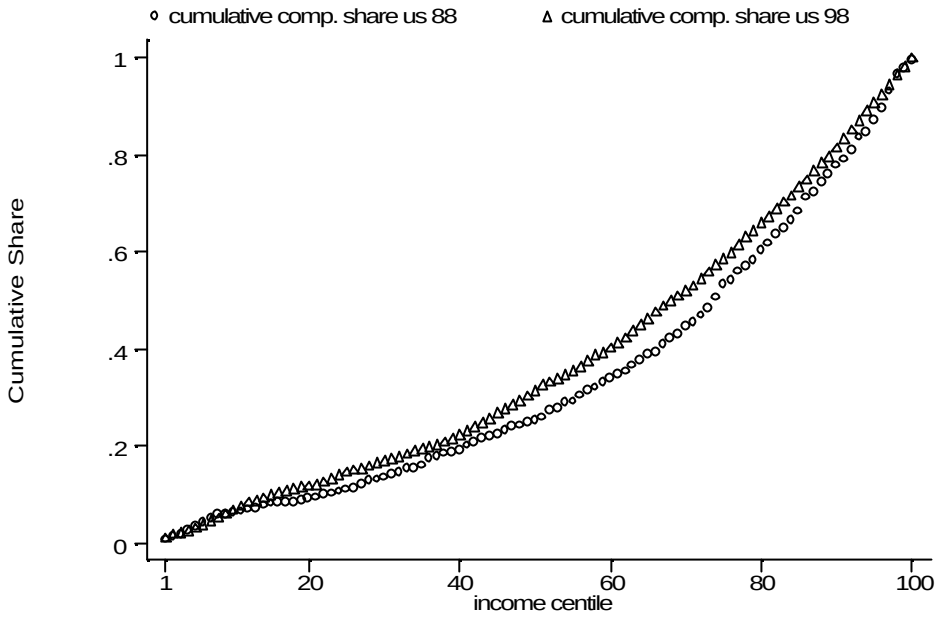

COMPUTER OWNERSHIP
-+- Great Britain
-o- United States
Share
.5
.4
.3
.2
.1
0
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98

Figure 2A: Concentration curves of PC Ownership, US & GB, 1988-98



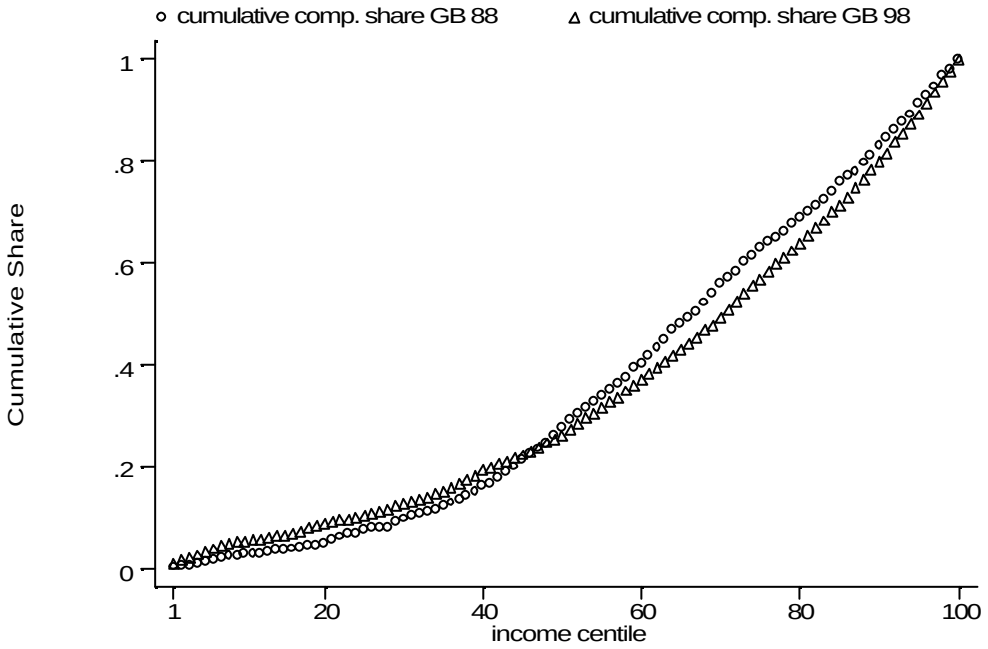
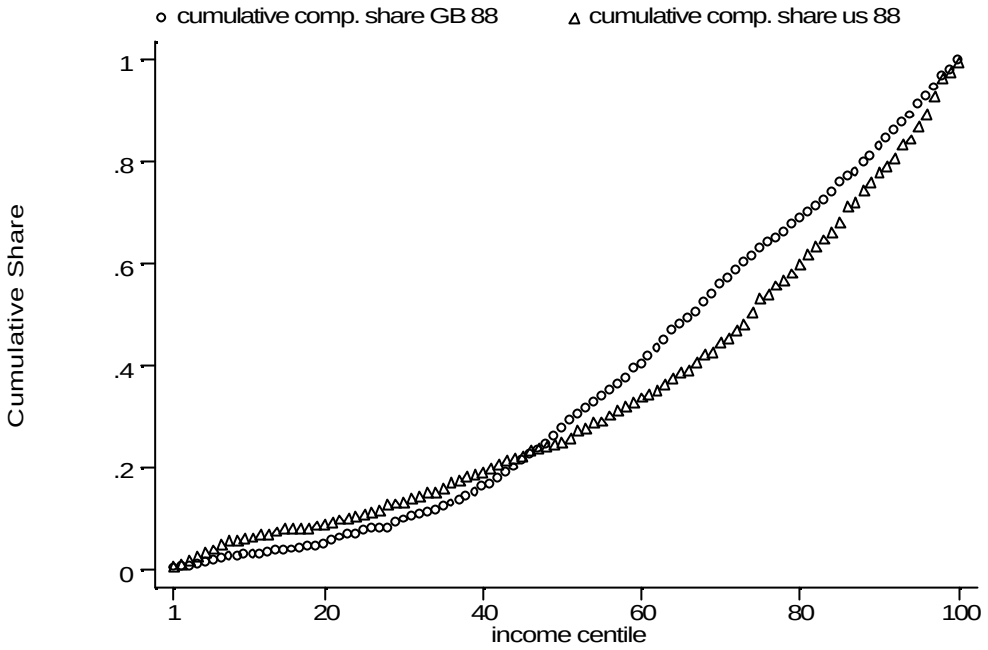


