ABSTRACT

Title of dissertation: THE NEW ECONOMY OF THE UNITED STATES: A NEW MODE OF PRODUCTION?

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In the past several years, academics, journalists, federal regulators and business gurus have been writing about the development of a New Economy in the United States. According to New Economy supporters, the recent technological developments in information technology and the expansion of globalization are changing the economy, producing increases in productivity, and creating economic growth. However, critics of the New Economy have emerged who argued against the veracity of the claims of New Economy supporters. A debate about the existence of a New Economy has ensued with supporters of the New Economy noting new changes and phenomena in the economy and critics expressing skepticism about either the existence of a New Economy or the claims of New Economy supporters. I endorse the view that there is a New Economy because the recent revolution in information technology can be seen as a new mode of production, where workers utilize computers in the performance of job tasks at work. However, the adoption and utilization of the computer varies by industry and thus adoption of a New Economy is also expected to vary by industry. I will use the October 1984, October

1989, October 1993, October 1997, and September 2001 Current Population Surveys to test my hypothesis that a new mode of production has been adopted by examining computer usage within the six major industries of the economy. By 2001, computer usage had become dominant in the industries of 'Finance, Insurance, and Real Estate,' 'Wholesale Trade,' 'Manufacturing,' 'Communications and Public Utilities,' and certain sectors of the 'Service' economy, which is a strong sign that a New Economy had been adopted in these industries by 2001.

THE NEW ECONOMY OF THE UNITED STATES: A NEW MODE OF PRODUCTION?

by

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DEDICATION

I dedicate this dissertation to my parents Alberta K. Hepler and Wayne Hepler for all their help and support throughout the years to make this possible.

TABLE OF CONTENTS

List of Tables vi

List of Figures viii

List of Abbreviations ix

Chapter 1 Introduction: Development of New Technology 1
- The New Mode of Production 5
  - Personal Computers 6
  - Internet 9

Chapter 2 Introduction to New Economy Supporters and Critics 12
- Classification of Supporters and Skeptics of the New Economy 12

- Introduction to the Critics of the New Economy 13
  - The New Economy Has Recently Faltered 14
  - The Old Economy Rules Have Not Changed 15
  - The New Economy is Less Impressive than Past Technological Revolutions 17
    - Direct Comparison 18
    - Absolute Comparison 19
  - Insufficient Data Exists 20
  - The New Economy is Not Well Developed and Has Changed Due to Natural Economic Change 21
- Conclusion 22

- Supporters of the New Economy 23
  - Supporters' Definitions of the New Economy 26
  - When Did the New Economy Begin? 32
  - Major Positions of New Economy Supporters 34

- Placing the Debate on the New Economy in the Proper Context: Late Capitalism 42
  - Profit, Capitalist Accumulation and Competition 44
  - Development of Information Technology 46
  - Expanding Globalization 47
  - Economic Restructuring 49
  - Deregulation 52
  - Finance 52
  - Expanding Service Economy 53
- General Theory of Historical Factors of Late Capitalism 54

TABLE OF CONTENTS

Chapter 3 Theory: New Economy as a New Mode of Production 61
Technology Diffusion and Past Technological Revolutions 61
Marxian Conception of a Capitalist Mode of Production 68
Articulation of the Concept of Mode of Production 71

The New Mode of Production and the New Economy 75
Office Technology as an Early Framework for Adoption 75
New Technology as a New Mode of Production 80
New Economy as a New Mode of Production 82

Measurement of a New Mode of Production 85
Development of Hypotheses: Diffusion of the New Economy in Different Industries 88

Chapter 4: Methods 95
Introduction 95
Description of Data 96
The Current Population Survey 96
Construction of the Data Sets 102
Evolution of the Current Population Survey 102
Reading in Raw Files 103
Data Experimentation 105
Filtered Responses 105
Creation and Checking of Data Sets 111
Variables Utilized in Current Population Survey 114
Socio-Economic Variables 115
Industry Recodes 116
Percentage of Knowledge Workers 125
Year Recodes 132
Part-Time and Full-Time Workers 133
Computer Usage Questions and Data 136
Internet Usage Questions and Data 140
Analysis 143
Regression Analysis 143
Hypotheses and Rate of Computer Usage 146
Weighting 150

TABLE OF CONTENTS

Chapter 5 Results: A New Mode of Production 151
Introduction 151
Descriptive Analysis of Key Variables across Time 152
Descriptive Analysis: Computer and Internet Usage over Time 159
Diffusion of Computer Usage over Time 159
Diffusion of Internet Usage over Time 161
Diffusion of Computer Usage over Time by Industry 163
Diffusion of Internet Usage by Industry 180
Diffusion of Computer Usage by Part-Time and Full-Time Workers 182
Diffusion of Internet Usage by Part-Time and Full-Time Workers 194

Hypotheses 195
Hypothesis I: Rate of Increase 197
Description of Rates 197
Support for Hypothesis I 202
Hypotheses 2: Level of Diffusion by 2001 211

Chapter 6 Conclusion and Discussion 219
Discussion: The Impact and the Future of the New Economy 225
Limitations and Future Research 227

References 231

LIST OF TABLES

1.	Percentage of Knowledge Workers by Major Industry, 1984-2001	91
2.	Actual Dates of Current Population Survey	97
3.	Description of Sampling Design in Current Population Survey	98
4.	Number of Records in Data Set Before and After Filtering	110
5.	Recode of Major Industry	122
6.	Changes in Occupational Classification Codes from 1989 to 1993	129
7.	Recode of Part-Time/Full-Time Employment into Dummy Variable	135
8.	Recode of Computer Usage into Dummy Variable	137
9.	Frequency Distribution of All Major Industries in the Private Sector, 1984-2001	153
10.	Frequency Distribution of Major Industry in the Private Sector, 1984-2001	157
11.	Frequency Distribution of Full-Time and Part-Time Workers in the Private Sector	158
12.	Computer Usage at Work in the Private Sector, 1984-2001	159
13.	Internet Usage at Work in the Private Sector, 1993-2001	161
14.	Computer Usage at Work by Industry in the Private Sector, 1984-2001	170
15.	Computer Usage at Work in the Service Industry in the Private Sector, 1984-2001	171
16.	Computer Usage at Work by the Industries of Mining, Construction, Manufacturing, Forestry and Fisheries in the Private Sector, 1984-2001	172
17.	Computer Usage in All Major Industries in the Private Sector, 1984-2001	173

LIST OF TABLES

18.	Internet Usage by Industry for Private Employees, 1993-2001	182
19.	Computer Usage at Work for Full-Time and Part-Time Workers in the Private Sector, 1984-2001	183
20.	Computer Usage at Work by Industry for Full-Time and Part-Time Workers in the Private Sector	185
21.	Percentage of Part-Time Workers in the Private Sector by Major Industry, 1984-2001	191
22.	Percentage of Full-Time Workers in the Private Sector by Major Industry, 1984-2001	192
23.	Percentage of Part-Time Knowledge Workers in the Private Sector by Industry, 1984-2001	193
24.	Internet Usage by Full-Time and Part-Time Private Employees, 1993-2001	195
25.	Rates of Computer Usage in the Private Sector by Industry, 1984-2001	198
26.	Rates of Computer Usage within All Major Industries, 1984-2001	204
27.	Knowledge Workers in All Major Industries of the Private Sector, 1984-2001	205
28.	Computer Usage within Transportation, Communications, and Public Utilities in the Private Sector, 1984-2001	213
29.	Computer Usage within the Trade Industry of the Private Sector, 1984-2001	214

LIST OF FIGURES

1.	Theoretical Model of the New Economy within the Context of Late Capitalism	56
2.	Difference in Computer Usage from Overall Rate by Industry in the Private Sector, 1984-2001	149
3.	Percent Computer Usage in Agriculture, 1984-2001	164
4.	Percent Computer Usage in Transportation, Communications & Public Utilities, 1984-2001	165
5.	Percent Computer Usage in Wholesale & Retail Trade, 1984-2001	166
6.	Percent Computer Usage in Finance, Insurance & Real Estate, 1984-2001	167
7.	Percent Computer Usage in Services, 1984-2001	168
8.	Percent Computer Usage in Mining, Construction, Manufacturing, Forestry & Fisheries, 1984-2001	169
9.	Rates of Computer Usage in the Private Sector by Industry, 1984-2001	199

LIST OF ABBREVIATIONS

1.	GDP	Gross Domestic Product	1
2.	ICT	Information and Communication Technologies	1
3.	IT	Information Technology	1
4.	Dot-com	Internet company	1
5.	GUI	Graphical User Interface	2
6.	WWW	World Wide Web	2
7.	PC	Personal Computer	2
8.	G-7	Group of Seven (includes France, United States, United Kingdom, Germany, Japan, Italy, and Canada)	4
9.	IPO	Initial Public Offering	5
10.	IBM	International Business Machines Inc.	6
11.	IBM PC	International Business Machines Personal Computer	6
12.	DOS	Disk Operating System	6
13.	LAN	Local Area Networks	7
14.	UCLA	University of California Los Angeles	9
15.	U.S.	United States	9
16.	TCP/IP	Transmission Control Protocol/Internet Protocol	9
17.	DARPA	Defense Advanced Research Projects Agency	9
18.	ITV	Interactive Television	9

LIST OF ABBREVIATIONS

19.	DSL	Digital Subscriber Line	9
20.	Wi-Fi	Wireless Fidelity	10
21.	NASDAQ	National Association of Securities Dealers Automated Quotations	14
22.	Web	Internet	17
23.	CEO	Chief Executive Officer	29
24.	Kmart	Discount department store chain	32
25.	e-commerce	Electronic commerce	37
26.	R&D	Research and Development	40
27.	GNP	Gross National Product	47
28.	WWII	World War II (Second World War)	49
29.	OPEC	Organization of Petroleum Exporting Countries	50
30.	PT	Part-time	50
31.	U-Turn	U-Shaped curve	51
32.	CI	Continuous Improvement	58
33.	TQM	Total Quality Management	58
34.	BPR	Business Process Reengineering	58
35.	CPS	Current Population Survey	87
36.	BLS	Bureau of Labor Statistics	97
37.	PSU	Primary Sampling Units	98
38.	FT	Full-time	101
39.	NBER	National Bureau of Economic Research	104

LIST OF ABBREVIATIONS

40.	SPSS	The Statistical Package for the Social Sciences	113
41.	ESR	Employment Status Recode	114
42.	SIC	Standard Industrial Classification	126
43.	N.E.C.	Not Elsewhere Classified	129
44	SOC	Standard Occupational Classification	129
45	NA	Not Applicable	137
46.	NIU	Not in Universe	137
47.	RAM	Random Access Memory	160
48.	CIM	Computer-Integrated Manufacturing	181
49.	LR-GIS	Land Resource Geographic Information System	190

Chapter 1 Introduction: Development of New Technology

In the past several years, academics, journalists, federal regulators and business gurus have been writing about the development of a New Economy in the United States. Former Federal Reserve Chairman Alan Greenspan was reported saying: "It's certainly become increasingly difficult to deny that something profoundly different from the typical postwar business cycle has emerged in recent year[s] (Executive Editor 2000:31)." Abramovitz and David (2001) pointed out that the New Economy has been associated with various things, such as: 1) positive economic growth as measured by the rise in productivity in the 1990s, growth in the Gross Domestic Product (GDP), lower unemployment, and lower inflation; 2) growth in the high-tech sector of the economy, focusing particularly on information and communication technologies (ICT), and their subsequent use by business; and 3) increased investment in the IT sector and the rise in stock prices of information technology (IT) companies. According to New Economy supporters, the recent technological developments in information technology and the expansion of globalization are changing the economy, producing increases in productivity and creating economic growth. So since the economic conditions of capitalism seem to have changed, the question easily becomes is there a New Economy?

However, critics of the New Economy have expressed skepticism. Several critical positions have emerged: 1) the recent technological changes are immature, 2) the New Economy has faltered as the dot-com bubble burst, stock prices fell, and the economy entered a recession, 3) the rules of the Old Economy still exist, 4) the influence of information technology is less impressive than the influence of past technological innovations, 5) the natural evolution of the economy may have produced the observed

changes in the economy, and 6) insufficient data exists to justify the conclusion that there is a New Economy. A debate about the existence of a New Economy has ensued with supporters of the New Economy noting new changes and phenomena in the economy and critics expressing skepticism about either the existence of a New Economy or the claims of New Economy supporters. However, the debate diminished in light of the technology recession that led to a more general economic recession. DeLong (2002), who is now a supporter, argued that claims of a New Economy are less powerful and numerous today because of the technology recession and stock market devaluation.

My view on the New Economy is that the adoption and use of new computing technology by business constitute a new way in which work is being performed, and is fundamentally different from the performance of work using less advanced office technology. With the decline in the price of IT and the development of more efficient computers, businesses were more inclined to purchase computers to keep up to date with new technology, maintain par with competitors, increase productivity and consequentially profit margins. Additionally, in the mid-1990s, the Internet became more user-friendly with the introduction of a graphical user interface (GUI) and the World Wide Web (WWW), which provided the necessary technological development for the explosion in Internet usage in the mid-to-late 1990s. As a result of the new technology offered by more efficient and faster personal computers (PC) and a quickly developing Internet, the process of work changed as businesses purchased new technology, and workers began using this new technology on a more wide spread basis. Use of new computing technology to perform work is similar to Marx's ([1867] 1977) description of the use of machines and the development of large-scale manufacturing as a new mode of

production, which amounted to the development of the industrial economy in the nineteenth century. Thus, I view the use of new computing technology to perform work tasks as something that is new and can be considered a new mode of production. In response to the critics who believe that the New Economy is short-lived due to media hype that fueled belief in a New Economy, a technology boom that failed to materialize long-term growth, or a large number of new technology startup firms that later went out of business, my perspective on the New Economy is more long-term. I argue that the nature of work has changed in the use of new information technology by workers and in the adoption and diffusion of new information technology throughout the economy.

While computers would be expected to be a critical aspect of the New Economy, surprisingly, not all New Economy supporters would agree. For example, Kelly (1998) claimed that the New Economy is about communication and the technological transformation of communication rather than computers, which have already produced consequences for us. I disagree with Kelly because I believe that computers are fundamental to the New Economy. Computers and the Internet provide the technological background to have the communication that Kelly refers to as being critical to the New Economy. Computers allow workers to work in a different way than work performed manually or with less sophisticated technology like the typewriter. Computers have become a critical part of the workforce and thus are paramount to a claim of a New Economy. Additionally, some critics argue that the introduction of new technology is part of the process of technology increasing productivity in the Old Economy. Thus, the adoption of computer technology is not fundamentally new. However, my focus is not on

the adoption of new technology, but on the use of new technology as a new way of performing work which can be argued to constitute a new mode of production.

