The Digital Divide And Job Stability During The Great Recession

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ABSTRACT

Researchers and policy makers have identified the existence of a Digital Divide in the United States, between those who have access to the internet and technology in general, and those who do not. Most research into the relationship between the access to technology and labor market outcomes has revolved around on-the-job computer use and the extent to which it determines wages. Using a nationally representative dataset, this study looks instead at access to the internet at home prior to the Great Recession, and examines whether this is significantly related to job loss during the Great Recession. The results of this analysis indicate that internet access prior was a stronger predictor of job loss during the Great Recession than on-the-job computer use. With recent data that internet access levels in the United States may have plateaued for certain sections of the population, this finding has broad implications for both workers and employers, and lends urgency to the policy objective of expanding internet access.

Keywords: Internet Access; Digital Divide; Job Stability; Great Recession

INTRODUCTION

The question of whether the a worker's use of computers, on the job or at home, has a positive effect on future employment prospects of workers has been an important topic of recent research in labor economics. Ever since Krueger (1993) reported the finding that computer use accounted for a significant part of the wage differentials between workers, researchers have been trying to identify if this effect can be simply explained by occupation or other worker characteristics, or if technological ability by itself has labor market consequences for workers.

Computer Use And Labor Market Outcomes

The nature and direction of causality between the computer use and labor market success remains unclear. DiNardo & Pischke (1997) make the case that occupational effects, such as the initial education level required for an occupation, accounts for most of the wage differentials observed by Krueger (1993) among workers who use computers at work. A related, but largely unexplored, line of research is whether computer use at home – and more specifically, access to the internet at home, provides a better proxy for technological ability that employers recognize and reward. There is reason to believe that computer use at home provides a separate, and better, proxy for technological ability than work-related computer use. For example, research into human capital accumulation clearly shows that access to a home computer improves the educational achievement, and subsequent job prospects of teenagers (Farlie et al, 2010). Moreover, DiMaggio & Bonikowski (2008) use data from the Current Population Survey (CPS) to find robustly significant positive associations between home internet use and earnings growth. Interestingly, DiMaggio & Bonikowski's results hold even when for the sub-population of workers who use the internet only at home, leading them to the conclusion that home internet use provides a separate, and important, signal of technological ability from occupational characteristics.

Recent research into the returns of a worker's technological abilities & access to the internet bears out the intuition that there is a significant positive return to such abilities, possibly arising from an improved ability to search for jobs and related information. Most of the research in this area has centered around the availability of internet access of work, and the utility of the internet in enabling better job matching between employers and

workers. Goss et al (2002) find that on-the-job internet usage results in a 13.5 percent average wage gain and, interestingly, they also conclude that industries that are less intensive users of technology provide larger wage gains for internet usage than industries that are more technology-intensive. While research carried out using 1999-2000 CPS data by Kuhn & Skuterud (2004) into the effectiveness of internet-based job searches found that they were ineffective in reducing the likelihood of unemployment, Kuhn & Mansour (2014) use more recent data to find that this result is reversed in recent years, and internet job searches have a significant positive impact on reducing unemployment. Also, Stevenson (2008) uses state-level internet penetration rates to find that workers who have internet access at work are less likely to transition into unemployment and increased likelihood of wage growth when transitioning to other jobs.

The idea of a "digital divide" separating workers who have easy access to computers and the internet, and those that don't, has gained increasing relevance during the Great Recession. The concept was formalized with the U.S. Department of Commerce (USDC) in a series of reports entitled *Falling through the Net* released from 1995–2000 (USDC, 2000). In the years since the release of these reports, the evidence for the existence of such a digital divide in the United States has grown in the research literature. Using nationally representative data from the United States, Talukdar & Gauri (2011) not only find evidence for existence of such a divide along socioeconomic lines, but also for the growth of this divide between 2002 and 2008. Further, surveys by the Pew Internet and American Life Project find that the internet penetration levels has plateaued in the United States between in recent years for poorer socioeconomic groups, after steady increases for many years. Further, there has been little evidence to support the notion that the digital divide is strictly a generation or age-based effect. Loges & Jung (2001) find limited support for generational effects and that older Americans view internet access to be as central to their lives as younger cohorts. Given the importance of digital literacy in the current labor market environment, the contribution of such a gap in internet access to the overall employability of workers is an important and under-researched area of study.