Figure 2B: Concentration curves of PC ownership across US and GB, 1988 and 1998



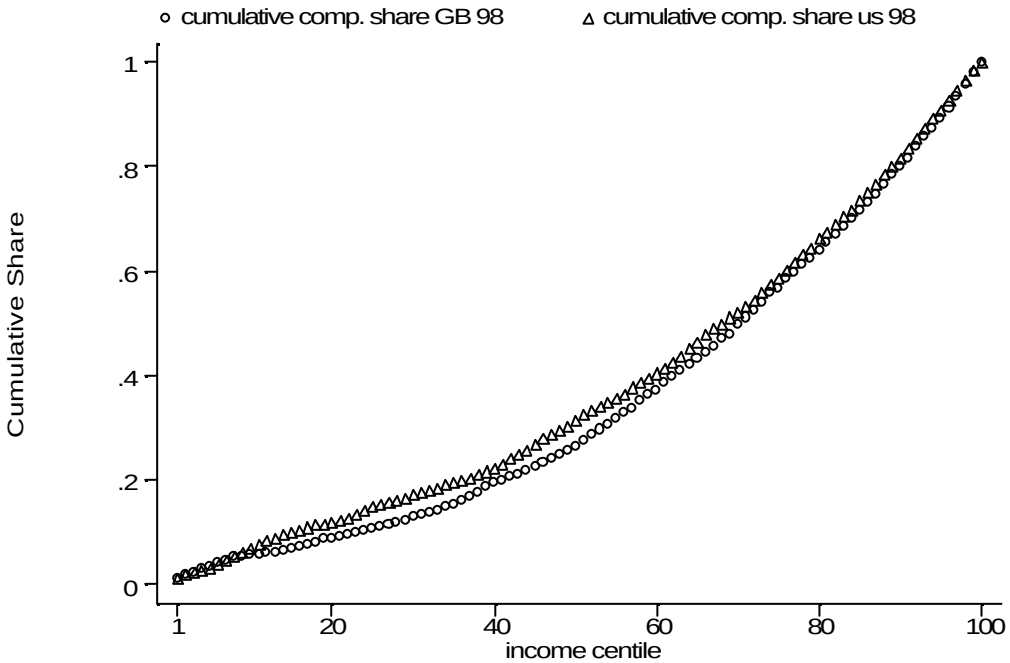


Figure 3A

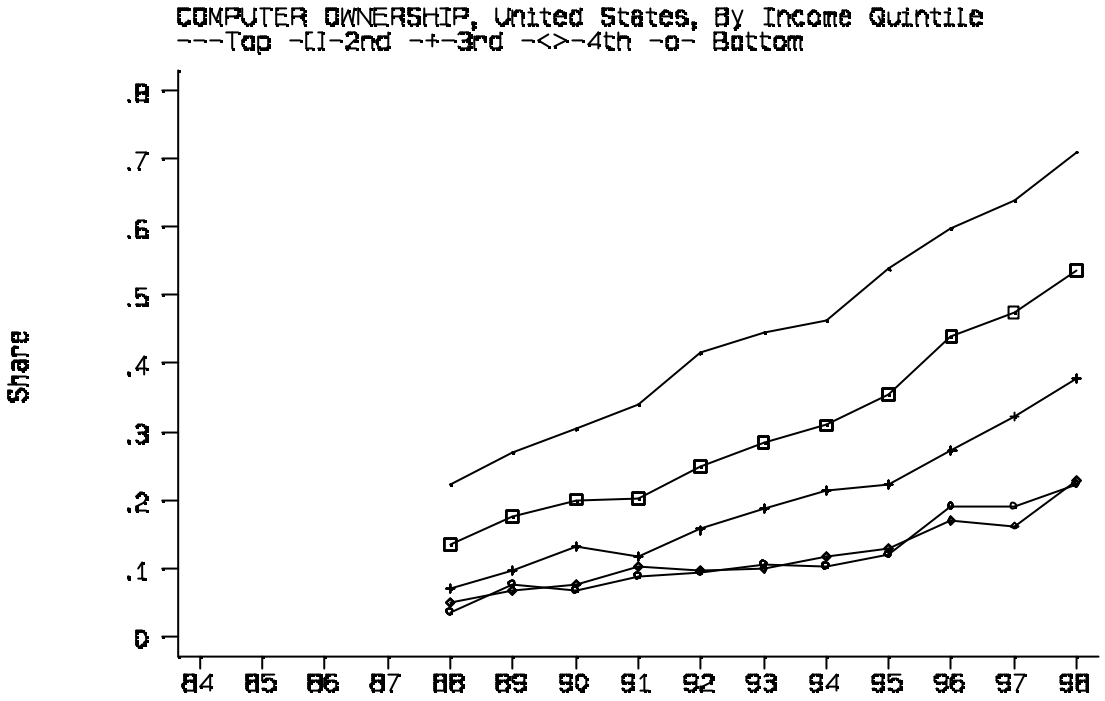


Figure 3B

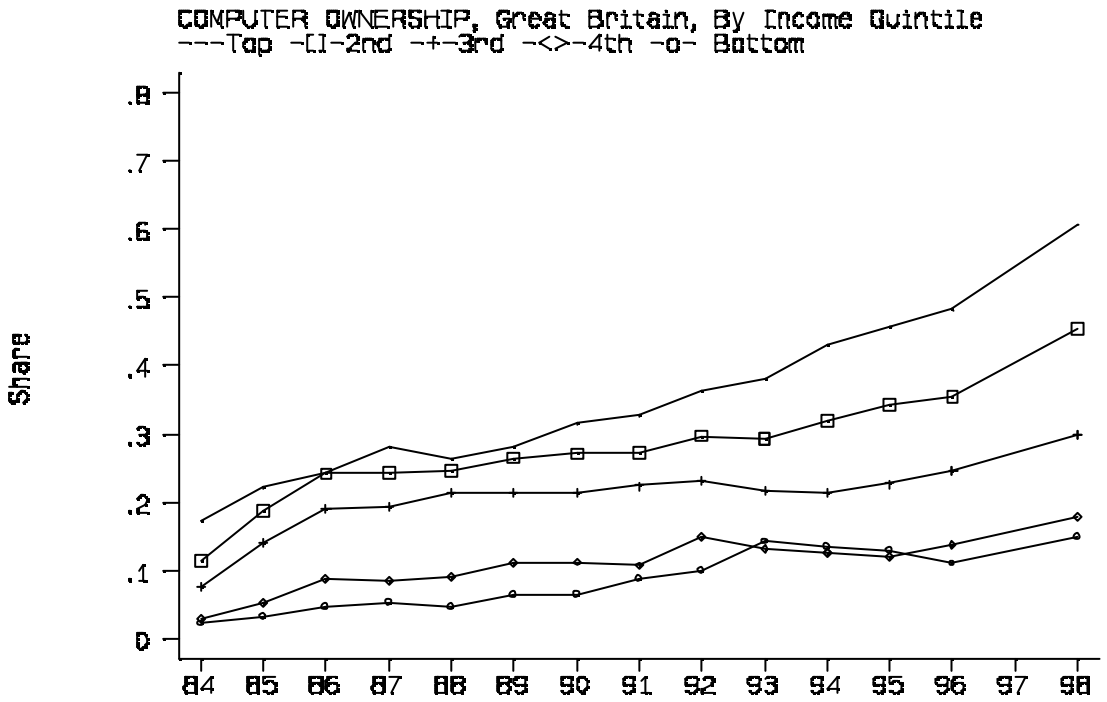


Figure 3C

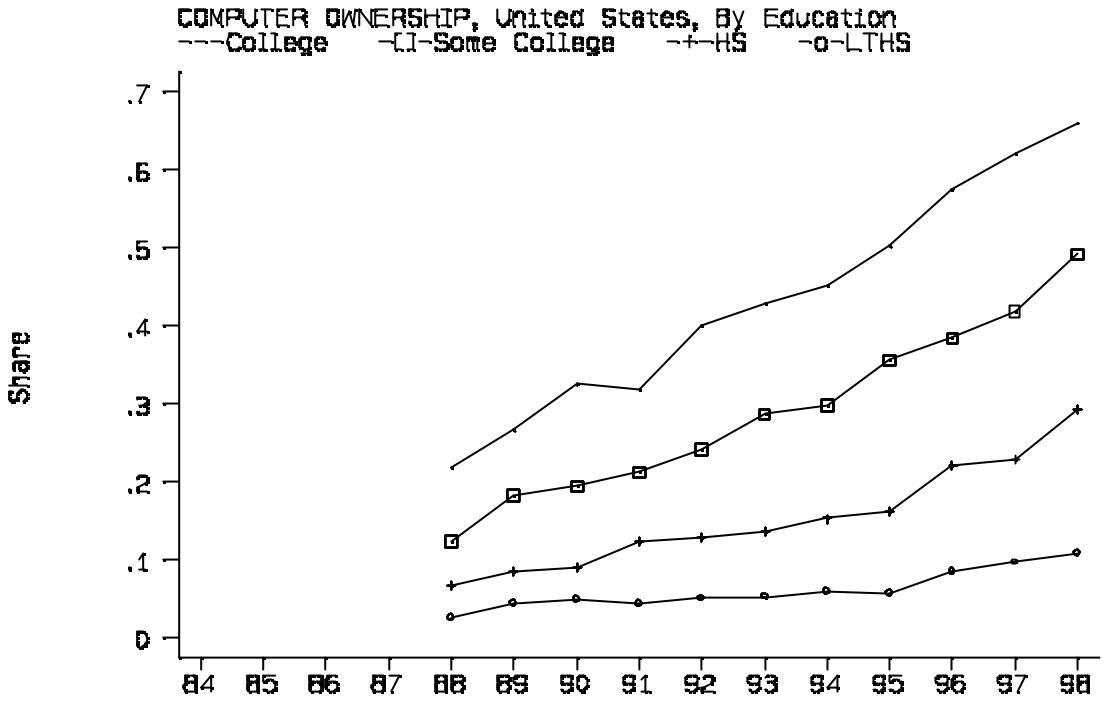


Figure 3D

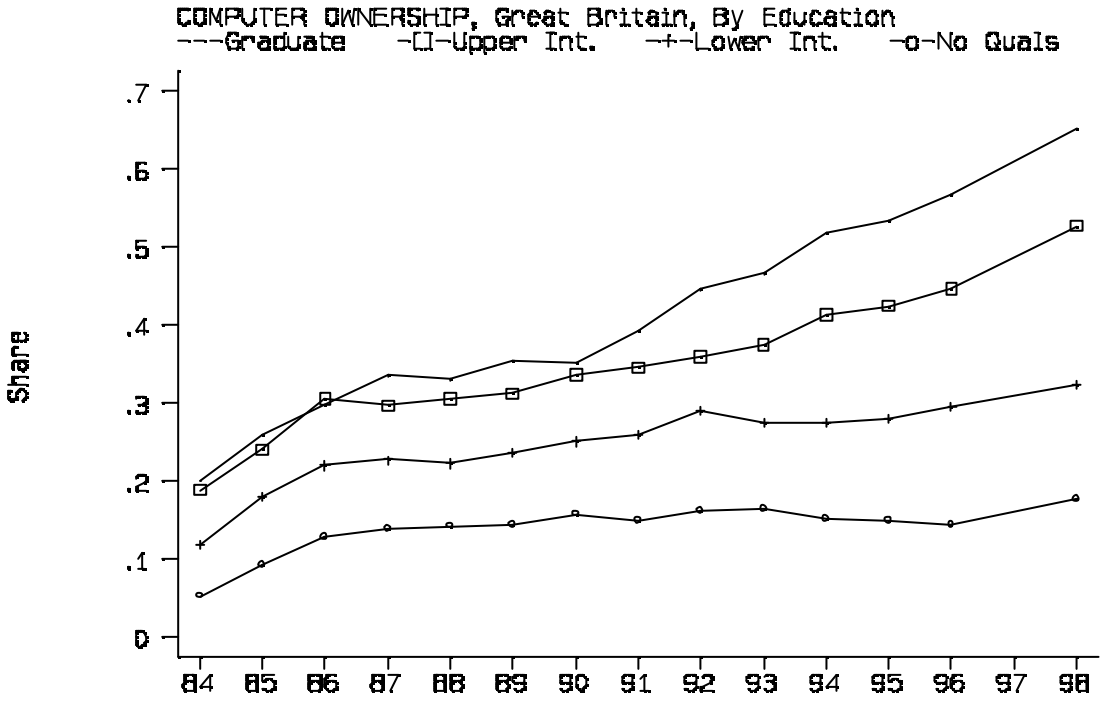


Figure 3E

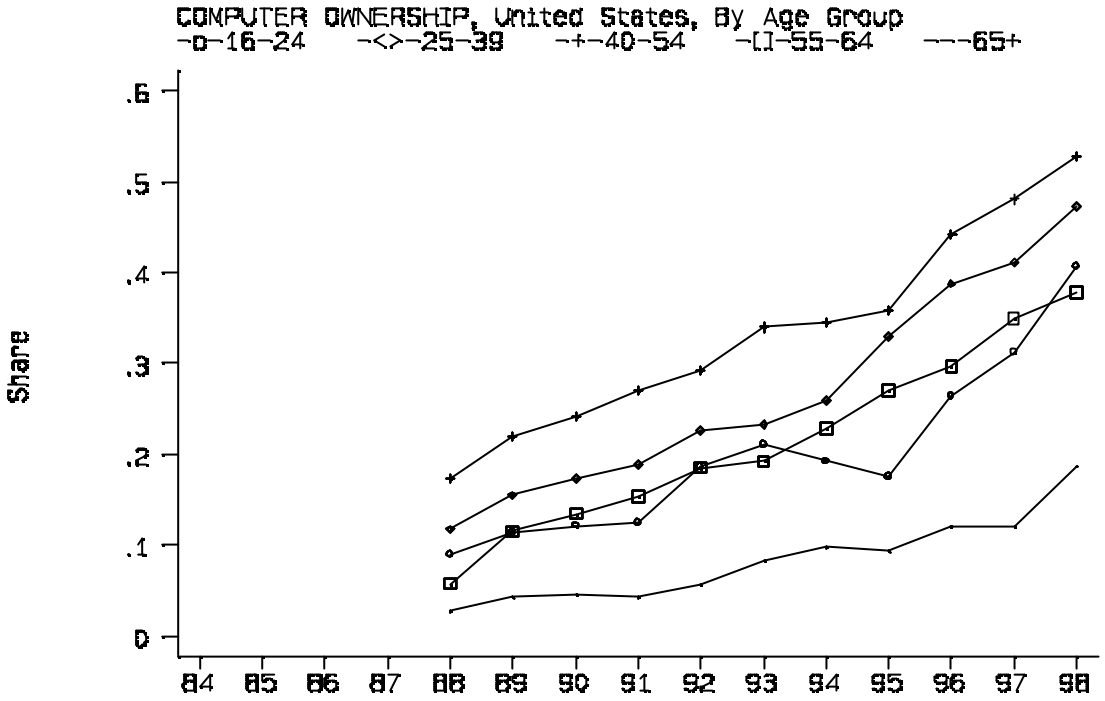


Figure 3F

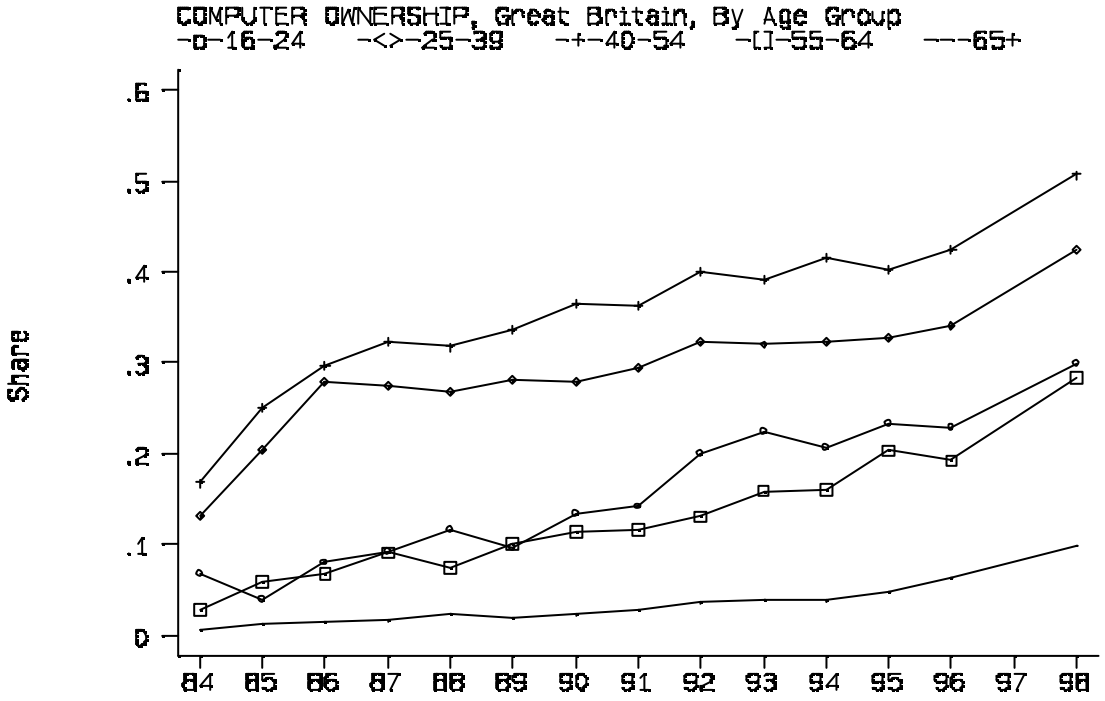


Figure 4A

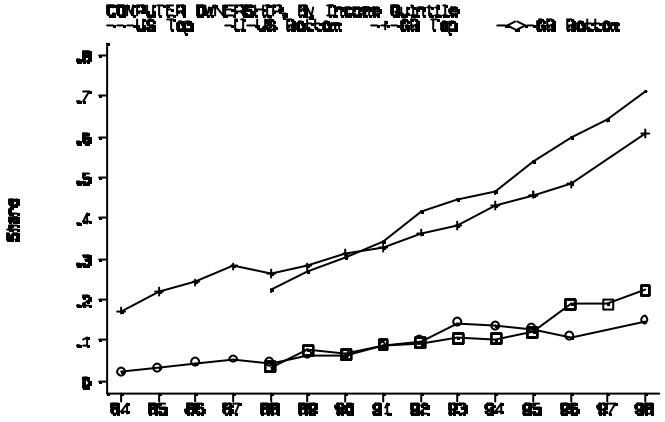


Figure 4B

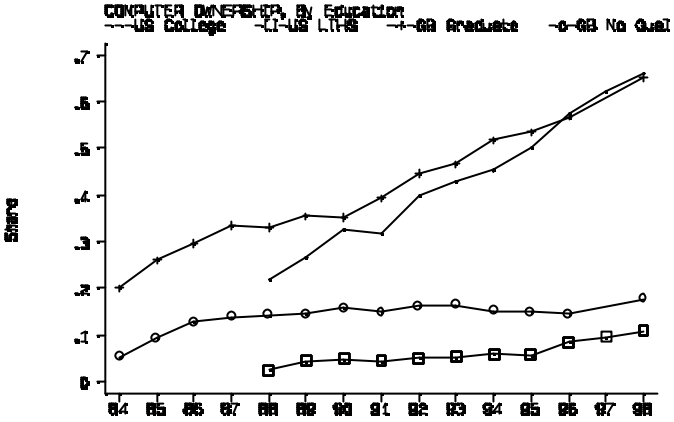


Figure 4C

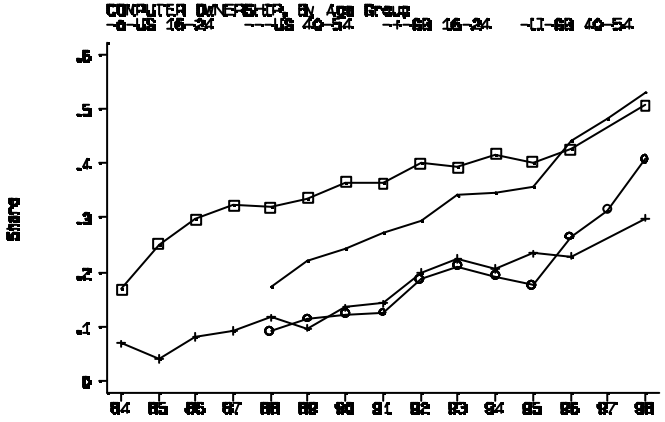