My dissertation will focus on the use of computing technology at work as a new mode of production solely in the United States. Castells ([1996] 2000a) might disagree with limiting my analysis of the New Economy to the United States because Castells believes that the New Economy is a global phenomenon. However, I decided to focus on the United States because the United States is seen as a world leader in the New Economy. For example, Salvatore (2003) showed that the New Economy developed more quickly in the United States than the other G-7 countries. Thus it makes sense to study the use of computing technology as a new mode of production in the United States.

Another goal of this dissertation is to attempt to provide better clarity and organization to the literature on the New Economy. The literature on the New Economy is vast and expansive and consists of both academic and non-academic sources. The academic literature is better at explaining the New Economy where the non-academic literature is better at describing it. However, among both academic and non-academic literature, only a small number of articles and books actually attempt to define, meaningfully characterize, or provide developed theory of the New Economy. Thus, literature supporting the New Economy is not organized into a developed research program, which also might be expected because the New Economy is relatively new at this point in time. Thus, an attempt to provide clarity is greatly needed.

Part of the confusion in the New Economy literature relates to the mention of many diverse characteristics associated with the New Economy such as information technology, globalization, biotechnology, finance, deregulation, economic restructuring,

and the service economy. I address these characteristics in the literature review section and put them in the proper context of late capitalism. Another reason for confusion over the nature of the New Economy is that the label 'New Economy' has been over used. For example, McGraw (1999:16) claimed that the use of the label "new economy" in the 1990s has referred to "everything from greater yields on Kansas wheat farms, to better inventory control at Midwest auto parts factories, to billion-dollar IPOs for Silicon Valley dot-com companies." Thus, there are diverse characterizations of the New Economy that have prevented a coherent conceptualization of the New Economy. Additionally, according to Gadrey (2003), a critic of the New Economy, there is no theory of the New Economy, and few scholarly studies of the New Economy exist; those that do, are almost always critical of the New Economy. Therefore, one purpose of this dissertation is to provide clarity of the New Economy by offering a coherent theoretical conception of the New Economy.

The New Mode of Production

Of key importance to the new mode of production of computing technology is use of the computer and Internet by employees as they perform job-related tasks in a networked work environment. Computers allow for the use of software to produce documents electronically for the purpose of work. The Internet allows for sharing information electronically, electronic communication, and the gathering of necessary information on job-related tasks. I will now trace out the history of the development of the personal computer and Internet.

Personal Computers

Computers have been in existence for several decades. Mohseni (1993) described different generations of computers based on electronic component technology. In the first generation of computers, the vacuum-tubes were used in the first computer, which was developed in 1945 by John Mauchly and John Eckert. Computers that used vacuum-tubes were still in production in the late 1950s. The second generation of computers used transistors, which were developed in 1948, but did not become dominant, replacing vacuum-tube technology, until 1958 to 1965. In 1965, the third generation of computers was developed and used the semiconductor or integrated circuit, which later led to microchips.

Hobijn and Jovanovic (2001) note that in 1971, Intel created their first microprocessor, which made PCs possible. As the power of the microprocessor would double every 18 months according to Moore's Law, computers would become more important to business (Hobijn and Jovanovic 2001). Kidder (1981) mentioned that by the late 1970s computers were part of nearly every business organization.

However, the computer was not efficient, user-friendly, or easy to use by business until much later. Personal computers became available beginning in the 1980s. Earles (2001) claimed that in 1981, International Business Machine Inc. (IBM) introduced their first microcomputer and the microcomputer industry expanded because the PC was faster than competitors. The IBM personal computer (PC) included Microsoft's Disk Operating System (DOS) software that had to be loaded into the computer by disk (Earles 2001). The hard-drives were introduced two years later (Earle 2001). IBM also installed an Intel

microprocessor (Manasian 1993)[1]. The next important development was the connection of personal computers in a network. In 1986, Horwitt (1986) claimed that they were working on connecting to local area networks (LAN) into mainframes and networks. Cool (1986) reported that PCs were hooked to mainframes, but the hope was that IBM 'Logical Unit 6.2 Communications protocol' would allow PCs to replace mainframes and remain networked. While PCs and networking had entered the marketplace, full replacement of older technology was not immediate. Greenbaum (1995) claimed that PCs replaced mini-computers at the end of the 1980s.

It was not until the 1990s that the computer showed promise of greater efficiency and ease of use to business. By 1993, Carter (1993) claimed that the office was turning digital and was influenced by advances in information technology, the motivation for opportunities in cost reduction, increased productivity, and better customer service that information technology hoped to provide. This led to increased investment in personal computers. According to a survey done by Computer Reseller News Magazine and Gallup, small and midsize businesses drastically increased spending on PCs by nearly 50% in 1994 (Roberts 1995). Sales were influenced by first time buyers, a strong economy, lower prices, new features, and new software (Roberts 1995).

Software products have expanded since the 1980s and helped to facilitate more efficient computing technology. Wagstaff (2002) claimed that there was not much software in the 1980s. One response was to develop "shareware," where individuals would develop software, and then users would try out the software and buy it, if they planned to use the product. Later upgrades were free. Shareware originally focused on

[1] Due to the dearth of scholarly literature on the New Economy, I am also using popular press literature as sources. The popular press literature has an asterisk next to each of them in the references section.

general software like spreadsheets, but large companies took over this market and "shareware" companies moved over to specialized products, such as utilities to fix computer glitches (Wagstaff 2002). By the 1990s, Lewis (2000) mentioned that there had been a change to developing software to make computers do new things instead of making better hardware at a lower price. Johnson (1995) reported that Microsoft's Windows 95 was expected to set the "new software standard," since new PCs would contain Windows 95 and Windows 95 was very easy to use. However, Microsoft has faced potential competition with its operating system from an unlikely source, open-source software. According to Belsie (1999), open-source software is where programmers release software versions and other programmers improve on it and release the improved versions, which is how Linux works. However, the open-source software market soured very quickly because their customers were mainly failing dotcoms (Associated Press 2002).

As we can see, it took many years to make the personal computer capable enough to be desirable for widespread use by business. Computers had to overcome inefficiencies, problems with usage, memory and processing speed, compatibility issues, primitive software, and high costs for the computer. Therefore, the personal computer became more widely used as it became more user-friendly, more efficient, more powerful, and cheaper. As a result, customers received personal computers that were significantly better than past computers at a fraction of the cost of computers in the past. An obvious consequence was greater adoption of personal computers by business.

Internet

The second major development in the New Economy was the Internet revolution. The Internet appears to the common lay person to be a completely new technology, but has actually been around longer than the personal computer. Johnson (1999) reported that the Internet began in 1969 when computers were first connected at the University of California at Los Angeles (UCLA) and Stanford University. Ladermann (1985) claimed that the U.S. Department of Defense created Transmission Control Protocol/Internet Protocol (TCP/IP), or the early Internet. More specifically, the Defense Advanced Research Projects Agency (DARPA) under the Department of Defense created the Internet (Associated Press 2003). Johnson (1999) noted that the next big advancement in the Internet occurred in 1991 with the introduction of the World Wide Web. The Internet expanded after Netscape was incorporated in April 1994 and companies realized the future was hooking up the computer to the Internet, not Interactive Television (ITV) (Lewis 2000). However, the Internet did not become a mass technology until after 1995. Sharette (1995) reported that Internet browsing traffic was still low in mid-1995, and Internet connections remained slow. For example, Sandberg (1997) reported that in May 1997, email could be slow and could take hours or possibly days to be received. However, the speed of Internet access was about to pick up. Bickers (1998) reported that Digital Subscriber Line (DSL) and cable modems offered much faster Internet access than 56 kbps modems and were beginning to be used in Asia. Despite these original limitations, Atkinson and Court (1998) claimed that the adoption of the Internet occurred much quicker than the PC, television, and telephone. Citing data from Cyber Dialogue,

Inc., Atkinson and Court (1998) reported that the percentage of American adults online more than doubled from less than 10% in 1995 to over 20% (nearly 22%) by 1997.

As a result of the development of the Internet, businesses took advantage of the possible opportunities that commercialization online might provide. Expectations were high that the new usable medium of the Internet could capitalize on the vast number of customers that might be infinite and global. Companies quickly set up webpage(s) online to interact with customers, clients, and business partners. The goal was to keep up with competitors, increase efficiencies and lower costs, and increase profits by taking advantage of a new mode of commerce, which allowed products and services to be offered online. The result has been quick development of the Internet and e-commerce. The global market of late capitalism was very competitive and companies hoped to capitalize on the vast opportunity for customers. The Internet was a new medium for business and businesses were attempting to capitalize on the new opportunities available on the Internet.

The next big evolution in the Internet was the development of a wireless web without a cable or phone line hookup. Crockett, et al. (2002) referred to this as Wireless Fidelity, or Wi-Fi, which are wireless networks. Williamson (2003) reported in 2003 that laptops and many PCs were now equipped to handle a wireless network to connect to a Wi-Fi network. The Internet is a new way to communicate using a personal computer and an Internet connection. The Internet allowed for the connection of different computers in various locations, thus connecting individuals who had previously been unconnected. Internet connections also allowed for the ability to share information and knowledge. Additionally, businesses took advantage of efforts to capitalize on the

Internet in an attempt to increase profits in the very competitive conditions of late capitalism.

Chapter 2: Introduction to New Economy Supporters and Critics

This chapter has two main purposes that will facilitate understanding of the New Economy. The first purpose of this chapter is to introduce the debate between those who support the idea of a New Economy and those who are critical of this claim. I will introduce the critics of the New Economy first, followed by the supporters of the New Economy. Before the introduction of the debate on the New Economy, I will explain the justification for my classification of New Economy supporters and critics. The second purpose of this chapter is to provide better clarification of the New Economy, since many key aspects of the New Economy also exist in the Old Economy, which leads to confusion in terms of distinguishing the Old Economy from the New Economy. Therefore, I will place the key aspects of the New Economy within the context of late capitalism to provide more clarity on the New Economy, since the New Economy developed within the context of late capitalism.

Classification of Supporters and Skeptics of the New Economy

I have classified proponents and skeptics of the New Economy using a face value approach after reading an authors work. Specifically, I classified supporters of the New Economy as writers who conformed to the following criteria: 1) claimed that a New Economy exists, 2) did not explicitly state that a New Economy existed, but described the New Economy and made supportive claims or explained why the New Economy was new, 3) described the New Economy, as if it already existed, but made no supportive claims about whether the New Economy existed, and 4) *supported* the New Economy, but were critical of certain aspects of the New Economy. Skeptics of the New Economy

were classified as those who: 1) did not take a stand about whether a New Economy existed until more evidence was in, 2) did not believe that a New Economy existed, 3) made critical arguments or points against the New Economy, but did not take a position about the existence of a New Economy, 4) questioned the existence of a New Economy, but did not reject the possibility that it could exist, and 5) took an overall *critical* position toward the New Economy, but supported certain aspects of the New Economy.

Introduction to the Critics of the New Economy

Stiroh (1999) reported that the New Economy proponents believe the economic prosperity of the 1990s in the United States has been shaped by computerization and globalization in a new way than in the past (Stiroh 1999). Baker (1998) also reported that supporters of the New Economy claim that information technology and globalization have produced productivity growth and lowered inflation, which will produce future prosperity. The growth in the stock market, low unemployment and low inflation are seen as reasons for such optimism. Miller (2000) provided further clarification of the view of New Economy supporters by stating that New Economy supporters believe that higher labor productivity will lead to growth in real wages, but will not spark inflation because in the New Economy, quicker economic growth is possible without leading to inflation. But we should not take the proponents of the New Economy at their word. Larson (2001) argued that the view of new technology is often quite positive and the disadvantages and limitations of new technology are usually ignored. Could it be that the New Economy proponents are overly positive about the New Economy, when in fact there is little reason to be so positive?

The skeptics of the New Economy have several arguments that are critical of the New Economy. Skeptics question the existence of a New Economy because they argue that: 1) the New Economy boom no longer exists, 2) the New Economy can be explained via Old Economy rules, 3) the New Economy is not as impressive as past technological revolutions, 4) insufficient data exists to demonstrate a New Economy, 5) the lack of development of the New Economy, and 6) the changes in the economy may be natural economic variation in the evolution of the economy. I will now describe each of these critiques of the New Economy.

The New Economy Has Recently Faltered

Stock prices fell after their highs in March 2000 and the economy went into a recession, thus ending the longest post-war boom prompting some skeptics to ask what happened to the New Economy? Kotz and Wolfson (2004) are critical of the New Economy because it did not create a permanent expansion as advertised. Thus, some skeptics will argue that with the stock market collapse and the severe reduction in the National Association of Securities Dealers Automated Quotations (NASDAQ), the New Economy no longer exists. For example, Pearlstein (2000) claimed that the stock market decreased and economic growth faltered. Bauder (2000) claimed in 2000 that: 1) significant investment in initial public offerings (IPO) in the stock market had ended, 2) the public had become aware of the questionable tactics of venture capitalists and insiders who made large profits as small investors lost money, and 3) high-tech companies' stock prices had fallen due to overvaluation of technology stocks. The effect of the tech recession had influenced the entire economy, such as fewer orders for telecom equipment,

increased bad loans among banks, decreased investment in the stock market by investors in general, and fewer loans were being offered in general (Pearlstein 2000). The recent economic recession had also led to higher unemployment, job cuts, and lower interest rates, thus undermining claims of a New Economy.

To better understand why the optimism of the New Economy failed, one needs to question the optimistic assumptions during the economic boom of the New Economy. In October 2000, Pearlstein (2000: A6) reported that industry experts now questioned the New Economy expectation of an unlimited "demand for high-speed Internet access" because it created overcapacity and lower profits as demand become saturated in long distance and business service arenas. Greater competition resulted and companies had to cut prices to gain customers, thus hurting profits. As a result, their stock prices fell by 60 percent. Since it is unlikely that telecom companies will continue to build networks, equipment companies that provided equipment to telecom companies also suffered (Pearlstein 2000). The junk bond market also suffered as a result of problems in the telecom industry because the junk bond market funded the telecom companies with $200 billion since 1995. Thus, recent economic problems have led some skeptics to be critical of the assumptions of the New Economy.