Job Stability

The primary labor market outcome explored in this paper is job stability – more specifically, the probability of involuntary job loss. There are multiple reasons why this is a particularly interesting topic for research into the impact of technology use and availability. First, the impact of technology on wages has been researched at length in the literature but its impact on job stability remains less clear. The most relevant work in this area was done by Zavodny (2003), who looks at the relationship between technological intensity and job retention rates in the period 1980-98 and finds that the relationship varies according to the proxy used for technology. Also, Aaronson & Housinger (1999) use data on displaced workers to find that technological intensity is not significantly associated with job displacement or reemployment after displacement whereas Engemann et al (2005) identify technological change as one of the reasons for declining job tenure in recent years. However, these studies investigate job stability in general but do not specifically study the reasons for involuntary job loss. Secondly, the defining feature of the Great Recession has been the persistently high levels of unemployment and under-employment. Though studies such as Pissarides (2013) have suggested that there was an unusually high level of labor market mismatch during the Great Recession, the role that the technological capability of the workforce played in inducing job separations remains unclear.

RESEARCH QUESTIONS

This study adds to the literature on the impact of computer & home internet access on labor market outcomes by addressing the following research questions:

1. Does home internet access have an impact on involuntary job loss?
2. Is the effect of internet access at home on labor market outcomes comparable to that of on-the-job computer use?
3. How does this digital divide, if it exists, correlate with occupational and demographic determinants of job loss?

Further, by using longitudinal data that covers the recent recession in the United States, this study breaks new ground in providing insight into how the extent of the digital divide preceding the Great Recession might explain job loss during the recession. This is a question of immediate importance to both employers and workers: if internet availability is shown to have a measurable and significant effect on the probability of job loss during the recession, increasing the level of home internet access and improving digital literacy would clearly need to be a priority for public policy.

The rest of this paper is organized as follows: first, we discuss the data from the PSID used in this study, and highlights a few of the important variables and their derivation from the source data. Next, the section on analysis describes the salient statistical features of the dataset, describes the empirical model used to study the impact of internet access on job loss during the recession, and discusses the results obtained. Finally, the last section notes the implications of the results for future research.

DATA

The PSID is a longitudinal survey of U.S. families and their members that has been ongoing since 1968, with information collected about economic, demographic and other measures from the respondents. The sample has grown from the initial size of 4,800 families to over 8,500 families in the latest wave in 2011. From 1968-1996, the PSID interviewed and re-interviewed individuals from families in the core sample every year, including people who "split off" from their original families to form new families and people born into these families; other members of "new" families are interviewed while they are in these families but not followed if the family dissolves. Since 1997, the survey started dong biennial interviews and a sample of immigrant families was introduced in order to improve the representative nature of the survey population.

PSID data is especially well-suited to analyze the research questions posed above, since it contains a wealth of information regarding the respondents' job status, as well as other socioeconomic indicators. Since this analysis aims to isolate the impact of internet availability during the Great Recession, we focus on three consecutive waves of the survey: the 2007 cycle, which serves as our baseline for the pre-recession job status and other variables and the next two biennial rounds of the PSID (the 2009 and 2011 cycles), which we use to determine if a worker has lost their job during the recession.

Occupation

Given the importance of a worker's occupation in determining the impact of technological ability in the previous research literature, we use the occupational coding available in the PSID to establish the pre-recession occupation of each respondent as shown in Table 1. These occupational categories have been established as being important determinants of access to technology at work in previous research (DiNardo & Pischke, 1997), and we use the pre-recession occupational category as specified in this table to control for occupation-related exposure to technology.