Figure 4D

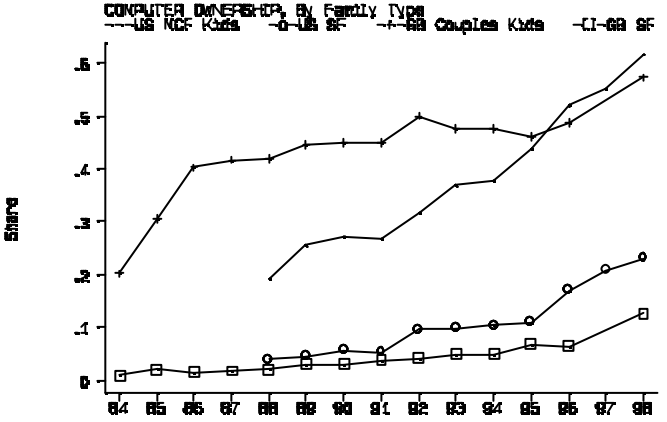


Figure 5A

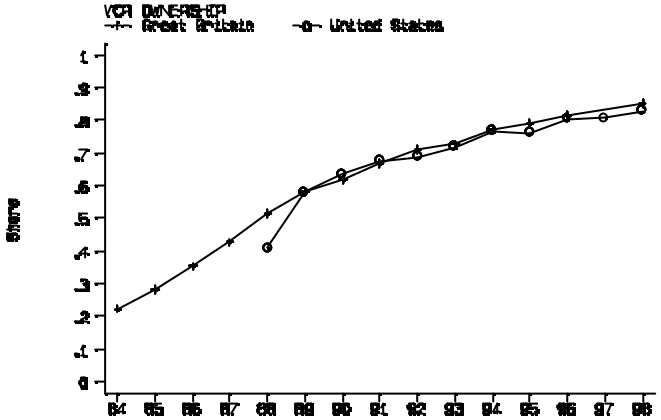


Figure 5B

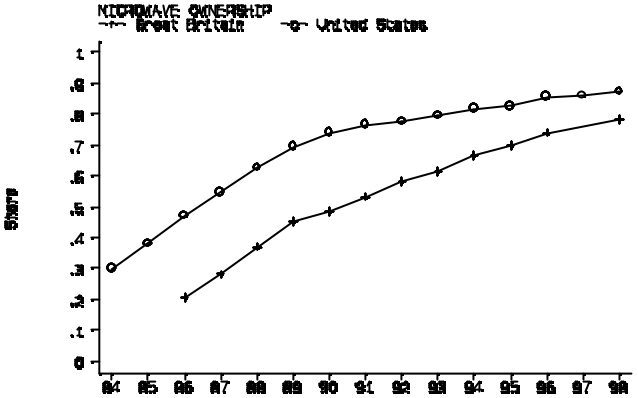


Figure 5C

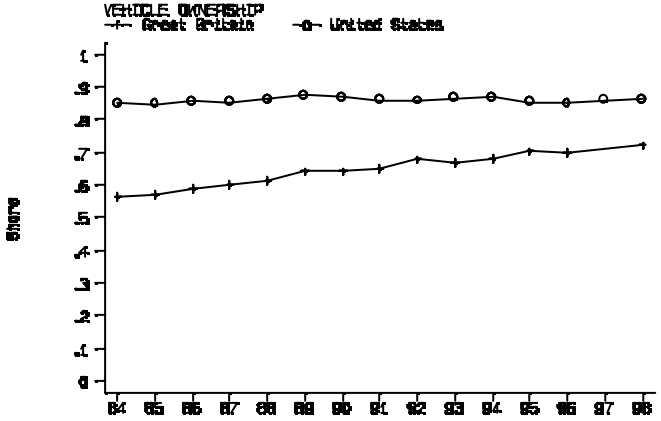


Figure 5D

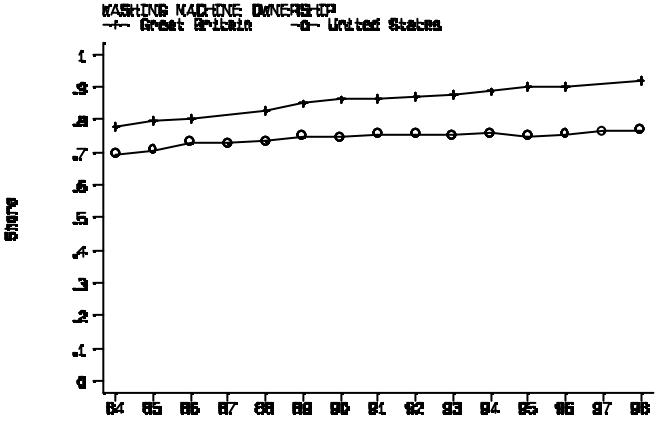


Figure 6A

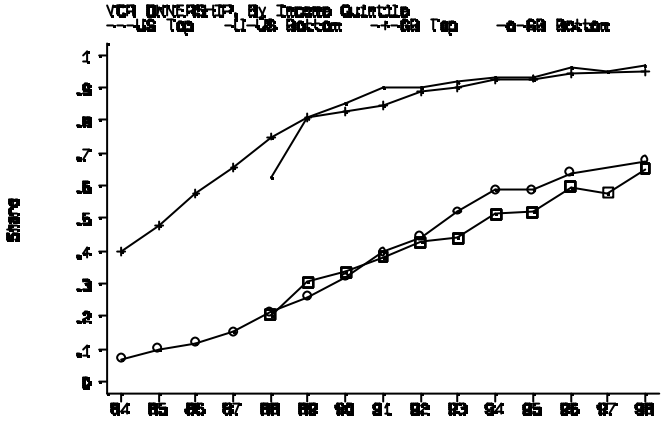


Figure 6B

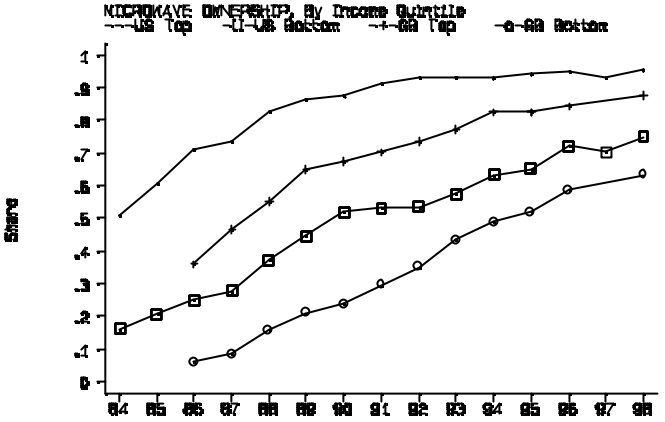


Figure 6C

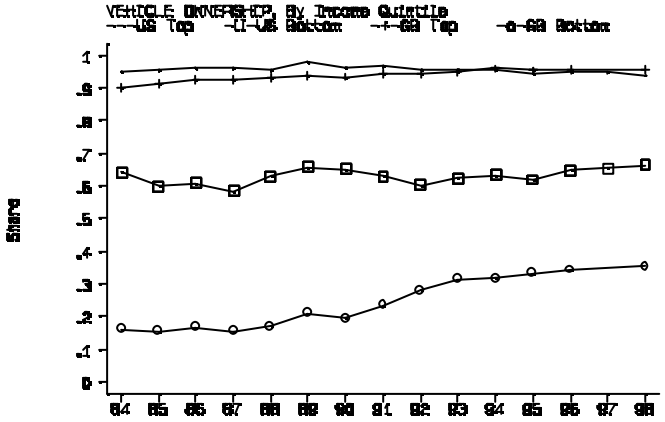
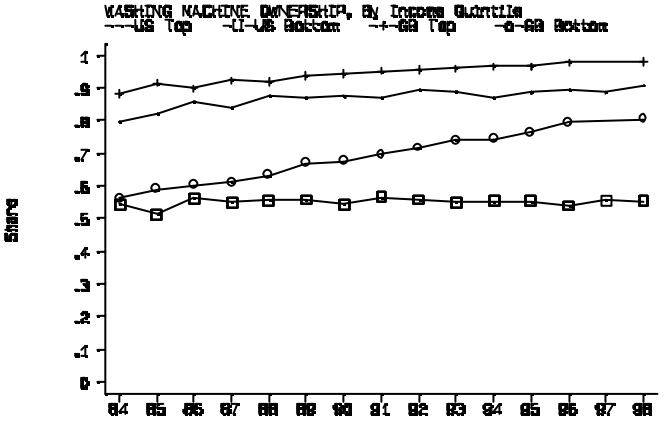


Figure 6D



Appendix Table 1: Means of variables in regressions in Table 5

	United States			United Kingdom		