The Old Economy Rules Have Not Changed

Weimer (2000) claimed that the underlying assumption of New Economy supporters was that something was fundamentally 'new' about the economy. The New Economy is seen as a new cybereconomy that has new rules that are different than the rules in the Old manufacturing economy. In this section, there are three types of critics

who believe that the Old Economy rules are still in existence. The first approach questions the assertion that the New Economy is based on technology influencing productivity growth. Weimer (2000:28) is critical of the existence of the New Economy based on technology as follows: "There is no New Economy. There are only new inventions and improvements in production in the Old Economy, which is advanced and advancing manufacturing, now, then and always." However, Stiroh (2002) claimed that the influence of technology on average labor productivity is part of the "Old Economy" framework. Stiroh (2002) showed that use of ICT is not influencing total factor productivity as expected by the "Old Economy" framework. If ICT use had influenced total factor productivity, ICT use could have been argued to produce spillovers and network effects that had a positive effect on total factor productivity, which is consistent with the New Economy perspective.

The second perspective that is critical of the proposal by New Economy supporters that there are "new economic rules" is focused on the relationship between inflation and unemployment. Evidence provided for the claim of a New Economy by New Economy supporters is that low inflation and low unemployment were present at the same time in the late 1990s, which was historically unusual. However, Kotz and Wolfson (2004) provide an explanation using Old Economy rules. They argue that low inflation and low unemployment existed at the same time because of worker insecurity that kept wages low due to corporate attacks on workers, and also superior U.S. economic performance relative to the rest of the world, which stabilized inflation (Kotz and Wolfson 2004). Kotz and Wolfson are also critical of the claim of a New Economy because it meant more economic restructuring at the expense of workers. They argue that

the New Economy claim that free markets and restructuring are needed to use IT effectively is incorrect. Rather they suggest that the choice to use IT by corporations is motivated by the desire to continue the process of restructuring.

The third criticism against the proposal of new economic rules by New Economy supporters is identification of myths propagated by New Economy advocates. New Economy supporters and business gurus in the 1990s argued that the traditional business methods were no longer applicable in the New Economy. However, Greco, Caggiano and Ballon (1999) argued that the proposed New Economy business methods were just myths and have only partial truth to them. Greco, et al. (1999:34-35) listed seven myths of the New Economy: "1. Grow or die. 2. You must be virtual. 3. Go global. 4. Capital is easy. 5. Everybody is an entrepreneur. 6. Technology makes life easier. 7. You must be on the Web in a big way." Greco, et al. provide examples of businesses that either failed or encountered hard times by following each of these myths.

For example, Greco et al. gave an example of Office Depot, a retail giant, which believed that they needed to 'grow or die.' Office Depot tried to expand beyond individual customers to corporate customers. They had a lot of problems with coordination, it was not thought out carefully enough, and they were not oriented toward corporate customers. Thus, growing does not necessarily produce greater value (Greco, et al. 1999).

The New Economy is Less Impressive than Past Technological Revolutions

Gordon (2000) claimed that there were five major technological revolutions which led to greater productivity growth, higher incomes and a higher standard of living:

1) electricity, 2) the internal combustion engine, 3) petroleum, chemicals, and pharmaceuticals, 4) communication, and 5) indoor plumbing. Comparisons of the current technological revolution in the New Economy to past technological revolutions takes two different forms: 1) direct comparison to discover which technological revolution performed better and 2) absolute comparison, with the criteria that the New Economy must be different than all past technological revolutions to be considered 'new.' However, a third perspective casts doubt on any such comparisons at this time. For example, Uchitelle (2000) believed that we would not know the full impact of IT on increasing productivity until 50 years from now, when we can see how it compares against previous technological revolutions. Thus, Uchitelle claims that we do not have the proper data yet to compare to past technological revolutions.

Direct Comparison

Gordon (2000) argued that the current 'Third Industrial Revolution' in computers did not compare well with past industrial revolutions in relation to improving the standard of living because of the lower productivity of computers. Gordon argued that the reason for the lowered productivity of computers is that: 1) the technology of the computer offered benefits to productivity almost immediately and experienced diminishing returns ever since, 2) humans still need to work with computers and human thought has not increased, thus slowing productivity growth, and 3) productivity is only increasing in limited sectors of the economy. Thus, Gordon concluded in 2000 that the Solow computer paradox, which is the inability to observe increases in productivity

despite the computer age, still existed. However, since Gordon's article, productivity has increased and has been associated with use of computing technology (see Alcaly 2003).

Absolute Comparison

The absolute comparison compares the current revolution in information technology to past technological revolutions and considers the New Economy 'new' only if there are fundamental differences. Thus, Stiroh and Triplett question what is so new or special about the New Economy? Stiroh (1999) questioned the existence of a New Economy because past technology also increased quality and lowered prices, and past innovations, such as languages or currencies, were also very important. According to Triplett (1999), New Economy supporters lack an historical perspective when they claim that many new innovations and products are evidence of a New Economy. A greater number of new products that have been observed recently does not equate with an increasing rate of new products due to larger bases in more recent times. The same thing is also true for technical advancements which create quality improvements more generally according to Triplett. Therefore, direct comparison of the current information technology revolution to past technological revolutions implicitly assumes a New Economy exists and makes an attempt to compare its performance to past technological revolutions. Absolute comparisons are more critical and only consider the New Economy 'new' if it is fundamentally different than past technological revolutions.

Insufficient Data Exists

Certain skeptics of the New Economy were not supportive of the New Economy despite noticeable increases in productivity after 1995 because of skepticism in concluding that there is a New Economy based solely on the connection between information technology and increases in productivity. These critics are more likely to be associated with the technology diffusion literature. Three critical positions have been proposed. The first position is that the proper economic data does not exist over a long enough period of time to conclude that a New Economy exists. Stiroh (1999) claimed that there is not the proper data, such as higher trend productivity growth, long-term productivity increases, comparison of unemployment and inflation numbers over time, and evidence of successive supply shocks to indicate that a New Economy exists. The second position is that the influence of technology on productivity takes a long period of time to materialize. Stiroh (1999) surmised that increases in measured productivity may take decades to become noticeable. In this case, Stiroh believes it may take many years for the effect of technology to be noticeable in the actual productivity numbers. Thus, it is too early to conclude there is a New Economy. The third position is that information technology has a limited effect on productivity increases. Gordon (2000) showed that the increases in productivity from 1995 to 1999 were due to increases in productivity in manufacturing of computer hardware and durable goods, which only represented 12% of the economy. However, Bernasek (2002), a supporter of the New Economy, points out that productivity actually increased during the recession in 2001, which indicated that investment in information technology led to improvements in productivity, thus justifying the assertion of a New Economy. Additionally, productivity growth is widespread and

not limited to computer manufacturing. However, despite increases in productivity, skeptics remain critical of a New Economy, especially with the technology recession.

The New Economy is Not Well Developed and Has Changed Due to Natural Economic Change

I combined the last two criticisms into one section because both of these criticisms were expressed by Kevin J. Stiroh and both criticisms argue for a negligible impact for the New Economy. First, Stiroh (1999) is critical of the existence of the New Economy because the descriptive changes may not be large enough to conclude there is a New Economy. Uchitelle (2000) took a similar perspective and argued that information technology is very productive, but only makes up a small part of the economy, and thus has not yet produced the type of productivity increases seen in past technological revolutions. Therefore, Stiroh believes the New Economy is not well developed and Uchitelle believes that the New Economy is too small to be effective. Second, Stiroh (1999) also believed that changes in the economy may be due to natural economic change. For example, Stiroh gave an example of the economy of the 1990s as different from the economy of the 1950s due to natural economic change in the same way that the 1950s economy is different than the 1900s. Thus, changes in the economy from the 1980s to the 1990s may be natural economic change and thus not the result of a New Economy.

Conclusion

Thus, there are multiple criticisms of the New Economy of the United States. To recap, they are as follows: 1) the New Economy has faltered because of the recession and stock market bear, 2) the Old Economy rules still apply, thus a New Economy does not exist, 3) the current technological revolution is not as influential as past technological revolutions, 4) insufficient data exists to claim there is a New Economy, 5) the recent technological revolution is too small to be considered a New Economy, and 6) the recent changes in the economy may be the natural evolution of the economy. In relation to criticism three, comparison to past technological revolutions were made as a direct comparison of data or were made as an absolute comparison, where the New Economy is only new if the New Economy is fundamentally different than past technological revolutions. It should also be noted that criticism five in relation to the small size of the economy, criticism two in relation to the existence of Old Economy rules, criticism three in relation to an absolute comparison of the New Economy to past technological revolutions, criticism six in relation to the natural evolution of the economy question the existence of the New Economy. Criticisms one, the New Economy has recently faltered, and criticism three, the part that focuses on the direct comparison of the New Economy to past technological revolutions, do not question the existence of the New Economy. Criticism one does not question the existence of the New Economy because the New Economy must exist before it can falter. In criticism three, the direct comparison to past technological revolutions implicitly assumes the New Economy exists because it attempts to compare it to past technological revolutions. However, it may be possible to find authors under these two criticisms who also question the existence of a New Economy.

Supporters of the New Economy

New Economy supporters claim that there is a New Economy in the United States and that it is somehow new and different from the Old Economy. However, it should be noted that my use of the term 'New Economy,' which seems to implicitly assume that a New Economy already exists, does not imply that I have prematurely concluded that there is a New Economy. Rather, I use the term 'New Economy' in citing literature from New Economy supporters' and critics,' and in building an argument about the existence of a New Economy that will be tested. The term 'New Economy' is not a new word, but rather it has been used to refer to past economies and past economic changes in the economy. For example, Greenspan (1998) claimed that our economy has been 'new' at various times in the past because businesses in competitive environments are seeking to be more innovative and increase the standard of living in a market economy. And use of the term 'New Economy' even occurred in the late 1980s and early 1990s to refer to the competitive and unpredictable economy, which was a separate discussion from the discussion of the New Economy in the mid-to-late 1990s. For example, Reich (1992:232) described the New Economy as unpredictable: "The habits and methods of experimentation are critical in the [N]ew [E]conomy, where technologies, tastes, and markets are in constant flux." I believe that Reich is describing increasing competition, shorter product cycles, greater use of technology, and greater uncertainty that was characteristic of the period of late capitalism just before the beginning of the New Economy in the mid-1990s.

In my literature review on New Economy supporters, I will include definitions of the New Economy, claims about when the New Economy began, and different positions

in support of the New Economy. But, before I introduce the New Economy supporters, I would like to characterize or define the Old Economy. Unfortunately, supporters of the New Economy, who have rarely defined the New Economy, are even less likely to define the Old Economy. The one definition I did find by a New Economy supporter was related to business models. Chorafas (2001:3-4) defined the Old Economy as older business models, such as "product innovation, paper-based supply chain, wanting inventory management, expensive modes of financing, slowgoing sales practices, and other aspects of distribution." However, the various ways that the Old Economy is described as being different from the New Economy can give us a light into how New Economy supporters may define the Old Economy.[2]

First, some distinguish the Old Economy as production-related versus the New Economy, which is viewed as knowledge-related. For example, Treasury Secretary Lawrence Summers believed that the economy has moved from the production of physical products to the production of knowledge and its various uses (Gottlieb 2000).

Second, and closely related, companies in the Old Economy are viewed as owning physical objects where New Economy companies are seen as increasingly owning objects that are not physical. For example, Liedtka (2002) indicates that the key difference between the New and Old Economies is the change from the ownership of assets, which formed a durable niche in the marketplace in the Old Economy, to intangible assets, based on knowledge and capabilities in the New Economy.

[2] But is should be noted that some criticize attempts to formally distinguish between the Old Economy and the New Economy. For example, Koepfer (2000) believed that the distinction between the Old and New Economies was too simple and seriously misleading because the economy consists of both the Old and the New Economy.

Third, a common characterization of the Old Economy by New Economy supporters is the inability of Old Economy firms to effectively compete. For example, Liedtka claims that Old Economy firms will have trouble surviving with a focus on centralized control, concern with increased productivity, and maintenance of the social order. These values are opposed to innovation, speed, and flexibility, which are key capabilities of the New Economy. In relation to the Internet, El Sawy, Malhotra and Gosain (1999) claimed that physical intermediaries will face more intense competition because producers and customers will directly interact on the web. Nakamura (2000) summarized the new business environment of the New Economy by applying Schumpeter's concept of "creative destruction" to the New Economy, as companies that have focused on producing new generations of products to capture market share and increase profits. Nakamura contrasts that with the Old Economy which focused on production and the conception of perfect competition. Thus, firms have to change their business operations to keep up with more intense competition.

Fourth, value is determined differently in the Old and New Economies. Chorafas (2001) distinguished the determination of market value in both the Old and New Economies. Chorafas explained that consideration of uncertainty in pricing is something new in the New Economy because in the Old Economy with adequate information, prices were in equilibrium. But there are many "unknown factors" in the New Economy, such as the complexity of institutions and their practices, or the overreaction to the problems of the global economy, which add risk to the New Economy (Chorafas 2001). Greater uncertainty in the New Economy is also due to "deregulation, globalization, innovation, and rapid technological advances," that create greater volatility (Chorafas 2001:13).

Thus, risk in the New Economy is added to the price of products and services by considering the likelihood of future events that are costly and are unknown at this time. Chorafas (2001) argued that most of the cost today is risk. Knowledge spillovers are also important to determining value and distinguishing the Old and New Economies. In the New Economy, knowledge spillovers are more likely to occur relative to the Old Economy. As a result, knowledge spillovers cause greater value in increasing Returns to Scale, which are defined as "…the value from a product or service increases through positive feedback loops as the number of users of the product or service increases (El Sawy, et al. 1999: 307)."

Supporters' Definitions of the New Economy

There are various types of definitions of our current New Economy. Liedtka (2002) refers to four broad types of definitions of the New Economy. First, Liedtka claims that economists have defined the New Economy in terms of increased productivity due to advancements in information technology, high economic growth coupled with low inflation, and the influence of increased globalization on production of a New Economy. In the second type of definition, the business field has viewed the New Economy as consisting of the high-tech industry or the boom in technology stocks. In the third type of definition, Liedtka refers to key books on the New Economy, such as Kevin Kelly's New Rules for the New Economy, which claim that competition has changed and technology is now influencing the economy and society. In the last type of definition, the New Economy is represented by the influence that technology is having on communication and the increasing importance of knowledge. Liedtka's four types of definitions of the

New Economy are similar in that they are related to new technology and the consequences of new information technology. These four types of definitions also mention the influence of both globalization and new technology on economic conditions in the economy. However, his typology fails to be all inclusive and does not include important factors of the New Economy which are mentioned in several other definitions of the New Economy. Therefore, I intend to introduce separately each of the types of definitions of the New Economy that I have encountered in the literature, since Liedtka's typology fails to classify all of them.