Table 1. Occupational Categories

Occupational Category	Occupations Covered
Management & Finance	Management Occupations
	Business Operations Specialists
	Financial Specialists
STEM Fields	Computer and Mathematical Occupations
	Architecture and Engineering Occupations
	Life, Physical, and Social Science Occupations
Healthcare	Healthcare Practitioners and Technical Occupations
	Healthcare Support Occupations
Service	Protective Service Occupations
	Food Preparation and Serving Occupations
	Building and Grounds Cleaning and Maintenance Occupations
	Personal Care and Service Occupations
Sales	Sales Occupations
Clerical	Office and Administrative Support Occupations
Trades and Transportation	Construction Trades
	Extraction Workers
	Installation, Maintenance, and Repair Workers
	Production Occupations
	Transportation and Material Moving Occupations

Job Stability

To study job stability, we make use of the PSID's extensive employment records for all respondents. Specifically, we look at the population of respondents who reported at least one job in 2007 to establish our sample population for analysis. Next, we observe whether any of these respondents reported an involuntary job loss in 2009 or 2011 for use as our indicator of job stability. To determine whether the job loss was voluntary or involuntary, we make use of the question asked of all respondents who report changing jobs as to the reason for the change.

Respondents who provided any of the following reasons are identified as having suffered an involuntary job loss:

1. Company folded/changed hands/moved out of town; employer died/went out of business
2. Strike; lockout
3. Laid off; fired

Job-Related Computer Use And Home Internet Access

The PSID contains questions that ask the respondent whether their job entails routine computer use, and whether they can access the internet at home during every interview cycle. We make use of these questions, asked during the 2007 cycle, to construct our variables for job-related computer use and internet access at home. Note that the data from the 2007 cycle is used here for the same reason that we use it to determine occupational category, viz. that the objective of the study is to determine the extent to which pre-recession internet access and/or job-related computer use is related to job loss.

ANALYSIS

Descriptive Statistics

Our analysis of the data starts with summary descriptive statistics about the sample population along two important measures that have been shown by previous research to have implications for technology use and adoption: occupation and age.

First, we look at the distribution of pre-recession wages, as reported in 2007, by occupational category as shown below in Table 2. The pre-recession wage levels accord with previous research on occupational wage effects,

with workers in management, finance and STEM fields earning the highest wages and those in service occupations in particular, earning the least. The broad range of wages within each occupation also indicate the diversity of the PSID respondents, making it a good representative sample for study.

Table 2. Pre-Recession Wages By Occupation

Occupation	Mean ($)	Std Dev ($)	Minimum ($)	Maximum ($)
Healthcare	57,742.53	100,533.82	180.00	880,000.00
Clerical	34,470.17	20,679.69	25.00	128,000.00
Management/Finance	96,357.26	193,487.26	150.00	3,200,000.00
Other	46,224.29	57,869.72	250.00	1,200,000.00
Sales	56,49.43	72,776.84	300.00	650,000.00
Service	26,531.46	23,430.98	120.00	175,000.00
STEM Fields	73,192.52	47,360.31	300.00	550,000.00
Trades/Transportation	39,449.71	28,824.88	86.00	354,000.00

Next, we look at the mean levels of computer use on the job, and internet access at home by occupation, shown in Figures 1 & 2 below. The charts show the expected occupational distribution, with job-related computer use being heavily occupation-dependent, lending weight to the DiNardo & Pischke (1997) hypothesis that job-related computer use is really a proxy for occupational effects. As can be seen from Figure 2, Internet Access at home, while still showing a clear pattern with regard to occupation, has a much smaller range than job-related computer use – especially with regard to occupations that are not Management & Finance related or in the STEM fields. For all other occupations, the mean level of internet access varies only between 52.39% (for Service occupations) and 74.36% (for Sales occupations). This relatively small range gives us a reason to expect that internet access might provide additional information which cannot be obtained from a simple occupational analysis.