	1988	1994	1998	1988	1994	1998
Computer Ownership	0.102	0.243	0.416	0.171	0.245	0.337
Income quintiles						
Fourth	0.203	0.201	0.203	0.201	0.200	0.200
Third	0.197	0.197	0.199	0.201	0.200	0.200
Second	0.200	0.200	0.201	0.199	0.200	0.200
Bottom	0.200	0.195	0.195	0.200	0.200	0.200
Education level						
Upper secondary	0.229	0.242	0.301	0.104	0.113	0.194
Lower secondary	0.306	0.314	0.283	0.270	0.287	0.248
Less than secondary	0.246	0.205	0.166	0.318	0.232	0.182
Age						
65+	0.223	0.225	0.217	0.289	0.266	0.262
55-64	0.113	0.103	0.103	0.147	0.135	0.145
25-39	0.347	0.326	0.307	0.270	0.291	0.287
16-24	0.083	0.075	0.079	0.057	0.045	0.032
Family type						
MCF no kids	0.221	0.213	0.219	0.370	0.361	0.348
Single male	0.132	0.134	0.124	0.116	0.120	0.143
Single female	0.160	0.153	0.170	0.208	0.193	0.192
Single kids	0.066	0.069	0.060	0.057	0.076	0.075
Other families	0.183	0.195	0.206	--	--	--
Race						
Not white	--	--	--	0.030	0.047	0.048
Black	0.101	0.101	0.098	--	--	--
Hispanic	0.062	0.077	0.087	--	--	--
Other	0.026	0.028	0.037	--	--	--
Sample size	4,479	4,253	4,408	7,114	8,515	7,529

Source: Authors' analysis of CE data for United States and GHS data for Britain.