The first type of definition of the New Economy defines the New Economy exclusively in terms of information technology (IT), or the 'Information Technology' definition. Salvatore (2003:534) defined the New Economy as: "The "New Economy" refers to the rapid improvements and spread in the use of information and communication technology (ICT), based on computers, software, and communication systems." Starzynsky (2000) also reported that Jim Roddey, an Allegheny County Executive, defined the New Economy as technology, the technology sector, and the integration of the New and Old economies. Landry et al. (2002) defined the New Economy both narrowly and broadly. The narrow definition refers to the IT field, which produces software and hardware, particularly focusing on software, which drives the New Economy. The broad definition includes the IT field as well as the adoption of software and its subsequent influence in increasing productivity for Old Economy companies. Each of these definitions of the New Economy centers on information technology and are broad in scope by not focusing solely on one type of technology.

The second type of definition of the New Economy adds globalization to IT, or the 'IT-Globalization' definition. Castells ([1996] 2000a:161) defined the New Economy at the end of the twentieth century as: "…the new economy is/will be predicated on a surge in productivity growth resulting from the ability to use new information technology in powering a knowledge-based production system." While this seems to be an 'Information Technology' definition, Castells ([1996] 2000a, 2000b) viewed the New Economy as having three fundamental characteristics: 1) it is informational, 2) it is global, and 3) it is networked. The New Economy is informational because information and knowledge are of fundamental importance to increasing productivity and remaining competitive. The New Economy is global because the main aspects of the economy, which are "production, consumption, and circulation," are organized globally. The New Economy is networked because of use of global networks to increase productivity and remain competitive (Castells [1996] 2000a). Meng Tat (2000) defined the New Economy as the recent information technology revolution, the advent of the Internet, and globalization. Meng Tat's definition stressed the importance of both globalization of business and information technology (IT).

The third type of definition includes information technology and other factors, but does not include globalization, so I refer to this definition as the 'IT-Minus Globalization' definition. The definition of the New Economy from the 'Economic Report of the President' Council of Economic Advisers (2001:20) is: "This Report defines the New Economy by the extraordinary gains in performance – including rapid productivity growth, rising incomes, low unemployment, and moderate inflation – that have resulted from this combination of mutually reinforcing advances in technologies, business

practices, and economic policies." This definition focuses on technology and the economic impact of technology. Bob Barker, Chief Executive Officer (CEO) of Laminer Software, defined the New Economy as consisting of information, services, efficiency and multi-tasking, rather than manufacturing, which is considered characteristic of the Old Economy (Starzynsky 2000). In Barker's definition, I interpret greater efficiency of time as a result of both corporate restructuring and information technology. He also mentions the service economy as being part of the New Economy.

The fourth type of definition is referred to as the 'Economic' definition, which also leaves out information technology altogether. Hansen (1998:7) described the New Economy in terms of economic conditions as follows: "globalization, sustained moderate growth, a flatter business cycle, an unusual combination of low unemployment and low wage and price acceleration, substantial growth in productivity and profits, and huge overall gains in the stock market." Hansen's definition does not specifically mention information technology; rather it includes economic characteristics such as growth, the business cycle, low unemployment, wage growth, inflation, productivity, profits, and increased stock prices. Balmaseda, et al. (2002) defined the New Economy in macroeconomic terms as changes in the "aggregate production function," where capital and labor are the main ingredients for increasing productivity and output.

The fifth type of definition is even more expansive, including information technology, globalization, and additional factors, or what I refer to as the 'Expansive New Economy' definition. Chorafas (2001:3) defined the New Economy as "globalization, deregulation, innovation, and technology." Chorafas (2001:ix-x) also referred to the New Economy as global, new risks, networked, leveraged, mostly deregulated, and a great

opportunity. Thus, Chorafas provides a more expansive definition by mentioning the additional factors of deregulation, risks, leverage, and opportunity. Kudyba and Diwan (2002:9) defined the New Economy as: "an integration of three interrelated elements: free-market economies, globalization, and new productive technologies (also known as information technology)." Greenwald, et al. (2000:67) defined the New Economy as "nothing more than a fancy term for the basic infrastructure that allows consumers and companies across the globe to shop, work and play at Internet speed." Additionally, Greenwald, et al. (2000:66-67) referred to the New Economy as: "The New Economy is supposed to be frictionless, tied as it is to the ultra-productive cyberworld of computers, broadband networks and the Internet, and cosseted by low inflation and low interest rates." Thus, Greenwald, et al. provided a more expansive description of the New Economy by mentioning inflation and interest rates.

The sixth type of definition has an economic and political element to it, which I will refer to as the 'Economic-Political' definition. Polski (2002) defined the New Economy as an:

> Integrated system of political and economic activity that includes four distinct elements: 1. Scientific discovery and technological innovation, 2. Entrepreneurial leadership that applies the results of research to create new sources of economic value, 3. Construction of technological and institutional infrastructures that enable individuals and firms to implement new business models, and 4. Processes that facilitate transformation. (P. 294)

This definition views entrepreneurship and technology within the context of the economic and political systems.

The seventh type of definition is the 'Opportunity' definition, which is of little theoretical relevance and is based on greater opportunities that exist in the New

Economy. Starzynsky (2000) also cited Sean Sebastian, managing principal at Birchmere Ventures, who defined the New Economy as taking advantage of new business opportunities that previously did not exist despite a lack of business experience by some new entrepreneurs. My assessment is that the New Economy does provide new opportunities, but so do most new things. Additionally, I believe this definition relates better to the period of the economic boom of the late 1990s, where there were many more opportunities than there were during the recession that followed.

Some academics and journalists have mentioned a related term to the New Economy, namely, the Knowledge Economy that views knowledge as important for economic growth. For example, Powell and Snellman (2004:201) define the 'knowledge economy' as: "production and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence." And Lengnick-Hall and Lengnick-Hall (2003:17) define the knowledge economy as: "The knowledge economy encompasses all jobs, companies, and industries in which the knowledge and capabilities of people, rather than the capabilities of machines or technologies, determines competitive advantage." Lengnick-Hall and Lengnick-Hall's definition of the knowledge economy is different from the definitions of the New Economy because the abilities of workers are separated from technological capabilities. In the New Economy, technological capability is intertwined with the ability of workers. However, both Powell and Snellman, and Lengnick-Hall and Lengnick-Hall focus on the importance of knowledge.

Hence, definitions of the New Economy by New Economy supporters vary based on which characteristics they choose to focus on. Some authors only include information

technology, other authors include both information technology and globalization, and some authors add additional factors beyond information technology and globalization in their definitions of the New Economy. It also highlights the lack of clarity of thinking and agreement about the nature of the New Economy.

When Did the New Economy Begin?

Despite the rapid growth of the New Economy, the New Economy is rather small and not particularly well developed due to the youth of the New Economy. Litan (2001) pointed out that according to the U.S. Commerce Department, IT industries made up a very small part of the economy, but were instrumental in creating nearly a third of overall economic growth from 1995 to 1999. Thus, the New Economy is small, but powerful. However, despite the youth of the New Economy, integration of the Old and New economies are taking place quickly. Litan and Rivlin (2001) and Greenwald, et al. (2000) believed that the New Economy is quickly integrating with the Old Economy. Greenwald, et al. (2000) believed that the integration of the New and Old Economies was happening quickly because brick-and-mortar companies (such as Kmart, Sears and Big Three Automakers) were leading the way in the integration of the Old and New Economies by offering products online (Greenwald, et al. 2000). Thus, the New Economy is not well developed, but is quickly integrating with the Old Economy, thus begging the question, "When Did the New Economy Begin?"

The literature provides varying dates on the beginning of the New Economy; however, there appear to be three viewpoints that surface when determining when the New Economy started: 1) before 1995, 2) approximately 1995, and 3) after 1995.

First, Atkinson & Court (1999:86) appear to claim that the New Economy may have started as early as 1985: "The U.S. economy has undergone a fundamental transformation in the past decade and a half, fueled in large part by revolutionary technological advances in personal computers, high-speed telecommunications, and the Internet." Alan Greenspan argued for a later date and claimed that differences were noticeable in the data in 1993 due to higher returns in technology and more capital investment orders of technological equipment (Executive Editor 2000). Therefore, Atkinson and Court and Alan Greenspan believe the New Economy began before 1995, but they provide different dates.

Second, investment executive Abby Joseph Cohen claimed that while restructuring has continued, something new began in the 1994 to 1995 time frame (Executive Editor 2000). Mandel (2000) believed that the New Economy started in August 1995 with the IPO of Netscape. Landry, et al. (2002) claimed that the New Economy became established in the mid-1990s when the PC was widely adopted in industry, new software was developed to run programs on the widely available PC, and when access to the Internet became readily available. Thus, Cohen, Mandel, and Landry et al. believe that the New Economy started sometime in the mid-1990s.

Third, Castells ([1996] 2000a:147-148) claimed that the New Economy began in the late 1990s in the United States in relation to information technology and finance. In 2000, O'Leary (2000) believed that the New Economy was just beginning.

Therefore, different authors cite different dates for the beginning of the New Economy based on different evidence from the New Economy, which likely reflects their differing perceptions of what the New Economy is. For example, Atkinson and Court

cited technological innovation in computers, communications, and Internet. Alan Greenspan focused on capital investment put toward technology and increasing profits in the technology sector. Landry et al. focused on the adoption of personal computers, the need for software and the availability of Internet access. However, it should be noted that each of these perceptions of the New Economy is similar because they all focus on technology.

Major Positions of New Economy Supporters

Obviously, New Economy supporters take the uniform position that the New Economy exists, so that is not in question. What is in question is why do they support the New Economy? Or why do they believe the New Economy exists? This section will try to answer these questions by identifying and explaining major reasons why supporters believe there is a New Economy, which will represent separate positions in support of the New Economy. Note, by focusing on major reasons, this is not meant as all inclusive, as minor reasons are not represented. Additionally, overlap between positions is inevitable because two positions may discuss the same concept, such as competition or technology.

First, New Economy supporters believe the New Economy is new and different from the Old Economy. Early in the 'Supporters of the New Economy' section, I explained how the Old and New Economies are different when I distinguished between them in an attempt to characterize the Old Economy. As explained earlier, New Economy companies are more likely to focus on knowledge production rather than production of physical goods. Ownership of intangible goods due to a greater focus on knowledge, information, and innovation was also important to New Economy companies. New

Economy companies were also more competitive than Old Economy companies because they were more flexible and could adapt better to an increasingly uncertain and competitive environment. And finally, value was determined differently in the New Economy due to the need to include uncertainty in determining the price of products and services. Additionally, knowledge-spillovers were producing more value in the New Economy.

Second, New Economy supporters believe that the New Economy increases productivity and creates economic expansion. According to the theory of New Economy supporters, the revolution in information technology should increase productivity, since historically, advances in technology have led to increases in productivity. In the past, growth in productivity enhances long-term economic growth and produces a higher standard of living. Thus, many had great hope for the technology of the New Economy. Alcaly (2003) showed that trend productivity rose from 1.4% from 1974 to 1995 to 2.6 percent from 1996 to 2002. According to Greenwald, et al. (2000) productivity increased to 5% in 1999 due to the New Economy. Neusner (2002) stated that productivity continued to increase despite the recession, thus providing evidence for the New Economy.

There are two different types of supporters of the New Economy in terms of the influence of information technology on increasing productivity. The first type of supporter believes that productivity will increase as a result of information technology. This perspective is most associated with the business and economic literature. According to Oliner and Sichel (2000), the productivity increase since the mid-1990s of about 1 percent is mostly due to IT investment and production of IT products. Litan and Rivlin

(2001) claimed that improvement in the speed of computer chips and strong investment in IT equipment led to productivity growth in the 1990s. McAfee (2001) also noted that use of computers and information technology more generally were having a positive influence on productivity growth in the second half of the 1990s. McAfee (2001) further mentioned that the introduction of the Internet was important in increasing productivity by making these computers interconnected.

The second type of supporter believes that productivity increases occur many years after the introduction of new technology. Thus, real increases in productivity due to IT have not yet materialized. Castells ([1996] 2000a) claimed that the increase in productivity will take decades to actually be observed because economists know from past technological revolutions that technological innovations do not lead to productivity until many years after the original innovation. This perspective is most often associated with the diffusion literature and will be examined in more detail.

Third, other supporters state that traditional economic conditions of the economy have changed in the economic boom of the New Economy and provide reasons for these economic changes. For example, Hansen (1998) noted three key traditional economic relationships that have changed in the New Economy. First, low unemployment has increased wages historically, but this relationship no longer holds because we had both low unemployment and low wage growth at the same time in the mid-to-late 1990s. Blinder (2000) attempted to explain this new phenomenon of low unemployment and low wage growth by suggesting that low unemployment and low inflation of the late 1990s could be due to quicker productivity growth than expected due to lower wages, which increased profits through lowered costs, which led to more hiring at lower wage rates.

Second, the historic relationship between higher productivity and wage growth no longer seems to hold as productivity and profits grow, but wages do not. Profits are high because of strong growth in productivity and very low wage growth. Overall, wages have not increased in the 1990s and real wages have declined since 1973. Wage growth is low due to de-unionization, lack of militancy in unions, and corporate downsizing (Hansen 1998). Third, the relationship between higher wages and inflation is weaker than in the past since, for example, real wages increased in 1996, without a subsequent rise in inflation (Hansen 1998). Fourth, another economic relationship that had changed in the mid-to-late 1990s, which was unmentioned by Hansen, was the traditional relationship between low unemployment and the ignition of inflation, which has been disrupted because both inflation and unemployment are low. While these new economic relationships occurred during the economic boom of the mid-to-late 1990s, only the second one consisting of productivity growth and low wage growth continued during the economic recession that followed.