Figure 1. Job-Related Computer Use By Occupation

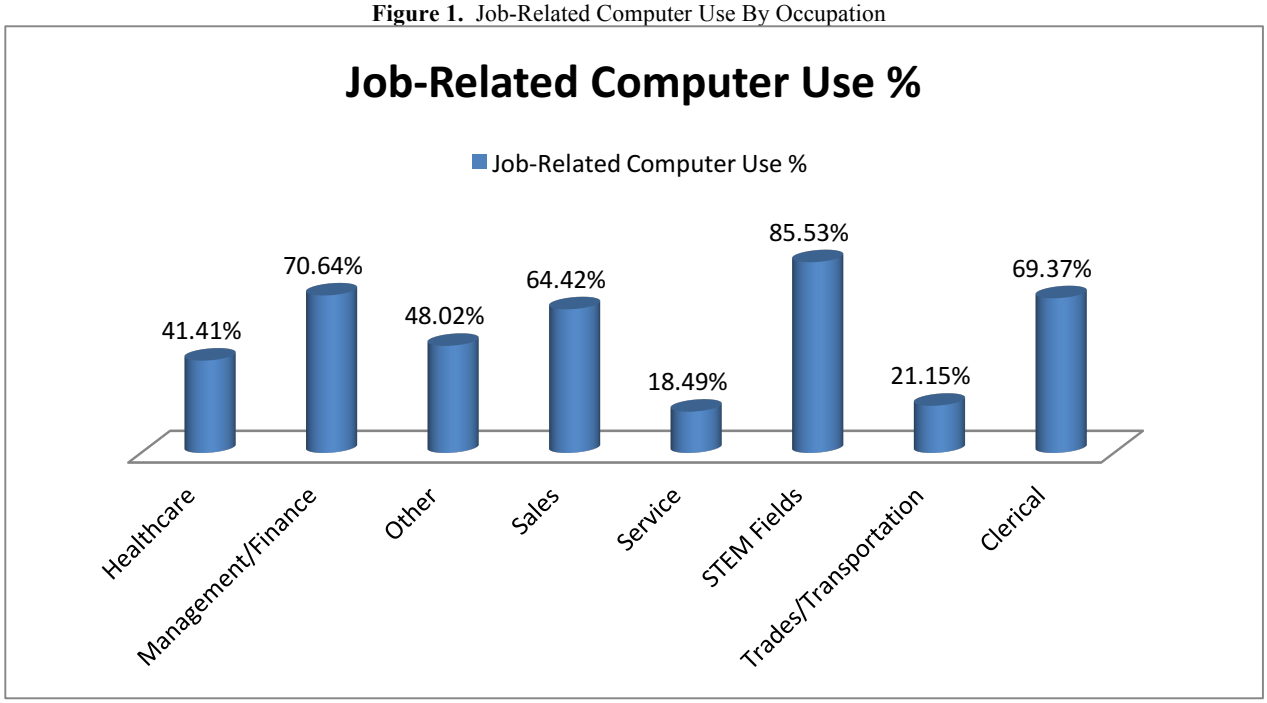
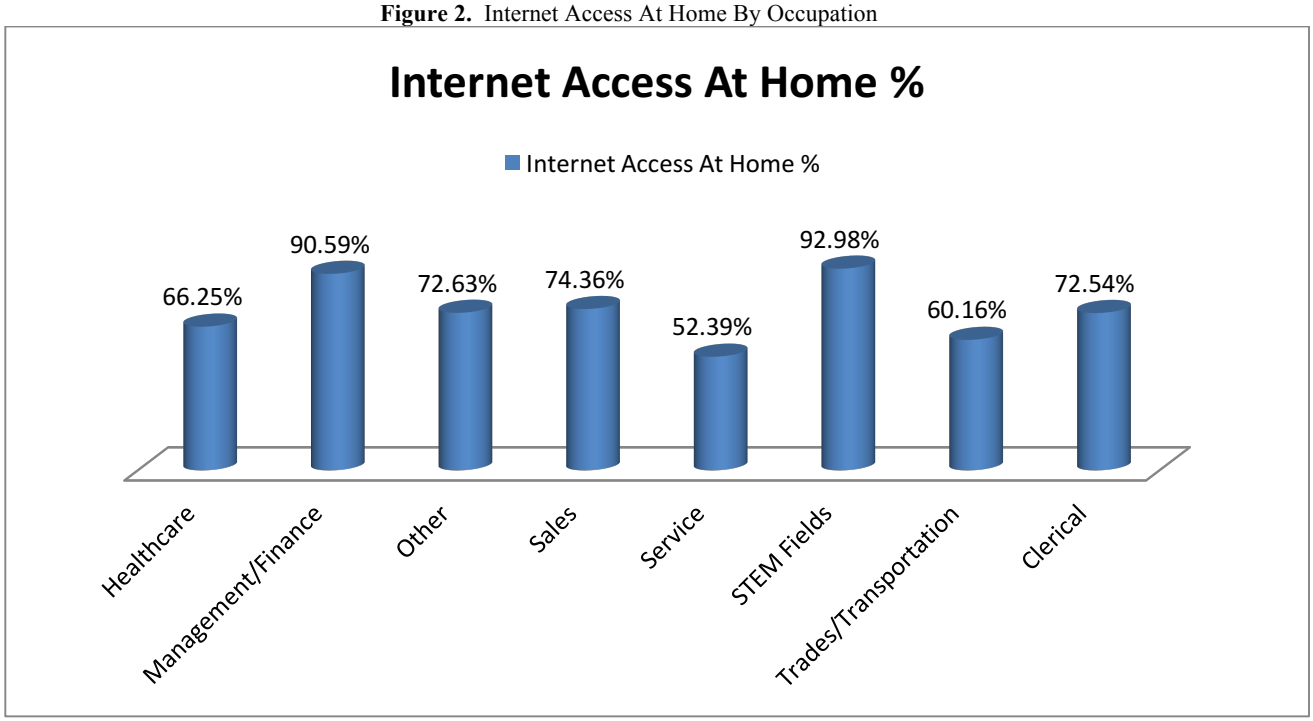