Note: All variables are dummy variables.

Appendix Table 2
Responsiveness of ownership to log equivalent income, by income quintile

	Income quintiles				
	Lowest	Second	Middle	Fourth	Top
(a) United States					
1988	-0.005	0.006	-0.007	0.207*	0.092*
	(0.005)	(0.028)	(0.059)	(0.085)	(0.047)
1989	0.024*	-0.032	0.074	0.209*	0.114*
	(0.011)	(0.035)	(0.072)	(0.104)	(0.049)
1990	0.007	-0.006	-0.033	0.222*	0.146**
	(0.008)	(0.043)	(0.084)	(0.105)	(0.054)
1991	0.011	0.006	-0.010	-0.019	0.160**
	(0.010)	(0.042)	(0.073)	(0.114)	(0.055)
1992	-0.011	0.033	0.037	0.158	0.301**
	(0.007)	(0.046)	(0.083)	(0.123)	(0.060)
1993	0.004	0.079	0.272**	0.183	0.110#
	(0.011)	(0.049)	(0.102)	(0.119)	(0.059)
1994	0.022#	0.014	0.033	0.261*	0.269**
	(0.013)	(0.056)	(0.108)	(0.131)	(0.056)
1995	-0.013	0.106#	0.116	-0.021	0.156*
	(0.008)	(0.059)	(0.107)	(0.155)	(0.067)
1996	-0.016	0.196*	0.377**	-0.007	0.199**
	(0.015)	(0.084)	(0.140)	(0.173)	(0.069)
1997	-0.014	-0.053	0.229*	0.376**	0.222**
	(0.012)	(0.066)	(0.116)	(0.146)	(0.052)
1998	0.002	0.052	-0.110	0.119	0.116*
	(0.014)	(0.089)	(0.129)	(0.139)	(0.048)
(continued)					

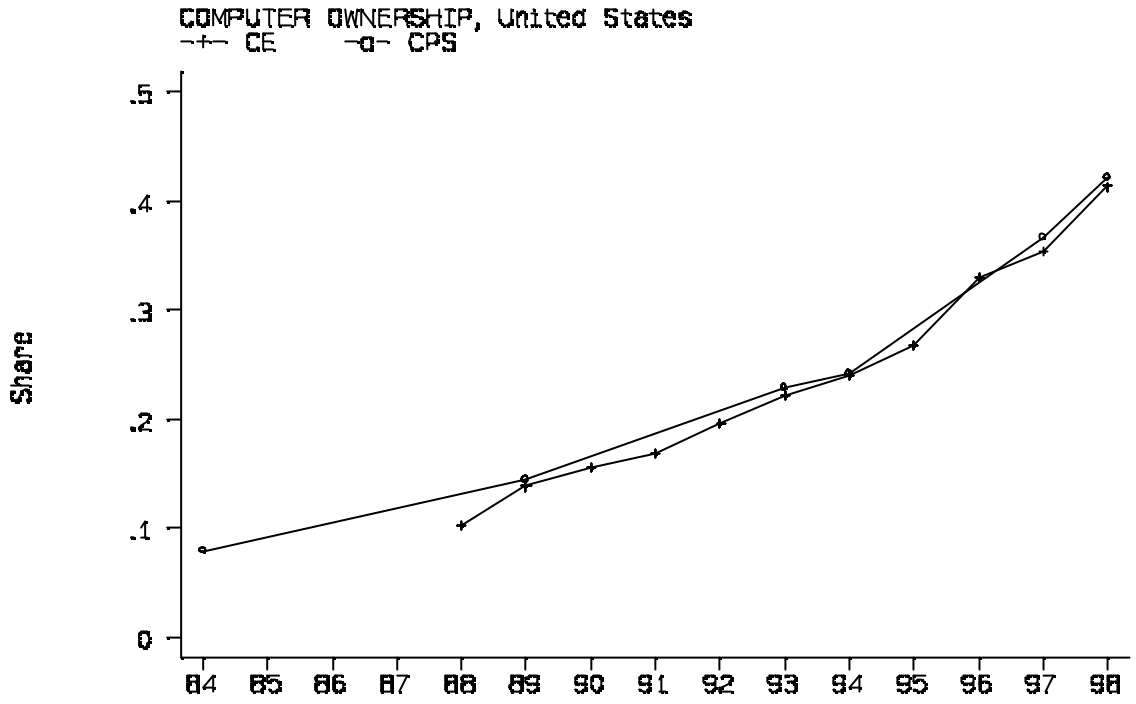
Appendix Table 2 (continued)
Responsiveness of ownership to log equivalent income, by income quintile

	Income quintiles				
	Lowest	Second	Middle	Fourth	Top
(b) Great Britain					
1988	0.002	-0.009	0.018	-0.070	0.107**
	(0.006)	(0.031)	(0.074)	(0.098)	(0.035)
1989	0.003	0.015	0.157*	0.126	0.097**
	(0.005)	(0.029)	(0.075)	(0.100)	(0.037)
1990	-0.003	0.056#	0.295**	0.104	0.064#
	(0.005)	(0.032)	(0.078)	(0.101)	(0.038)
1991	0.011	0.222**	0.006	-0.020	0.065#
	(0.021)	(0.080)	(0.100)	(0.107)	(0.039)
1992	0.001	0.100**	0.077	0.226*	0.049
	(0.009)	(0.038)	(0.070)	(0.093)	(0.035)
1993	-0.002	-0.034	0.083	0.242**	0.164**
	(0.007)	(0.036)	(0.064)	(0.087)	(0.036)
1994	-0.029*	0.000	0.070	0.052	0.089*
	(0.012)	(0.035)	(0.069)	(0.098)	(0.038)
1995	-0.017	-0.013	0.062	0.123	0.173**
	(0.013)	(0.090)	(0.093)	(0.110)	(0.038)
1996	-0.004	0.032	0.004	0.242*	0.230**
	(0.006)	(0.046)	(0.081)	(0.103)	(0.044)
1997	--	--	--	--	--
	--	--	--	--	--
1998	-0.028#	0.233**	0.333**	0.304*	0.191**
	(0.016)	(0.059)	(0.099)	(0.120)	(0.039)