Fourth, some New Economy supporters specifically point to the new Internet economy that developed in the late 1990s as evidence of a New Economy. Internet and e-commerce are new developments which expanded the capitalist marketplace to an electronic medium of global communication through use of a personal computer and an Internet connection. Internet commerce entails "consumer retail and business-to-business transactions; online financial services; media; infrastructure; and consumer and business Internet access services (Atkinson and Court 1998, section 3, page 1)." Atkinson and Court (1998, section 3, page 1) argued that the Internet is a critical aspect of the New Economy: "The internet, with its enormous potential to increase efficiency and raise

productivity, is a critical component of the New Economy." Marshall Acuff, Chief Equities Analyst for Saloman Smith Barney, cited the Internet as the reason for the recent economic boom (Greenwald, et al. 2000). The U.S. Internet economy has exploded, increasing many times since 1996. Atkinson and Court (1998, section 3, page 1), cited data from Forrester Research in Cambridge, MA, which indicated past growth in e-commerce as follows: "The total U.S. Internet economy more than doubled between 1996 and 1997, from $15.5 billion to $38.8 billion." The Internet provides convenience to both businesses and customers by the ability to provide both services and products online. Stiller (2002) pointed out that e-commerce allows for customer ease in trade, increased globalization, and decreased trading costs, resulting in increased efficiency in the supply chain.

Fifth, many authors argue that increased use of technology, innovation, knowledge, information, and intangibles are critical in the New Economy. As explained in the last argument for a New Economy, technology in the form of the Internet is influencing economic growth. New innovations in information technology are expected to increase productivity, and thus raise the standard of living, since past technology has increased productivity and has led to economic growth, resulting in a higher standard of living. In relation to innovation as a critical aspect of the New Economy, innovation is seen as important to economic growth. For example, Lewis (2000) cited Paul Romer, the pioneer of New Growth Theory, which explained that past and current wealth is derived from technological innovation. Stein (2000) reported that successful New Economy companies continually innovate. Continual innovation is needed to keep up with increasing competition. Additionally, knowledge spillovers are important to innovation.

Carlino (2001) mentioned Jacobs spillovers, named after Jane Jacobs, which are spillovers that occur when there are diverse industries in one location which leads to idea exchanges from many different areas, which facilitates innovation. Carlino (2001) found that density of people and businesses in urban areas is related to increased innovation; however, little support was found for either type of spillover.

While the New Economy took a hit with the collapse of technology stocks, as typically is the case, technological innovation has made a comeback. According to Levy (2002b:45), booms and busts are common in the technology field and set the stage for the next round of innovation. For example, Saffo (2002) claimed that the past failure of interactive television was an important influence on the development of the Internet because the failure of interactive television produced a laid off workforce in Silicon Valley that were experts in multimedia design and were very important to the later development of the Internet (Saffo 2002). After the technological bust, venture capitalist investment hit a low point in 2002 and 2003 (Grimes 2004). Grimes (2004) reported that venture capitalists have begun to finally speed up the pace of investment in technology companies and other new startup companies.

In relation to information and knowledge as critical aspects of the New Economy, New Economy proponents often associate information and knowledge with the New Economy. El Sawy, et al. (1999:307) argued that knowledge is imperative for success of an organization in an unpredictable market since, "Knowledge is critical to satisfying customer needs for customized products and services, and speedier and improved service." Atkinson and Court (1998) argued that knowledge is the key aspect of the New Economy because some industries produce knowledge in the form of new products and

services via "research, design, and development" that promote economic growth where others "manage or convey information." However, Gottlieb (2000), in response to the remarks of Treasury Secretary Lawrence Summers, claimed that knowledge is not new because technological revolutions in the past needed ideas too. What is new in this knowledge economy is the ability of the Internet to rapidly transmit knowledge to others, thus increasing the power of technology (Gottlieb 2000). The cost associated with transmitting data has decreased as well, thus more data can be transmitted cheaply and easily (Atkinson and Court 1998). Thus, the ease of access to knowledge and information as a result of technological advances and cost reduction has made knowledge and information increasingly important to business decisions. Greenspan noted that companies now can get real-time information that will decrease uncertainty in decision-making (Executive Editor 2000). Chorafas (2001:207-208) indicated that senior management must have real-time information and knowledge about risks (Chorafas 2001:108-109).

In relation to intangibles, Liedtka (2002) and Côte (1997) believed that knowledge assets or intangibles are increasingly important in the New Economy. Leadbeater (1998) described intangibles as consisting of things like research and development (R&D), marketing, brand value, human capital, and training. But why are intangibles more important today? Nakamura (1999) reminded us that since the time of Adam Smith, tangible goods were seen as assets and were considered wealth producing. However, intangible assets were not sought after because they were not physical goods, and thus were not seen as wealth producing despite their ability to influence future profits as a result of technological innovation (Nakamura 1999). Thus, Nakamura (1999)

commented that historically intangible assets, such as research and development or purchase of software, were not recorded as investments. Although intangible assets have grown since the mid-1970s, tangible ownership has decreased (Nakamura 1999). Nakamura (1999) argued that not counting intangible assets as investments underestimates income and investments. Since intangible investments have increased, corporate investment, output, income, and savings are higher than the accounting numbers indicate. As a result, profits are reduced because intangible assets are counted as current expenses; thus they are subtracted from current profits (Nakamura 1999). Professor Lev, who works at the Stern School of Business at New York University in a recent speech, indicated that he does not believe in the traditional system of accounting because of the increased investment in intangibles (Leadbeater 1998).

Sixth, some argue for the importance of globalization in the New Economy as was seen in the definitions of the New Economy in the 'Supporters' Definitions of the New Economy' section. Castells ([1996] 2000a) argued that the New Economy is global and involves global networks. Kelly (1998) believed the New Economy is different due to globalization and electronic interlinking networks. Benner (2002) argues that globalization and networks provide most of the foundation for recent changes in the economy of the United States and are a result of technical development in IT over the past 30 years. In relation to globalization, Benner argues the boundary space of economic activity has changed. In relation to networks, Benner argues the organization has made production part of a network.

The New Economy supporters have various positions on the New Economy of the United States. I am summarizing their positions as best I could determine them as

follows: 1) the New Economy exists and is new and different from the Old Economy, 2) the New Economy creates productivity and economic growth, 3) the traditional economic relationships have changed with the advent of a New Economy, 4) the development of e-commerce is an important development of the New Economy, 5) technology, innovation, knowledge, information, and intangibles are key aspects of the New Economy, and 6) globalization has a critical influence on the New Economy.

Placing the Debate on the New Economy in the Proper Context: Late Capitalism

In attempting to understand the debate on the New Economy, I ran into various points of confusion, which would later require me to understand the economic conditions of late capitalism before gaining a better grasp of the New Economy. Placing the New Economy within the context of late capitalism helped to provide clarity to the New Economy, which was a major goal of this dissertation. Briefly, I want to identify some of the points of confusion to make the reader better understand why I thought it was necessary to place the New Economy historically within the context of late capitalism. Afterwards, I will identify each major aspect of late capitalism and I will end with a model of late capitalism showing the influence on the New Economy. Before I start, it should be noted that not all aspects in the literature are listed; for example, biotechnology is not listed. I tried only to choose commonly referred aspects of the economy. My confusion over the New Economy related to economic phenomena which were claimed to be part of the New Economy, yet these same factors seemed to be part of the Old Economy as well. Some of the factors often associated with the New Economy were: 1)

a highly competitive business environment, 2) the importance of globalization, global networks, and global communication, 3) continual developments in information technology, 4) an increasingly expansive service economy with increasing importance in the economy, 5) continuation of economic restructuring in the forms of a global division of labor, smaller workforce, new management practices, and fewer benefits, and 6) continual expansion of deregulation in new sectors of the economy. In other words, how can these economic phenomena characterize the New Economy, yet exist in the Old Economy? Thus, a framework was needed to better understand these economic phenomena in relation to both the Old and New Economies. What I encountered was quite basic in nature. The economic phenomena I just described, increasing competition, information technology, globalization, etc., were economic phenomena that were part of the context of late capitalism, which were influential in helping to shape the New Economy. Thus, the economic phenomena of late capitalism exist in both the context of late capitalism in the Old Economy and the New Economy. Thus, these economic phenomena are not specific to either the Old Economy, or the New Economy, and thus should not be described as factors that distinguish the New Economy from the Old Economy. One may ask how can I use computers, which could be considered to be part of both the Old Economy and the New Economy, as an indication of a New Economy? My response is that no one would disagree that computer usage took place in both the Old Economy and the New Economy. My point is that it is not computer usage alone that is important for distinguishing a New Economy, but rather computer usage on a broad enough scale to consider it a dominant mode of production, which distinguishes it as a New Economy. In the theory section, I will go into more detail about the criteria used for

distinguishing a dominant mode of production from one which is not. I will now introduce the major historical aspects of late capitalism.

Profit, Capitalist Accumulation and Competition

First, I will mention profit, capitalist accumulation, and competition in the context of late capitalism. Marx ([1867] 1977:254) claimed that the capitalist is mainly focused on making continued profits. Braverman ([1974] 1998) claimed that the creation of profit lends itself to the accumulation of capital. As profits increase, capitalist accumulation increases. Competition is an important aspect of a market economy and existed before the development of capitalism. Capitalists not only compete against existing competitors, but also are under the constant threat of the use of new technology by existing or new actors to the marketplace. However, the nature of competition changed in the later half of the twentieth century.

In the Old Economy, Galbraith (1967) referred to corporations as 'polyglot,' as a few large corporations controlled the marketplace. The purpose of control of the markets by major corporations was to try to control the market to absorb uncertain outcomes in the marketplace, so they can effectively plan. Part of this process was achieved in tandem with a few competitors who fixed prices to maintain their secure positions within the marketplace. Corporations were also able to control suppliers by having corporate holdings of resources, or by controlling suppliers by the simple fact that they were the largest customer, or held long-term contracts with suppliers and dealers.

Galbraith (1967) described these large corporations as having a technostructure because decision-making now required specialized knowledge and information. As a

result, decision-making became decentralized as workers contained specialized knowledge. Galbraith (1967:77) defined the technostructure as: "an apparatus for group decision – for pooling and testing the information provided by numerous individuals to reach decisions that are beyond the knowledge of any one."

However, in late capitalism, competition has changed from a small group of companies controlling the marketplace with a well planned out agenda to a more competitive marketplace involving more companies, some of which are global actors in the marketplace. As a result, companies had to change their methods used in the technostructure to remain competitive, since competition may reduce market share due to new technological innovations. First, companies reduced their product cycles by using shorter time periods to plan and develop new products to effectively compete with competitors. Second, new technology was used in the production process to achieve greater flexibility. As a result of shorter product cycles and fiercer competition, basic R&D spending has decreased, and there is a new focus on new product development. For example, Atkinson and Court (1998) reported that research and development (R&D) has increased since the early 1990s, but basic research has decreased as companies focus more on producing products quickly due to competition and faster product cycles. Since less money is given to basic research, Atkinson and Court (1998) posed the question: "Will this hurt economic growth in the future?" Kirchhoff, Merges and Morabito (2001) mentioned that companies that do not focus on long-term R&D eventually lose their competitive edge and ultimately customers.

Development of Information Technology

I now turn to the development of information technology in the context of late capitalism. The importance of computers in modern business organizations has drastically grown since the 1960s and 1970s. Better chip technology, smaller models, and cheaper computer models facilitated later computer adoption. Minicomputers were made possible because of silicon chips that had thousands of tiny circuits and separate cost cutting measures that had occurred in computer manufacturing due to the economic crisis, saturation of computer markets, and increased R&D spending in the 1960s (Greenbaum 1979). The result was great decreases in prices by the late 1970s, which opened up new markets in such things as video games and automated checkout systems in grocery stores (Greenbaum 1979).

By the 1980s, personal computers and networks were developed, which had a much greater impact on actual business operations. One advantage to the PC is that work that was previously done on a mainframe could now be done on a PC. Microsoft's operating system was bundled with the IBM PC and had become the key operating system of PCs during the 1980s. In the 1990s, personal computers were widely adopted and new software was needed, which led to increased software development (Landry et al. 2002). As a result, spending on software has increased dramatically. Sawyer and Guinan (1998:552) reported that "about 40 percent of U.S. corporate capital expenditures are directed toward software." Also in the 1990s, the Internet, World Wide Web, and networks for clients were developed, thus expanding the use of computers in the workplace (Davis 2002:4).

Expanding Globalization

The third characteristic of late capitalism is the expansion of globalization. While globalization has been acknowledged as part of the New Economy, globalization has existed for centuries. Fröbel, Heinrichs, and Kreye ([1977] 1980) noted that the global economy began in the 1500s with the production of certain manufactures regionally such as the craft production of textiles in Western Europe. Other examples of regional manufacturing are domestic labor as part of the putting-out system, shipbuilding, metals, arms production, slave labor for mining (Peru, Mexico), sugar plantations (Brazil and West Indies), serf labor for grain production in Eastern Europe, use of wage labor for industrial production, and slave labor for cotton production (Fröbel, et al. [1977] 1980). Later on in monopoly capitalism, Braverman ([1974] 1998) claimed that monopoly capitalism led to increased 'internationalization of capital' or globalization. During late capitalism, globalization has continued to expand. Cyert and Mowery (1989) indicated that foreign trade nearly doubled from the 1960s to the late 1980s in terms of U.S. Gross National Product (GNP). From the 1980s to the 1990s, globalization continued to expand. Atkinson and Court (1998) used data from the Economic Report of the President in February 1998, and graphically showed that U.S. imports and exports have increased steadily from a little over 15% of GDP in 1984 expressed in 1992 dollars to approximately 22% of GDP in 1993 expressed in 1992 dollars. Thus, globalization is not new and has existed for quite sometime; however, the extent of globalization has increased more recently.

The increase in globalization coincided with an increase in the underlying processes of globalization. Benner (2002) claimed that the processes of globalization

have expanded with greater use of production networks globally, an expansion of international trade, and increased investment globally. Developments in information technology made the expansion of each of these processes possible. Part of the process of increased investment globally and the expansion of international trade is the movement of production to developing nations. Fröbel, et al. ([1977] 1980) noted that starting in the 1960s and expanding greatly in the 1970s, companies in industrialized countries moved production to developing countries as a rationalization scheme (increasing foreign investment) as a response to greater global competition. Fröbel, et al. ([1977] 1980) and Harrison and Bluestone (1988) referred to this change in the location of production from developed to developing countries as the "new international division of labour." Production was moved to new sites (referred to as World Market Factory), which consisted of production sites in free production zones in foreign lands, which produced products to be exported onto the international market. Free production zones took advantage of cheap labor, few governmental regulations, no rent for a specified period, and no construction costs (Fröbel, et al. [1977] 1980). Companies also relocated production to other countries for greater profits and new manufacturing technologies or advanced communications (Fröbel, et al. [1977] 1980). Harrison and Bluestone (1988) also added the ability to sell to foreign markets and to take advantage of lower taxes abroad as a reason for moving production abroad. According to Fröbel, et al. ([1977] 1980), in the past, companies survived through increasing efficiency, deskilling workers, and decreasing the number of workers employed. But in the 'new international division of labour,' production is relocated to places with very cheap labor to increase profits and remain competitive (Fröbel, et al. [1977] 1980).