Figure 2. Internet Access At Home By Occupation



Next, we examine the age profile of workers who report having internet access at home. The age profile is interesting because of the research into the relationship between age, on-the-job computer use and labor market outcomes (Schleife, 2006), though no equivalent research exists regarding home internet access and labor market outcomes. The summary statistics do not reveal any major differences in this regard between the sub-populations of workers with and without internet access: workers who had home internet access had a mean age of 41.07 with a standard deviation of 11, versus a median age of 41.74 with a standard deviation of 13.09 for workers without internet access. As can be seen from the histograms of the age distribution of workers with and without internet access (Figures 3 & 4 respectively), the kernel distribution of workers in these two sub-populations also do not differ in a significant way.

Figure 3. Histogram Of Age Distribution For Workers Without Internet Access

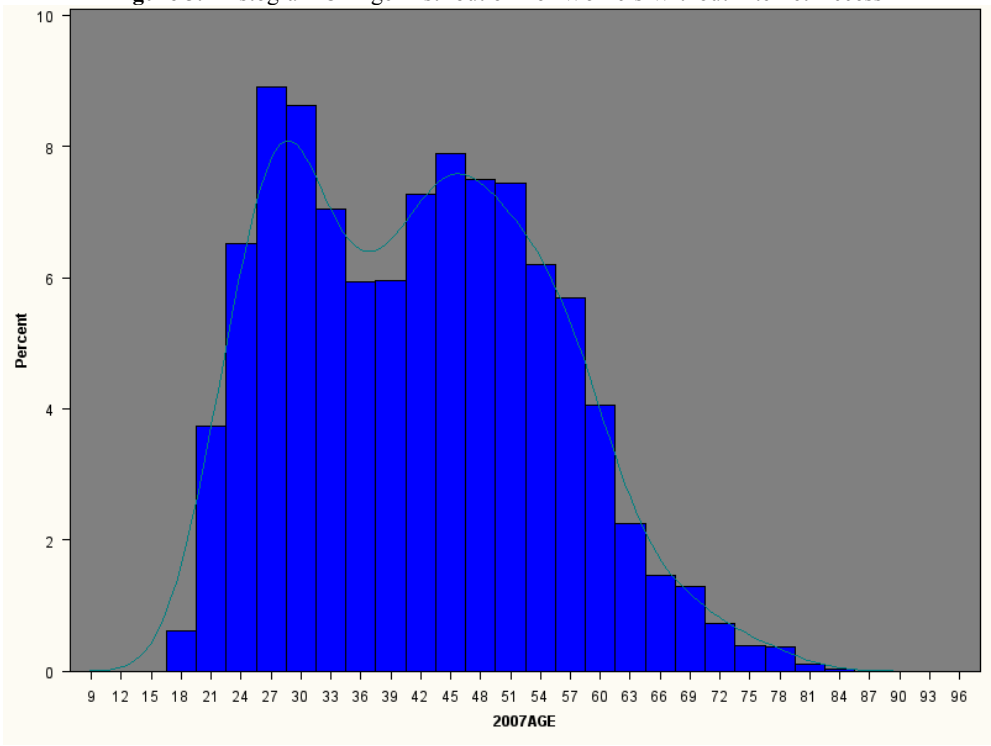
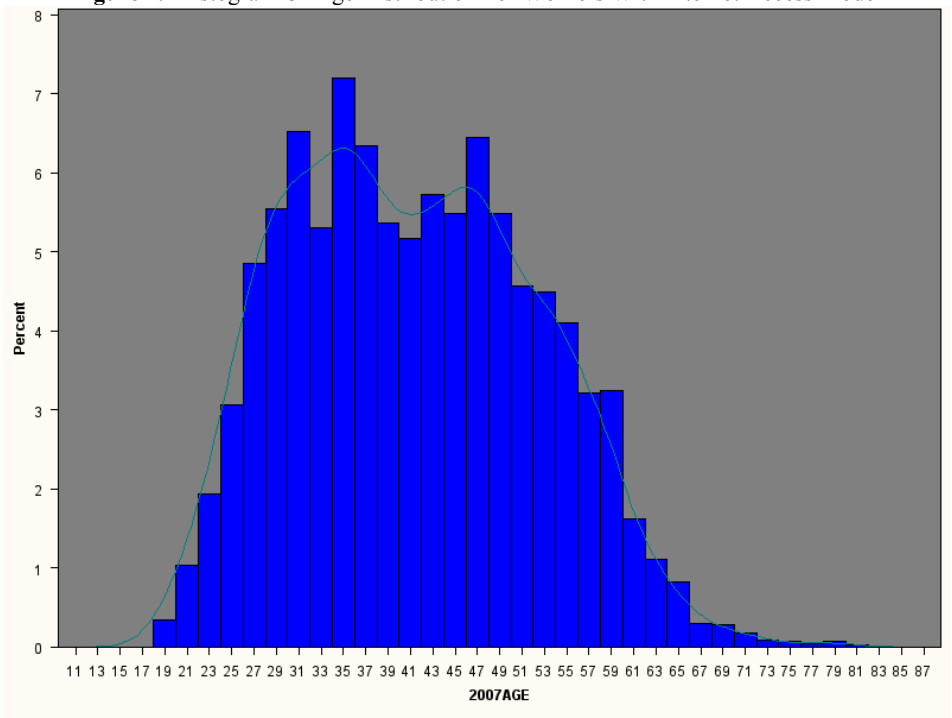


Figure 4. Histogram Of Age Distribution For Workers With Internet Access Model



The analysis now turns to modeling the impact of a worker's pre-recession individual and job characteristics on the likelihood of involuntary job loss during the recession. To do this, we define the variable:

U_i = 1, if the worker i reported involuntary job loss during the 2009 or 2011 waves of the PSID
= 0, otherwise.