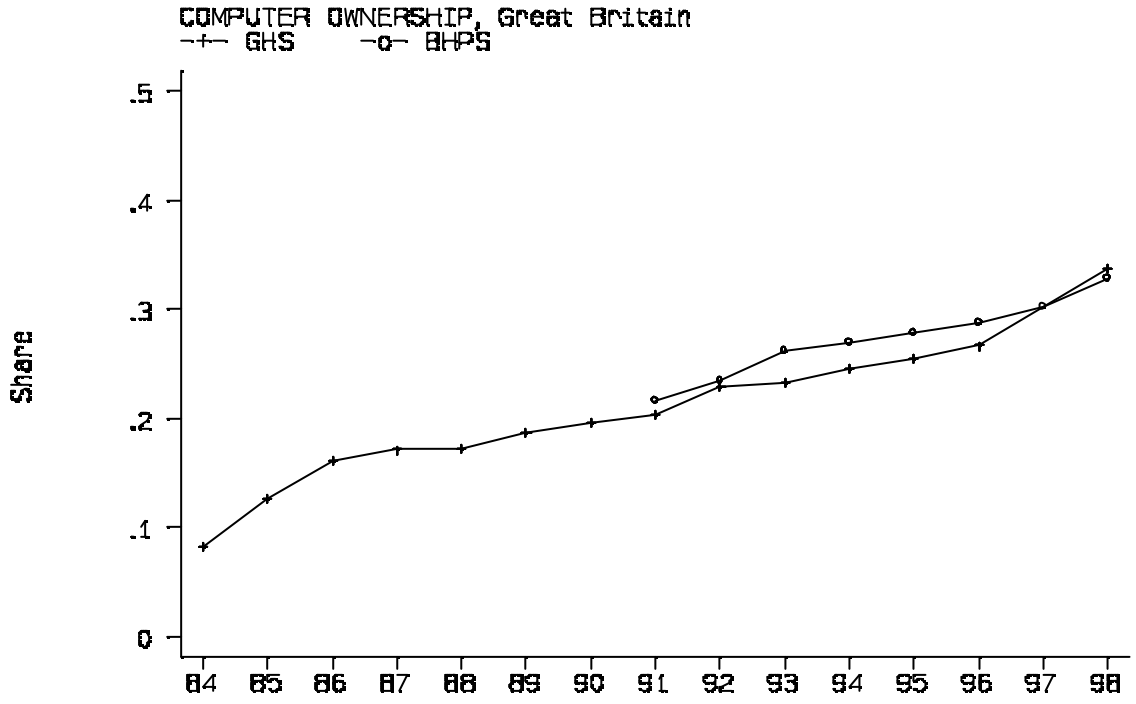
Source: Authors' analysis of CE data for the United States and GHS data for Great Britain.

Notes: As Table 7, except that regression sample are divided into 5 income within each year. ** indicates statistically significant at the 1% level; *, at the 5% level; and #, at the 10% level.

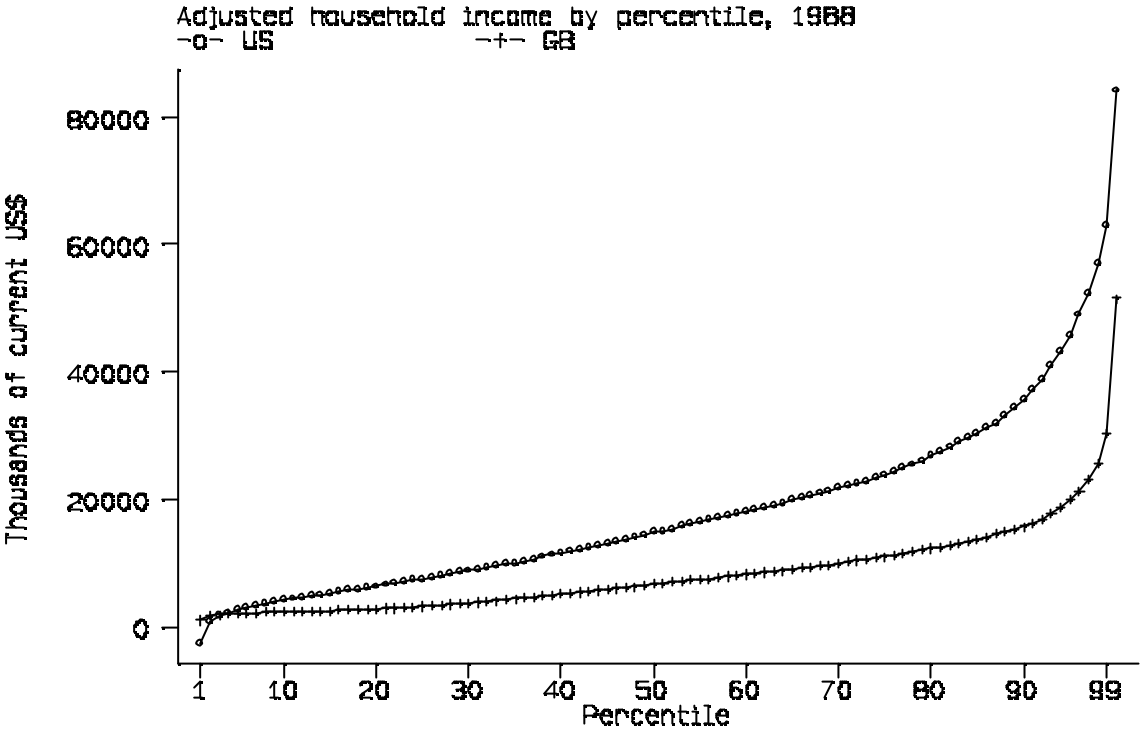
Appendix Figure A1



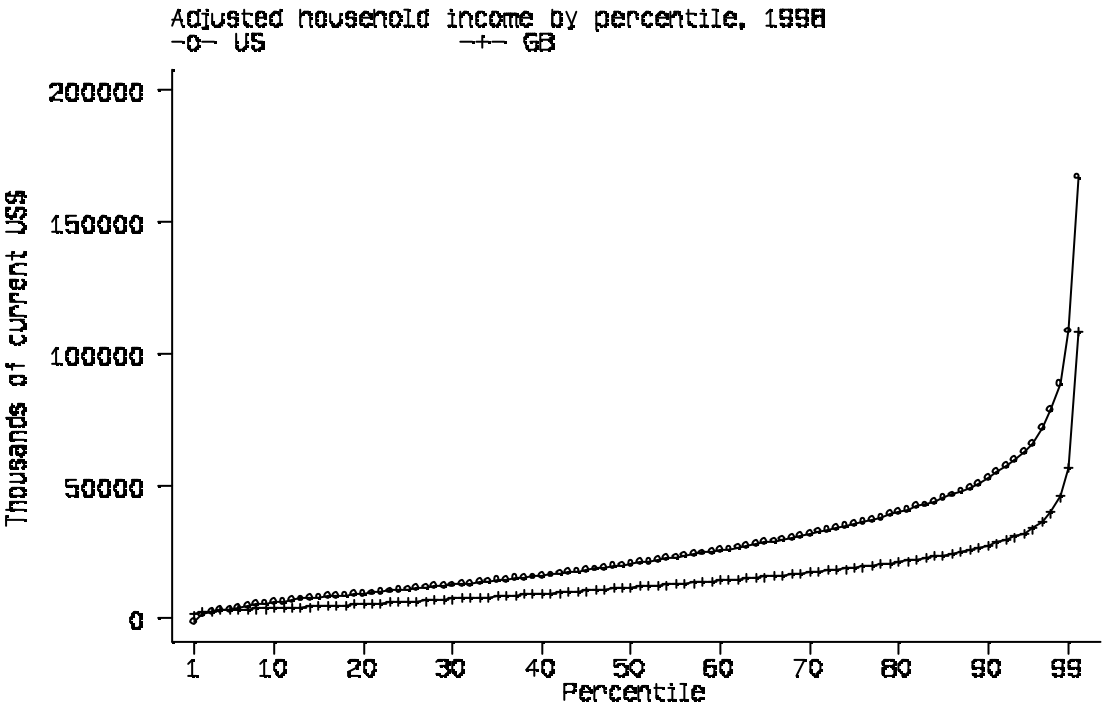
Appendix Figure A2



Appendix Figure 2A



Appendix Figure 2A



References

Autor, D., Katz, L. and Krueger, A. (1998), 'Computing Inequality: Have Computers Changed the Labor Market?', Quarterly Journal of Economics, vol. 113, no. 4, pp. 1169-1213.