Increased globalization also takes place in the form of increasing global interconnections within and between firms, which are referred to as networks or webs. International trade of products and services are made possible by webs which are formed among companies within the same multinational or are part of different companies (Reich 1992). Atkinson and Court (1998) pointed out that companies are collaborating and taking advantage of networks between companies to become more competitive through "innovation and growth." Kelly (1998) claims that networks have increased and have obtained greater penetration due to technology. Atkinson & Court (1998), citing 1996 data from the National Science Foundation, Science and Engineering Indicators, from the U.S. Government Printing Office, found that networks between companies more than doubled in the United States after 1991, but have remained stable in Europe and Japan. Meiksins (1996) believed that economic restructuring increased networks as companies no longer performed activities in house. Additionally, advances in information technology solved the difficulty of coordinating various actors in these networks (Meiksins 1996).

Economic Restructuring

The fourth aspect of late capitalism is economic restructuring. Harrison and Bluestone (1988) pointed out that from the end of World War II (WWII) to the 1970s competition from foreign businesses was virtually non-existent. Profits could be increased by inflation (raising prices). But Harrison and Bluestone (1988) reported that profits peaked in 1965 and fell quickly in the next ten years due to overproduction in manufacturing plants globally (foreign competition) and saturation in domestic markets

(domestic competition). As a result, competition (mostly global) kept prices in check, so profits could not be made up by raising prices (inflation). Additionally, manufacturers were not producing at full capacity, which undermined productivity and raised the cost of production. Profits were further undermined by the cost of labor in America which is higher than in most industrialized nations because we do not have a national health care system like other industrialized nations (Harrison and Bluestone 1988). Additionally, Harrison and Bluestone (1988) argued that economic deregulation increased competition.

Harrison and Bluestone (1988) argued that one response to the inability to raise prices due to foreign competition was use of cheaper raw materials, but plastics failed when Organization of Petroleum Exporting Countries (OPEC) raised oil prices. Another way was to obtain cheaper capital borrowed from banks; however, interest rates sky-rocketed undermining this possibility. Companies also chose not to innovate to increase productivity in the 1970s because executives lacked knowledge about the production process and were focused on making short-term profits. Instead of using new technology to increase productivity, American business decided to restructure itself by cutting costs. American companies restructured themselves by moving production overseas, lowering wages and benefits at home, utilizing anti-union measures, cutting production and management jobs, creating more part-time (PT) jobs at home, and utilizing government lobbying to reduce taxes and regulatory costs (Harrison and Bluestone 1988). Harvey (1990) noted other methods used in economic restructuring, some of which used technology, as follows:

> Technological change, automation, the search for new product lines and market niches, geographical dispersal to zones of easier labor control, mergers, and steps to accelerate the turnover time of their capital surged to the fore of corporate strategies for survival under general conditions of deflation. (P. 144)

As a result, economic restructuring produced a more flexible economy with greater flexibility in "labour processes, labour markets, products, and patterns of consumption (Harvey 1990:147)." Harvey (1990:147) referred to this as flexible accumulation, which has the following characteristics and consequences: 1) increase in the size of the service economy, 2) decline in the size of the manufacturing sector, 3) innovation allowing for small batch production to replace large-scale production which satisfied requirements for specialized markets, 4) increased use of subcontracting in the production process and an increase in the underground economy, 5) increase in mergers and business diversification into several different arenas to increase profits, 6) access to up-to-date information to be used for decision-making, 7) a need to know how to do the latest technological innovation, 8) development of a complex global financial system, 9) increase in the power of the financial system in relation to state system, and 10) decrease in the power of labor movements.

Thus, the consequences of deindustrialization and economic restructuring were increased income inequality, increased corporate profits, weaker union power, fewer prestigious jobs, and a more flexible economy (Harrison and Bluestone 1988). As a result, the economic prosperity in the 1980s was based on consumer and government debt, not on sound economics, such as increasing productivity. The result was a great U-turn, as the standard of living increased from the end of WWII to 1973, but decreased after 1973 (Harrison and Bluestone 1988).

Deregulation

The next major aspect of late capitalism is increasing deregulation. In the early twentieth century, the U.S. government tried to break up monopolies by Anti-Trust laws in an attempt to increase competition. However, after the Great Depression, controls were placed on the economy, so that the economy was less volatile, and much better controlled, which would avoid future economic depressions. However, many of the controls in the U.S. economy and global economy have recently been repealed. McGuckin and Van Ark (2002) noted that deregulation in the 1970s and 1980s occurred in communications, banking and transportation. In the 1980s and 1990s, the finance industry experienced deregulation.

The positive side of deregulation is that it has produced competition, innovation, greater efficiency, and decreased prices for services and products (Atkinson and Court 1998). However, deregulation also has had many negative effects. Harrison and Bluestone (1988) noted that deregulation on an international scale allowed savings, losses, and debt to be moved elsewhere, thus spreading the problems of troubled banks. Deregulation in other sectors also led to increased harm, death, and illness, such as in meat packaging or saw milling industries because workers worked much quicker in a deregulated environment (Harrison and Bluestone 1988). Additionally, the quality of services, both public and private, has decreased due to deregulation.

Finance

The growth in the finance industry is also a major aspect of late capitalism. Part of the increase in the finance industry is due to the greater role that businesses took in the

stock market. Harrison and Bluestone (1988) indicated that companies entered the finance arena and significantly increased their role in investment beginning in 1973 in response to declining profits, the hope of making money, and the ability to write off plant closings by subtracting them from corporate profits, and the desire for corporate mergers. Finance also grew due to computerization of trading which started in the 1970s. Computerization facilitated buying and selling and led to quicker market reactions, which facilitated the 1987 stock market crash (Harrison and Bluestone 1988).

Expanding Service Economy

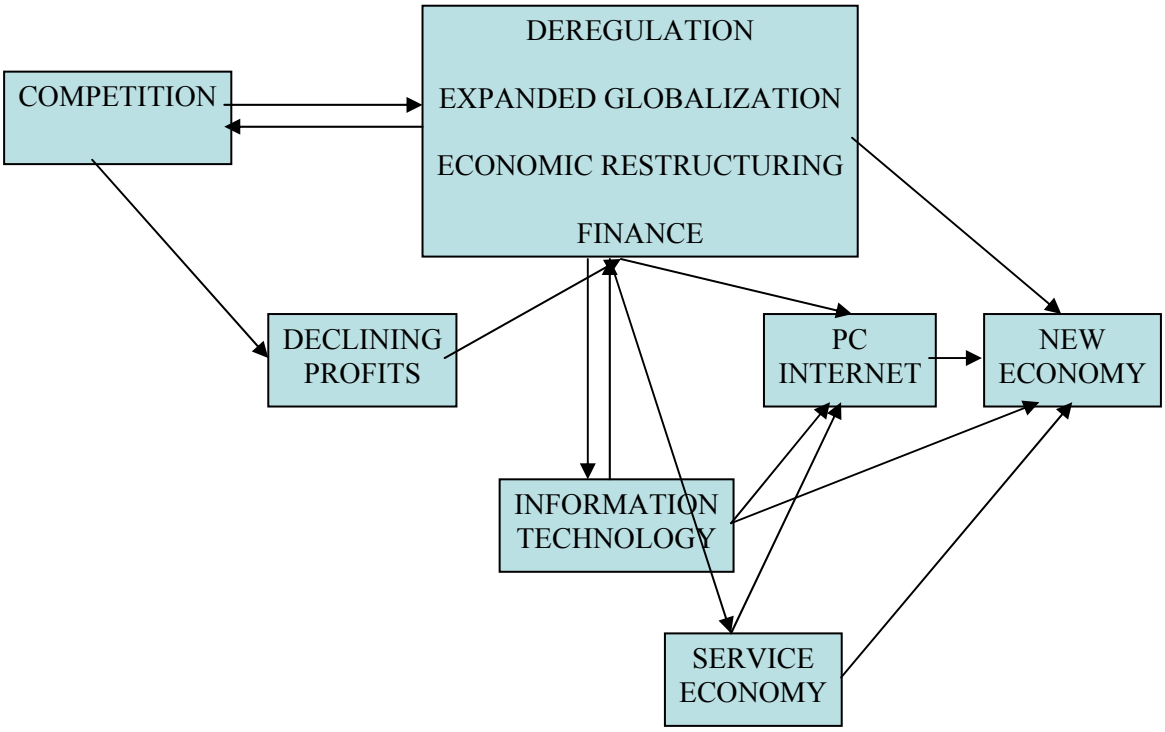
The last major aspect of late capitalism is the expanding service economy. The service economy has continued to expand in the twentieth century and many more services exist today than in the past. Braverman ([1974] 1998) reported that service jobs grew over three times as fast as growth of employment overall from 1900 to 1970. The increase in employment in the service economy can be attributed to increases in "producer services, finance, insurance, and real estate, and certain other sectors such as health and education," as well as sub-contracting and consultancy (Harvey 1990:156-157). However, Braverman provided an alternative explanation for the increasing service economy: 1) items of goods production have become saturated, 2) manufacturing has cut jobs in economic restructuring, and 3) services are needed as the modern corporation and urban society have developed. Muther (2002) offered another explanation by arguing that increasing competition due to globalization and deregulation have led to companies increasingly offering particular services and particular information and decreasingly attracting customers through products and lower prices.

General Theory of Historical Factors of Late Capitalism

Throughout this section, I have identified the key aspects of late capitalism in the United States, which are information technology, globalization, economic restructuring, deregulation, increased competition, finance and the expanding service economy. Figure 1 gives a theoretical model of these key concepts of late capitalism and their relationships which I will describe in this section. First, increasing global competition due to an increased presence from foreign competitors undermined profits in the late 1960s and early 1970s. There were several responses in an attempt to recapture declining profits. Most notable was economic restructuring as businesses tried to recapture profits through cost cutting procedures. Such procedures included a reduction in the size of the workforce, use of contingent workers instead of permanent workers, a reduction in employee benefits among existing permanent workers, less time spent on training new and existing employees, and utilization of new management techniques in the hope of increasing productivity. In relation to globalization, companies moved production overseas to cut costs and created connective webs of various suppliers and buyers, which increased globalization. In addition, there is a mutually supportive cyclical relationship between increasing competition and increasing globalization. As globalization increased in the 1960s, competition increased and lowered prices. As competition increased, corporations were more likely to move production abroad, which only furthered the global trade of commodities, which increased competition and undercut prices. After WWII until the 1960s, corporations increased profits by increasing prices, which led to inflation, but this technique could no longer be utilized. Thus, there is a double arrow between competition and the block including globalization. In the finance arena, some

corporations took a more active role in the finance industry through direct investment in other companies, such as mergers with or acquisition of other companies, or by a public offering on the financial markets. As a response to declining profit and economic growth, the government used deregulation of industries as a way to increase competition, which would hopefully create economic growth, and break the 'polyglot' of a few dominant actors in the marketplace. However, the recent expansion of the service economy was not due to declining profits directly, since Harrison and Bluestone (1988) claimed that the service economy resulted from corporate restructuring. Thus, declining profits led to corporate restructuring and corporate restructuring led to the increased use of services in an attempt to gain profits and successfully compete with competitors as the economy de-industrialized and the service sector expanded. Thus, since economic restructuring, globalization, finance, and deregulation were a response to declining profits, I will put these in one block in the theoretical model. Since the service sector of the economy was an indirect response to declining profits, I will include it in a separate box.

Figure 1. Theoretical Model of the New Economy within the Context of Late Capitalism.



I have an arrow from the block of variables containing 'Deregulation, Expanded Globalization, Economic Restructuring, and Finance' to the box containing 'Information Technology' for two reasons. First, Castells ([1996] 2000a) pointed to the influence of capitalist restructuring in the past 15 to 20 years (since the 1980s) to be the major influence on the direction of information technology as Castells referred to this as informational capitalism. Second, Salvatore (2003) argued that greater adoption of information and communications technologies (ICT) in the United States than other G-7 countries was facilitated by greater involvement in globalization and economic restructuring in the United States. I also have an arrow moving in the reverse direction for two reasons. First, the expansion of finance occurred due to advances in information technology, which paved the way for electronic transactions and enhanced profits.

Second, information technology facilitated communication between global players and made it possible to move production abroad.

Descriptions of the New Economy also include major aspects of the context of late capitalism, such as: increasing globalization (Castells [1996] 2000a; Chorafas 2001; Liedtka 2002; Meng Tat 2000; Hansen 1998; Kudyba and Diwan 2002; Greenwald, et al. 2000; Stiller 2002; Atkinson and Court 1998; Kelly 1998, and Benner 2002); continual economic restructuring (Thurow 1999; Stelzer 2000); continual effect of deregulation (Chorafas 2001; Stelzer 2000); deregulation coupled with growth in the finance industry (Chorafas 2001; and Castells [1996] 2000a); expansion of the service economy (Balmaseda, et al. 2002; El Sawy, et al. 1999; and Albrecht and Zemke 2002); and the influence of information technology (Potoker 2002; Castells [1996] 2000a; Meng Tat 2000; Kudyba and Diwan 2002). I will now examine the role of each of these factors of late capitalism in the New Economy.

Globalization has been a significant influence on the New Economy. Castells ([1996] 2000a) described the New Economy as "informational, global, and networked," which I explained earlier in the 'Supporters' Definitions of the New Economy' section. Castells ([1996] 2000a) used the idea of networks and combined it with globalization and information technology to provide an historical explanation of the development of the New Economy. Information technology over the past 25 years has produced the "informational, global and networked" aspects which are now associated with the New Economy.