In keeping with previous models on job stability, we can model the probability of job loss as:
$Logit\ (Prob(U_i = 1)) = I + \alpha_i T_i + \beta_i X_i$ where

1. Logit represents the log-odds function
2. T_i represents a measure of the worker's access to technology. This measure takes two forms – on-the-job computer use and at-home internet availability - which are used in two separate specifications of the model.
3. X_i is a vector of individual characteristics that influence job stability of worker. We control for a variety of factors that have been shown in previous research to influence job stability including (a) individual characteristics such as age, race and level of education represented by the receipt of a college degree (b) pre-recession wages and (c) dummy variables that represent occupational characteristics of the pre-recession job.

The odds-ratio estimates from this regression with home internet access as the variable T_i is shown in Table 3 below. As can be seen from this table, the effects of the individual characteristics of the respondent on involuntary job loss are consistent with the previous literature. For example, workers in clerical occupations, trades and transportation related occupations, and minorities show a significantly high probability of job loss during the Great Recession. The very large effect shown for workers in the trades, in particular, fits in well with the heavy job losses experienced in this sector due to the downturn in housing.

Table 3 shows that internet access has a strong, negative effect on the odds of job loss during the recession, even after controlling for age, education, race and occupational effects. In fact, having internet access is seen to have a comparable effect on preventing job loss to having a college degree, emphasizing the impact of this indicator.

Table 3. Logistic Regression Results With Internet Access As The Technology Variable

Odds Ratio Estimates

Effect	Point Estimate	95% Wald Confidence Limits	Effect
Occupation= Service	0.996	0.823	1.204
Occupation = Trades/Transportation	2.183**	1.896	2.513
Occupation = Clerical	1.534**	1.257	1.871
Age	0.990**	0.985	0.995
Education = High School	0.950	0.839	1.077
Pre-recession Wages (log)	0.806**	0.765	0.849
Race = Hispanic	1.322	1.056	1.654
Internet Access = Yes	0.819**	0.724	0.926
Race = Black	1.598**	1.407	1.814
Occupation = Stem Fields	1.291*	0.981	1.700
Education = College	0.867	0.736	1.020

* indicates significance at 0.05 level
** indicates significance at the 0.01 level

To compare the impact of internet access with that of on-the-job computer use, we run the same regression using on-the-job computer use as the indicator of the worker's access to technology. The results of this regression are shown in Table 4 below. These results are fairly similar to those in Table 3 with regards to demographic and other determinants of job loss. However, the effect of on-the-job computer use, while strong and significant, is found to be less than that of internet access as shown in Table 3. This demonstrates that internet access is an independent, and slightly stronger, predictor of job loss during the recession than on-the-job computer use.

Table 4. Logistic Regression Results With On-The-Job Computer Use As The Technology Variable

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	**Effect**
Occupation= Service	0.976	0.805	1.182
Occupation = Trades/Transportation	2.119**	1.834	2.449
Occupation = Clerical	1.579**	1.292	1.930
Age	0.990**	0.985	0.995
Education = High School	0.949	0.837	1.075
Pre-recession Wages (log)	0.802**	0.762	0.845
Race = Hispanic	1.376**	1.102	1.717
On-the-Job Computer Use	0.836**	0.730	0.957
Race = Black	1.620**	1.427	1.839
Occupation = Stem Fields	1.327*	1.006	1.750
Education = College	0.861*	0.732	1.014

* indicates significance at 0.05 level
** indicates significance at the 0.01 level