Berman, E., Bound, J. and Griliches, Z. (1994), 'Changes in the Demand for Skilled Labor within US Manufacturing: Evidence from the Annual Survey of Manufactures', Quarterly Journal of Economics, vol. 109, no. 2, pp. 367-397.

Berman, E., Bound, J. and Machin, S. (1998), 'Implications of Skill-Biased Technological Change: International Evidence', Quarterly Journal of Economics, vol. 113, no. 4, pp. 1245-1279.

Bikson, T. and Panis, C. (1999), 'Citizens, Computers, and Connectivity: A Review of Trends', RAND corporation, MR-1109-MF.

DeNew, J. and Schmidt, C. (2001), 'Brothers in Rams. Diffusion of the PC and the New Economy', University of Heidelberg Working Paper.

DiNardo, J. E. and Pischke, J. S. (1997), 'The Returns to Computer Use: Revisited: Have Pencils Changed the Wage Structure, Too?', Quarterly Journal of Economics, vol. 112, no. 1, pp. 291-303.

Gandal, N., Greenstein, S. and Salant, D. (1999), 'Adoptions and Orphans in the Early Microcomputer Market', Journal of Industrial Economics, vol. 47, pp. 87-105.

Gomulka, J. and Stern, N. (1990), 'The Employment of Married Women in the United Kingdom', Economica, vol. 57, May, pp. 171-200.

Handel, M. J. (1999), 'Computers and the Wage Structure', Working Paper No. 285, Jerome Levy Economics Institute, Bard College, Annandale-on-Hudson, New York.

Howell, D. (1999), 'Theory-Driven Facts and the Growth in Earnings Inequality', Review of Radical Political Economics, vol. 31, no. 1, pp. 54-86.

Katz, L. F. and Autor, D. H. (1999), 'Changes in the Wage Structure and Earnings Inequality', in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3A. North Holland: Amsterdam, pp. 1463-1554.

Kominski, R. and Newburger, E. (1999), 'Access Denied: Changes in Computer Ownership and Use: 1984-1997', Paper presented at the American Sociological Association meetings, Chicago.

Krueger, A. B. (1993), 'How Computers Changed the Wage Structure: Evidence from Microdata, 1984-1989', Quarterly Journal of Economics, vol. 108, no. 1, pp. 33-60.

Machin, S. and Van Reenen, J. (1998), 'Technology and Changes in Skill Structure: Evidence from Seven OECD Countries', Quarterly Journal of Economics, vol. 113, no. 4, pp. 1215-1244.

Mishel, L., Bernstein, J. and Schmitt, J. (2001), *The State of Working America 2000-2001*, Cornell University Press: Ithaca, N.Y.

National Telecommunications and Information Administration (1999), *Falling Through the Net: Defining the Digital Divide*, Government Printing Office: Washington, D.C.

National Telecommunications and Information Administration (2000), *Falling Through the Net: Toward Digital Inclusion*, Government Printing Office: Washington, D.C.

Office of National Statistics (2000), 'Internet Access', (July) O.N.S.: London.

Rogers, E. (1995), *Diffusion of Innovations*, The Free Press: New York.

Stoneman, P. (ed.), (1995), *The Handbook of the Economics of Innovation and Technological Change*, Blackwell Press: Oxford.

Thierer, A. D. (2000), 'How Free Computers are Filling the Digital Divide', Backgrounder No. 1361, The Heritage Foundation: Washington, D.C.

US Bureau of the Census, Robert Komiski. (1988), Current Population Reports, Series P-23, No. 155, 'Computer Use in the United States: 1984', Government Printing Office: Washington, D.C.

US Bureau of the Census (1991), Current Population Reports, Series P-23, No. 171, 'Computer Use in the United States: 1989', Government Printing Office: Washington, D.C.

US Bureau of the Census (1998), *Questionnaire, Quarterly Interview Survey, Consumer Expenditure Surveys*.

US Bureau of the Census (1999), Current Population Reports, Series P-20, No. 522, 'Computer Use in the United States: 1997', Washington, D.C.: Government Printing Office.

CENTRE FOR ECONOMIC PERFORMANCE
Recent Discussion Papers

525	S. Fernie H. Gray	It's a Family Affair: the Effect of Union Recognition and Human Resource Management on the Provision of Equal Opportunities in the UK
524	N. Crafts A. J. Venables	Globalization in History: a Geographical Perspective
523	E. E. Meade D. Nathan Sheets	Regional Influences on US Monetary Policy: Some Implications for Europe
522	D. Quah	Technology Dissemination and Economic Growth: Some Lessons for the New Economy
521	D. Quah	Spatial Agglomeration Dynamics
520	C. A. Pissarides	Company Start-Up Costs and Employment
519	D. T. Mortensen C. A. Pissarides	Taxes, Subsidies and Equilibrium Labor Market Outcomes
518	D. Clark R. Fahr	The Promise of Workplace Training for Non-College Bound Youth: Theory and Evidence from Germany
517	J. Blanden A. Goodman P. Gregg S. Machin	Change in Intergenerational Mobility in Britain
516	A. Chevalier T. K. Viitanen	The Long-Run Labour Market Consequences of Teenage Motherhood in Britain
515	A. Bryson R. Gomez M. Gunderson N. Meltz	Youth Adult Differences in the Demand for Unionisation: Are American, British and Canadian Workers That Different?
514	A. Manning	Monopsony and the Efficiency of Labor Market Interventions
513	H. Steedman	Benchmarking Apprenticeship: UK and Continental Europe Compared
512	R. Gomez M. Gunderson N. Meltz	From 'Playstations' to 'Workstations': Youth Preferences for Unionisation

511	G. Duranton D. Puga	From Sectoral to Functional Urban Specialisation
510	P.-P. Combes G. Duranton	Labor Pooling, Labour Poaching, and Spatial Clustering
509	R. Griffith S. Redding J. Van Reenen	Measuring the Cost Effectiveness of an R&D Tax Credit for the UK
508	H. G. Overman S. Redding A. J. Venables	The Economic Geography of Trade, Production and Income: A Survey of Empirics
507	A. J. Venables	Geography and International Inequalities: the Impact of New Technologies
506	R. Dickens D. T. Ellwood	Whither Poverty in Great Britain and the United States? The Determinants of Changing Poverty and Whether Work Will Work
505	M. Ghell	Fixed-Term Contracts and the Duration Distribution of Unemployment
504	A. Charlwood	Influences on Trade Union Organising Effectiveness in Great Britain
503	D. Marsden S. French K. Kubo	Does Performance Pay De-Motivate, and Does It Matter?
502	S. Nickell L. Nunziata W. Ochel G. Quintini	The Beveridge Curve, Unemployment and Wages in the OECD from the 1960s to the 1990s
501	S. Redding M. Vera-Martin	Factor Endowments and Production in European Regions
500	Edited by D. Marsden and H. Stephenson	Labour Law and Social Insurance in the New Economy: A Debate on the Supiot Report
499	A. Manning	A Generalised Model of Monopsony

To order a discussion paper, please contact the Publications Unit
Tel 020 7955 7673 Fax 020 7955 7595 Email info@cep.lse.ac.uk
Web site http://cep.lse.ac.uk