Economic restructuring has continued in the New Economy as companies have continued to reduce the cost of labor by cutting their labor force. Economic restructuring

has also involved the use of new management techniques in an attempt to make workers more productive. According to Kraft (1999), competition of global markets has led to the adoption of Continuous Improvement (CI), Total Quality Management (TQM), and Business Process Reengineering (BPR). CI and TQM concentrate on decreasing defects and BPR wants to change the workplace through downsizing and corporate restructuring (Kraft 1999). CI, TQM, and BPR also focus on reducing the steps in the process of designing and making the product (Kraft 1999). Each of these focuses on the increase in the ability to predict product outcomes, control workers and processes, and are thus similar to Taylorism. The consequences of these methods are "intensified labor, more job competition and job insecurity, and downward pressure on wages (Kraft 1999:23)." Thus, the work environment can be less desirable for workers in the New Economy.

Deregulation has continued to take place in the New Economy. In 2000, Castells ([1996] 2000a) mentioned that additional deregulation happened in the finance industry as barriers to mergers between banks, securities, and insurance companies were lifted, which meant that banks, security firms and insurance companies could now have the same owners. Originally, in the 1930s and 1940s, the purpose of these barriers was to prevent another depression (Castells [1996] 2000a).

To remain competitive and continue to grow in the New Economy, financial institutions had to offer services globally (Chorafas 2001). However, it created risk because in the virtual economy, there is a much greater amount of money that is at risk in the form of derivatives than income generated from the real economy, and this trend has greatly widened in the 1990s. For example, in 1998, derivatives were 640% of the U.S. Gross National Product (GNP) versus only 166% in 1990 (Chorafas 2001). As a result,

greater risk exists in the economy today and risks have the possibility of compounding for financial institutions in the New Economy (Chorafas 2001). For example, Chorafas (2001) claimed that credit risks are increasing for financial institutions, but due to competition, they are offering lower rates. Thus, we need better regulation in finance due to the risks of the "globalization of finance" (Chorafas 2001).

Albrecht and Zemke (2002) believed that the New Economy has the characteristic of being a service economy. Information technology is transforming the service economy. Triplett (1999:15), a critic of the New Economy noted that in 1992, the year in which the most recent data is available, 50% of computer investment nationally occurred in the following parts of the service economy: "financial services, wholesale trade, miscellaneous equipment renting and leasing, and business services" … "insurance and communications" (p. 15). The Internet has also become a new medium for the service industry. Information is easily available online and thus an Internet connection and a web browser are the only requirement to find information. The Internet allows for bills to be paid online and products and services to be sold online. Online services increase customer satisfaction because it is easier for the customer to access bills, information, and services online.

Of course, information technology is part of the New Economy as the computer and Internet have become relevant to the daily functions of business. Therefore, information technology has become increasingly important in the New Economy and has become a vital and necessary part to business organizations today (Potoker 2002).

In the New Economy, increased uncertainty due to competition and other key factors makes control of the market less likely. This complicates decision-making

resulting in the need for quicker innovation and adaptation to the environment. Greater uncertainty in decision-making offsets any value gained from increased information. Survival in the electronic economy will depend on regular technological innovation and the ability to create value in a new way (El Sawy, et al. 1999). The market share advantage goes to the first mover into the niche in the Internet market, so companies must move fast (Lewis 2000). To be able to compete, organizations may need the ability to reorganize their organizational structures quickly based on the marketplace by aligning infrastructure with business strategy (El Sawy, et al. 1999).

Therefore, the influences of late capitalism have had a profound effect on shaping the New Economy. These factors existed before the New Economy, were important factors in the development of the New Economy, and continue to exist in the New Economy. The similarity of the characteristics of the Old and New Economies should not be a surprise, since Braverman ([1974] 1998) claimed that successive eras of social relations will have the same characteristics when one ends and the other begins. As a result, in Figure 1, I have arrows from the block of variables including 'Deregulation, Expanded Globalization, Economic Restructuring, and Finance' to the 'New Economy,' and an arrow from the 'Service Economy' to the 'New Economy,' and an arrow from 'Information Technology' to the New Economy. I also have arrows from 'Information Technology' to the 'PC, Internet' because the continual development of information technology led to the development of the PC and Internet, both of which had an influence on the development of the New Economy as shown in the arrow from 'PC, Internet' to 'New Economy.'

Chapter 3 Theory: New Economy as a New Mode of Production

In the debate between New Economy supporters and critics, there is some question as to whether there is in fact a New Economy. My dissertation attempts to address this question by proposing that a new dominant mode of production is based on worker use of new computing technology that is sufficient enough to make the claim that there is a New Economy. I will develop this argument more thoroughly in this chapter. In the process of building this argument, I will introduce the technology diffusion, the mode of production, and the articulation of the mode of production. I will also provide my definition of the New Economy and I will also present my hypotheses to test whether a new mode of production exists.

Technology Diffusion and Past Technological Revolutions

The technology diffusion literature comes from the field of economics and examines the adoption of new technology, its subsequent diffusion, and the economic impact of technology adoption. However, before I introduce the technology diffusion literature, I want to explain the historical context of the technology diffusion literature, so that the reader has a more grounded understanding of the literature. Adam Smith's ([1776] 1963) perspective, usually referred to as the 'Law of the Invisible Hand,' views perfect competition in the marketplace as companies who act efficiently in their business practices and lower costs to offer products at the lowest possible price. Smith ([1776] 1963) viewed monopolies as disrupting the process of the 'Law of the Invisible Hand' by the control exerted by monopolies over the process of supply, as monopolies could charge higher prices, and thus were less efficient in business practices. In contrast to the 'Law of

the Invisible Hand,' Schumpeter (1942) argued for the process of "Creative Destruction", where technological innovations destroy old economic structures and create new economic structures to replace them. Schumpeter (1942) remarked that capitalism is an evolutionary process that creates new goods, markets, method of production, organizational forms, and methods of transportation. Thus, creative destruction influences business practices and in the long run increases output and lowers prices. In this process of "Creative Destruction", Schumpeter (1942) argued that capitalism rewards creative innovators by creating temporary monopoly profits as long as the economy is not highly competitive. In other words, new creative innovators have a temporary competitive advantage over profits with their new inventions, which threatens the existence of competitors using older technology. Monopoly profits can also be used to fund new creative ventures and are thus valuable for creative innovation and economic growth. In other words, Schumpeter is pointing out the importance of technology to competition and economic growth. Alcaly (2003) also noted the importance of technology to economic growth. Alcaly (2003) claimed that Schumpeter's view of economic growth, which claimed that innovation caused long-term growth, and additionally that the development of innovations was unpredictable, has been shown to be largely correct. Nakamura (2000) also argued that modern economies have followed the creative destruction model better than the Invisible Hand model because modern economies promote creative innovation by governmental protection of intellectual property to facilitate creation of temporary monopolies and profit creation through innovation.

So what is diffusion? Grübler (1991) characterized diffusion as a series of replacements of an existing type of technology that continues to grow, and is influenced by business techniques that are currently in place. Grübler (1991) also noted that a framework needs to exist to support the adoption of new technology. Grübler (1991) also noted different phases of diffusion, in which, new technological innovation influenced the development of new industries, which subsequently led to improvements in the technology itself, and finally resulted in new products. As this process developed, adoption of new technology increased over time. In the first phase, many designs exist, but one design becomes dominant as a standard design, which leads to the first phase of diffusion. As a result of this first phase of diffusion, improvements in technology occur and prices are reduced. In the second phase, growth is much faster as incremental improvements occur, cost reductions increase, and applications in other areas increase as well (Grübler 1991).

In relation to adoption of new technology by firms, Kelley and Brooks (1991) noted three perspectives of why some firms are more prone to quicker adoption of new technology than others. In the first branch of the literature, the heterogeneity of organizational firm types is important to explaining why certain firms are more likely to adopt new technology than others. In particular, high wage firms have higher payrolls and thus are more likely to invest in new technologies to reduce costs than low wage firms. Secondly, some firms have better technical knowledge and better competencies, which leads to faster adoption of new technology, as firms are more aware of new technology, and are more likely to see a use for the adoption of new technology. Third, certain relationships among firms or certain economic institutions in certain regions or

places may facilitate the adoption of new technology. However, it should be noted that adoption of new technology does not happen without resistance. For example, Ram and Jung (1991) found that there is resistance to new technology adoption within organizations.

How might the diffusion of computers be measured in the technology diffusion literature? For example, Bessant (1988) mentioned that the diffusion literature on computer parts in manufacturing often examines adoption and diffusion of particular technological items. This would include examination of a specific type or model of computing technology. Additionally, they may create adoption curves of expected usage for a particular model with the purpose of creating separate profiles of adopters, such as innovators, early adopters, early majority, late majority, and laggards (see De Marez and Verleye 2004). De Marez and Verleye also mention media-related and attitudinal factors as part of segmented profiles of types of adopters as predictive reasons for adoption of new technology. Furthermore, computer imports can be measured (see Caselli and Coleman 2001). Additionally, social psychological characteristics on the intention and actual usage of new technology, such as performance expectancy as a gain in job performance, effort expectancy in terms of ease of use of new technology, social influence of important others, intention to use, and facilitating conditions toward infrastructural support (Venkatesh, et al. 2003). Venkatesh and Davis (1996) measure the influence of 'perceived ease of use' on new technology acceptance and subsequent usage. Abrahamson and Rosenkopf (1997) examined the effect of social networks, for example, jumping on the bandwagon (bandwagon theories) on innovation diffusion. Additionally, firm level variables are critical to the decision to adopt new technology. As just

mentioned, Kelley and Brooks (2001) noted three perspectives as important for why some firms are more capable at adoption of new technology. Malmi (1999:651) reported other important firm characteristics to be: "Firm size, profitability of an innovation, innovation champions inside the firm, production type, degree of centralization, organizational slack, proportion of specialists, functional differentiation and intensity of competition have been linked to adoption (e.g., Abernathy and Utterback, 1978; Aiken and Hage, 1971; Davies, 1979; von Hippel, 1988; Kimberly & Eviansko, 1981; Rothwell & Zegveld, 1985; Tornatzky & Fleischer, 1990)."

Why is the technology diffusion literature important to the study of the New Economy? In the New Economy, the recent technologies of the PC and Internet are being continually diffused in the economy and thus the importance of the technology diffusion literature comes into play. In a comparison of the computer to past technological revolutions, Gordon (2000) previously argued that the New Economy is unfavorable in relation to past technologies due to a lack of significant productivity increases in most sectors of the economy; however, New Economy technology fares better in other comparisons. First, Litan (2001) compared the technology of the New Economy to the railroad and automobile, and claimed that the failure in the dot-com industry of the late 1990s is not indicative of a lack of a New Economy because most automobile and railroad companies also went out of business at first. Second, the introduction of new technology in the past has had little immediate impact on productivity as new technology takes time to be adopted and integrated into business processes and thus takes time to increase productivity. Pakko (1999), Meyer (2001) and Alcaly (2003) believed that the reason that productivity did not immediately increase with the introduction of new

information technology was because historically with other key technological innovations, the same pattern occurred with productivity increasing sometime after the introduction of new technology. Pakko (1999) argued that productivity gains occurred after the technology was more fully adopted, not during the original investment, but during adoption and integration of the new technology. David (1990), who has examined and compared the electric dynamo and the information technology revolution, argued that it took about 50 years for electricity to influence productivity because electric power took time to be adopted. David argued that it took decades for the electric dynamo to be integrated enough to substantially increase productivity because of the following five factors that inhibited adoption of electric power: 1) technological advances in the production of electric power took time to develop, 2) existing plants needed to be redesigned or new plants needed to be built to handle electrical power, 3) the development of power networks were necessary to transmit electric power, 4) the existing technology of steam engines had to deteriorate enough for business to see the need to replace steam engines with electrical power, and 5) the economic boom of the 1920s provided the money necessary to replace older technology (David 1990). Alcaly (2003) added that lower prices later on facilitated adoption of electricity. Once these factors that inhibited adoption of electrical power were overcome, the adoption of electric power increased, which influenced productivity. David (1989, 1990) suggested that once 50% of firms used electric power productivity increased. Thus, David (1990) argued that based on the introduction of electricity, it should not be surprising that computers had not increased productivity significantly, since diffusion of new technology takes decades and productivity occurs after the diffusion becomes significant or above the level of 50%.

However, the diffusion of computers is happening quicker than the diffusion of electricity (David 1990), thus there is hope that productivity gains may happen more quickly with computers. Therefore, the Solow-Paradox of noticeable IT investment and low productivity does not seem so unusual when compared to major technological revolutions of the past.

The slow introduction of new technology mentioned by David and Alcaly is not unusual, since technology diffusion is often a slow process, as new technology is introduced, adopted over time, and integrated into business operations. For example, Cybert and Mowery (1989) argued that it is difficult to assess projection of employment because it takes a long time for new technology to be diffused into the economy. During this time, the new technology will advance, applications will be developed, the organization of production will change, and workers will be retrained. In comparison of the adoption of computers to the adoption of electricity, it should be expected that the adoption of computers will be quicker than the adoption of electricity because the importance of an existing framework for computer adoption that was already in place, which was not the case with electricity. In particular, an existing framework of office technology and physical office structure existed to support more rapid adoption of information technology (see the later section on 'The New Mode of Production and the New Economy' for more details). Additionally, significant technological advancements have increased computer adoption more quickly, such as the introduction of the PC in 1981, PC word processing in the mid-1980s, LAN connections to networks in the mid-to-late 1980s, and greater speed and storage space later in the 1990s. And computer prices have continued to fall, which has also facilitated quicker adoption of computers. For

example, Alcaly (2003) showed that as computer prices fell over the past twenty years, investment in information technology increased.

Using Perez's (2002) different periods of diffusion, I can trace out the adoption of computers. Perez (2002) described a period of installation and a subsequent period of deployment for adoption of new technology. The period of installation is the first two to three decades of a 50 year period, and since Perez places the beginning of 'The Age of Information and Telecommunications' at 1971, this phase would last to about the mid-1990s. At this point, information technology is in a deployment phase and is spreading throughout the economy (Perez 2002). As a result, adoption rates of new technology should not be in its infancy, but rather should be beginning the period of a pushing toward full adoption of new technology. Thus, adoption rates of new technology should possibly be mid-range in the late 1990s (30%-70%). This makes sense because developments in information technology had occurred over many decades and the beginning of the deployment phase in the mid-1990s corresponds with the development of the New Economy. Thus, it took the deployment phase before adoption of computers was significant enough to be considered a New Economy.