CONCLUSION

The results described above highlight the nature of the digital divide in the US population, and the high likelihood that this contributed to the magnitude of job loss during the Great Recession. While previous research has focused on the effects of technology adoption in the workplace, internet access at home has been shown to be an equally powerful indicator of labor market success, and this indicates that broadening such access needs to be a matter of urgency for public policy. While the dataset used for this study did not provide details on the nature of the reported internet access, national surveys such as the Pew Internet and American Life survey have shown that access to broadband internet is fast becoming a dividing line, with households in poorer socioeconomic groups and rural areas reporting significantly lower levels of such access. Given the results of this study, this divide is of concern to both workers and employers.

Another area for future research is the extent to which mobile internet access influences labor market outcomes. While mobile internet usage rates show generational divides rather than socioeconomic ones, it is unclear whether mobile internet access influences labor market outcomes in a similar fashion to broadband internet access, given that the cost of such access varies by usage in the United States. There is a paucity of longitudinal data sources that would allow the investigation of such effects of mobile internet access within and between cohorts at the moment. However, this should provide a promising line for future research as such sources become available.

AUTHOR INFORMATION

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REFERENCES

Aaronson, D., & Housinger, K. (1999).“ The impact of technology on displacement and reemployment.” Economic Perspectives-Federal Reserve Bank of Chicago. 23. 14-30.

Aubert, P., Caroli, E., & Roger, M. (2006). “New technologies, organisation and age: firm-level evidence”. *The Economic Journal*, 116:509. F73-F93.

DiMaggio, P., & Bonikowski, B. (2008)“Make money surfing the web? The impact of Internet use on the earnings of US workers”. *American Sociological Review*, 73:2. 227-250.

DiNardo, J. E., & Pischke, J. (1997). “The Returns to Computer Use Revisited: Have Pencils Changed the Wage Structure too?” *The Quarterly Journal of Economics*: 1. 291.

Engemann, K., Freiburg, L., & Owyang, M. T. (2005). "Keep your résumé current: The causes behind declining job tenure." *The Regional Economist*. January 2005.

Fairlie, R. W., Beltran, D. O. and Das, K. K. (2010). "Home Computers and Educational Outcomes: Evidence from the NlSY97 and CPS". *Economic Inquiry*, 48. 771–792.

Goss, E. P., & Phillips, J. M. (2002). "How information technology affects wages: Evidence using internet usage as a proxy for IT skills". *Journal of labor Research*, 23:3. 463-474.

Krueger, A. B (1993). "How computers have changed the wage structure: Evidence from Microdata, 1984-1989. *Quarterly Journal of Economics*. 108:33-60.

Loges, W. E., & Jung, J. Y. (2001). "Exploring the digital divide internet connectedness and age". *Communication Research.* 28:4. 536-562.

Kuhn, P., & Mansour, H. (2014). "Is internet job search still ineffective?" *The Economic Journal*.

Kuhn, P. and Skuterud, M (2000). "Job Search Methods: Internet versus Traditional." *Monthly Labor Review*, October 2000: 3-11.

Pissarides, C. A. (2013). "Unemployment in the great recession". *Economica*, 80:319. 385-403.

U.S. Department of Commerce (2000). *Falling through the net: Toward digital inclusion: A report on Americans' access to technology tools*. Washington, DC: U.S. Dept. of Commerce, Economic and

Statistics Administration, National Telecommunications and Information Administration.

Schleife, K. (2006). "Computer use and employment status of older workers—an analysis based on individual data." *Labour*, 20:2. 325-348.

Stevenson, B. (2008). "The Internet and job search" National Bureau of Economic Research. w13886.

Talukdar, D., & Gauri, D. K. (2011). "Home Internet access and usage in the USA: Trends in the socio-economic digital divide". *Communications of the Association for Information Systems*, 28:7. 85-98.

Zavodny, M. (2003). "Technology and Job Separation among Young Adults, 1980-98." *Economic Inquiry*. 41:2. 264-278.