Marxian Conception of a Capitalist Mode of Production

The difference between the technology diffusion and the mode of production literature is that the diffusion of technology literature would study the diffusion of all types of technology, not just those types of technology influencing the workforce, which the mode of production literature would focus on. Additionally, not all new technology that is used in the labor process would be considered as a new mode of production

because new technology must be able to change how work is performed to be considered a new mode of production. In this section, I will describe the mode of production beginning with Marx and subsequently ending with articulation of the capitalist mode of production. Additionally, I will explain how I am conceptualizing the mode of production in relation to the work of Marx.

Marx focused the bulk of this work on both trying to understand and critique the capitalist mode of production. Marx mentioned earlier modes of production that existed prior to capitalism such as agriculture, and craft production; but Marx focused on the capitalist mode of production because it was a new dominant and highly exploitive mode of production. Marx ([1867] 1977) conceived of the 'mode of production' as the production process. For example, on page 617 of volume I of Capital, Marx treats the mode of production as the particular method of production. On page 1034-1035 of the Appendix of volume I of Capital, Marx directly mentioned the mode of production as the production process by referring to capitalist production as a particular mode of production. It should be noted that the production process would include how work is performed as well as the organization of labor. Thus, Marx conceived of the 'mode of production' as the method utilized in the production of new products. However, Marx takes this a step further, and refers to the varied production processes in different industries as separate modes of production. On p. 505 in volume I of Capital, Marx described the influence that the mode of production in one industry can have on another industry. While Marx focused on the mode of production as how products are produced, many scholars view the mode of production more broadly to include such things as the relationship of the mode of production to society in the form of social and technical

relations of production, the influence of the mode of production on the social relationships between classes, and relationships of the mode of production to the political system. For example, Castells ([1996] 2000a) gives examples of the mode of production as capitalism or statism. Such a view of the mode of production equates the mode of production with an economic system, such as capitalism, and ties the mode of production to a political-economic system. While Marx does tie the mode of production to other aspects of society in an attempt to ground the mode of production in the social world, such as the social and technical relations of production, these are not in themselves the mode of production. Rather, the mode of production has influences on other aspects of society, such as the relationship of the mode of production to society in the form of social and technical relations of production, the influence of the mode of production on the social relationships between classes, and relationships of the mode of production to the political system.

Another problem that the view of the mode of production as "capitalism" has is that this view ignores that Marx mentioned more than one mode of production within capitalism. For example, Marx ([1867] 1977) described the process of the evolution of the mode of production of manufacturing to the mode of production of large-scale manufacturing in capitalism. Eventually, the new developing mode of production of large-scale manufacturing replaced the older dominant mode of production in manufacture because technological advances in machine making in manufacture laid the foundation for the technological development of complex machinery (Marx [1867] 1977). Thus, manufacturing and large-scale manufacturing were separate modes of production in capitalism with manufacturing preceding the development of large-scale

manufacturing. In a similar manner, I am describing the new mode of production of computing technology as another new mode of production that developed in late capitalism. Thus, I am not arguing for a new mode of production that is separate and distinct from capitalism. In my work, I am testing the rate of adoption of this new mode of production and whether this new mode of production is a new dominant mode of production.

Marx also used a similar concept in his work, the 'means of production,' which can easily be confused with the mode of production. The difference between the two concepts is that the 'mode of production' applies to the method of the production process, where the 'means of production' focuses on the materials and instruments used to make the products. Marx ([1867] 1977:287) defined the means of production as consisting of the instruments of production and the physical objects (raw materials) that go into making the product. Marx ([1867] 1977) noted that the means of production are required items for the labor process. The worker uses the means of production to produce products in the labor process.

Articulation of the Concept of Mode of Production

The articulation of the mode of production is a reaction to the Marxian concept mode of production as the literature attempts to clarify the concept of the mode of production, which has been admittedly a vague concept. Additionally, it attempts to clarify the mode of production as malleable and applicable to particular cultural and geographic contexts. Davidson (1989) claimed that due to its abstract nature, the mode of production is an abstract concept that cannot be completely empirically specified.

Goodman and Redclift (1982) pointed out that the articulation perspective on the mode of production attempted to more clearly define the Marxian concept 'mode of production.' The articulation literature also serves as various ways of conceiving and organizing the concept of a mode of production. I will now present both of these aspects of the literature which try to better clarify the concept and summarize different organizational schemes of the articulation literature.

In better conceptualizing the concept 'mode of production,' Davidson (1989) described four main issues to help characterize the concept of a mode of production. First, it is important to distinguish which elements make up the concept of the mode of production. Davidson pointed out that the method of production and the social relations of production are elements of the mode of production and that they are also responsible for the foundations of society. Second, what is the "theoretical scope" of the term mode of production? Some theorists make social relations prime, others make productive forces prime, and others combine the two. For example, Davidson (1989) pointed out the following:

> All agree that the productive forces comprise labor, organisation techniques, and technology, while the relations of production specify forms of access to and control over them, in addition to the social forms of product appropriation and attendant distribution. What differs is which has primacy. (p.245)

Third, the relationship of the mode of production to the rest of society is the "base/superstructure" argument (Davidson 1989). Goodman and Redclift (1982) summarized this position as the relationship of the economic base to social class and politics. In this debate, two positions take precedence, the economy explains the social world, or the structures are important to explaining our social world. The result of this debate leads some to use "social relations of production" or "total systems of

reproduction" instead of the term "mode of production" (Davidson 1989). In a related fashion, Foster-Carter (1978) summarized this position as the mode of production is key to informing politics by: 1) arguing that the veracity of theory is based on its political usefulness and 2) the process of the modes of production are a catalyst for class relationships. Fourth, Davidson pointed to the issue of the extent to which the mode of production is socially reproducible. Goodman and Redclift (1982) viewed this perspective as the social reproduction of the relationship of the economic base to social class and politics and the level at which social reproduction should be measured at (Goodman and Redclift 1982). Foster-Carter (1978) added a perspective not mentioned by Davidson. Articulation is a process in time between the relations of different modes of production to one another. For example, the transition to capitalism from the other modes of production except feudalism occurred by way of violence.

In relation to organizational schemes, Perlin (1985:97) defined the mode of production as "the sphere of organisational content (organisation and relationships of production) considered sufficient for generating social reproduction." Perlin (1985) classified modes of production in micro-logical and macro-logical forms. Micro-logical modes of production are for example, domestic, family, African modes, peasant, and sharecropper modes of production. These types of modes of production are easily distinguishable from other types of modes of production because they often exist alone and not in combination with other modes of production in a society. Supporters of micro-logical modes of production do not make connections to society as a whole, but to other modes of production in social history. Supporters of macro-logical modes of production on the other hand, confuse political, class or family boundaries with the mode of

production, since macro-sociological modes of production consider the relationship between the mode of production to economic, cultural, political, and social parts of society (Perlin 1985). As a result, despite being broader in scope than micro-logical modes of production, macro-logical modes of production are more specific to time and place because of their relationships to other aspects of society, which are time and place specific. Thus, micro-logical modes of production apply theoretically in a clearer manner across time and geographical location than macro-logical modes of production, which are more specific to time, society, and place (Perlin 1985). In the end, Perlin rejected the macro-logical modes of production because of their false generalizations and their contradiction in making distinctions between different types of society based on their mode of production when they are time and place specific. However, Goodman and Redclift (1982) would disagree with Perlin because limiting the concept of the mode of production to the relations of production is a narrow perspective on the mode of production because it does not consider how it relates to social class, politics, and further social reproduction. In relation to my work on the New Economy as a new mode of production, the new mode of production is a macro-logical mode of production because it is time and place specific as a development coming out of late capitalism. Therefore, as explained earlier, I view the new digital mode of production to be the development of another mode of production within capitalism.

The New Mode of Production and the New Economy

The purpose of this section is to describe and argue that the adoption of new computing technology in the workforce is a new mode of production. The adoption of computers and the Internet is an interesting case because diffusion is taking place both inside and outside of the workforce unlike the use of machines in large-scale manufacturing originally. However, my focus will not be the adoption of the computer and Internet within the workforce per se, but on actual usage. Adoption is related to adoption of actual technology, where the mode of production is related to actual usage of this technology by workers once the technology has been adopted. The actual usage of new computing technology in the workforce will establish a new mode of production. Afterwards, I will also make an argument that the new mode of production is a sign of a New Economy and give my definition of the New Economy.

Office Technology as an Early Framework for Adoption

The development of office technology has set the groundwork for the later development and subsequent use of the computer in the office as well as other work locations. In the expansion of the office setting since the 1900s, new technologies were needed to more efficiently handle new and expanding amounts of information, thus office technology has developed over time. For example, Greenbaum (1979) pointed out that computers were an improvement over electronic accounting machines in the 1950s, since electronic accounting machines were no longer able to handle the increasing number of transactions involving information. Prior to the computer, other technologies existed in the office to perform office work such as the typewriter, word processor, and office

business machines. These earlier forms of office technology were used to perform tasks in the office and computers were seen as an improvement over the functioning of existing office technology in the performance of office tasks. Sichel (1997:123) pointed out that "type writers, adding and calculating machines, punched-card tabulating machines, and the telegraph" were precursors to the personal computer and the functions of each were integrated into the computer.

Office technology in the past has set the ground work for later adoption of new computing technology. Historically, adoption of new technology is a slow process due to the need for earlier technological advancements to set the ground work for later more developed technological advances. For example, mainframes were the first computers, later on macroprocessors and minicomputers were developed, which eventually led to the personal computer. According to Barkume (1992/93), mainframes were used to process a lot of information, but were not efficient for the purpose of processing smaller amounts of information. In the 1970s, minicomputers were developed to deal with smaller amounts of information. Development of the PC led to much wider use of the computer at work to process smaller amounts of information (Barkume 1992/93). The personal computer was seen as an improvement over mainframes, minis and macroprocessors in the performance of job tasks in the office. Additionally, the personal computer has continued to evolve as speed and memory increase, size of technology has decreased, prices have fallen, and more advanced software has been developed. Therefore, office technology has set a framework that was supportive for the later adoption of the personal computer.

As mentioned earlier, Grübler (1991) referred to an existing framework as being important for the adoption of new technology. I believe there are three parts to the

framework that provided a basis for later adoption of the personal computer and quickened the adoption of computers relative to past technological revolutions. First, preexisting office technology existed which gave a technological base that the computer could easily replace. For example, the personal computer can perform the tasks of many of the older forms of technology, such as the type writer, word processor, electronic calculators, electronic adding machine, slide rule, and other office business machines. Thus, once computing technology had sufficiently developed enough it was able to replace these older technologies without much difficulty, and adoption occurred more readily. Second, office work had developed and expanded since the nineteenth century, as knowledge, professional and clerical workers were needed to help businesses perform properly as bureaucracy expanded and the number of organizational units increased. The increasing prevalence of office work provided structural support for more advanced computing technology. Third, when capitalists decided to buy personal computers in the 1980s, they were expensive. Yet, despite the cost, capitalists saw the need to place computers in work environments that are most amenable to use of the computer, which are office jobs and jobs involving information and knowledge. The capitalists likely chose to purchase new computers with the hope of increasing low productivity and also to remain competitive. As a result of this prior framework to the development of the personal computer, the personal computer was adopted more quickly than past technological revolutions and became commonly used at work as business adopted the new technology and integrated it into business operations.

But I will now look at the particular comparison of the framework to adopt computers to the framework to adopt electricity to help explain why computers were in

better shape to be more quickly adopted. In comparison of the introduction of electricity to the introduction of the personal computer, the adoption of electricity as a replacement for steam engine technology was not nearly as straightforward as the adoption of the computer. As explained earlier, David (1990) claimed that the introduction of electricity was slowed by: 1) the existence of fully functional plants with steam engine technology, which resulted in a waiting period for the adoption of electric power until these fully functional plants powered by steam engines decayed and needed replacement, 2) difficulty in the physical process of actually introducing electrical motors which required rebuilding the plants, 3) lack of capital until the economic boom in the 1920s which provided the necessary capital for improvements, and 4) the need to develop the infrastructure needed to successfully transmit electricity. In comparison, the personal computer was able to replace existing technology with little effort except for cost because computers were seen as an improvement over existing office technology, there was less of an incentive to wait until older technology decayed, there was no need to re-configure the office except for new outlets and new office furniture, there was no need to wait for the infrastructure to develop before using computers, the availability of capital due to two long economic booms in the 1980s and 1990s negated the cost factor. Since a framework was already in place which provided continuity between pre-existing office technology and personal computers, the personal computer was adopted more quickly than electricity.

While I have noted the pre-existing framework of office technology for facilitating quick adoption of the personal computer, this is only half the story. Computers are highly useful and have broad application outside of office work. There

are many examples of non-office jobs that have adopted computers due to information processing needs, such as shipping and receiving, customer service, rental truck outlets, bank tellers, and manufacturing. The quick adoption of computers was also facilitated by the flexibility in application of computers. However, jobs that already involve a high degree of information or knowledge and are situated in an office setting are more amenable to computer adoption than jobs that involve less information and are not situated in an office environment because of the need to use computers to process information and knowledge. As a result, they should be more likely to use personal computers than non-office settings.

Additionally, technological developments in computing technology that facilitated adoption happened very quickly in the 1980s and 1990s. In particular, the speed and memory of the personal computer increased, and the cost of computers decreased. These developments in the PC facilitated software development too. Later on, the development of the World Wide Web facilitated Internet adoption. All of these factors facilitated later adoption of the computer. Additionally, adoption of the personal computer was also facilitated by the ease of application of new technology to a wide variety of existing tasks which businesses perform. Once business realized the benefit of the PC and Internet, and could easily utilize them in an attempt to make a profit, they began using the PC and Internet more extensively and hooked the two technologies together. The hope was that the PC and Internet would act as a "rescue" technology that would increase lagging productivity and thus ultimately increase profits, since historically technological advances led to increases in productivity that subsequently led to greater corporate profits and a higher standard of living. However, it should be noted that profits had already been

rising due to economic restructuring and outsourcing of the 1970s and 1980s. But global competition formed an intensely competitive business climate in which profits were constantly seen as at risk. Thus, while new computers are expensive to purchase, another hope of IT may be that it decreases costs as productivity increases, which would enhance the ability of companies to compete in a very competitive business environment.

New Technology as a New Mode of Production

Computer technology has been around since the 1940s and has been the technological foundation for the communication and information technology products that we see today. While computer technology has existed for decades, it was not involved in the creation of a New Economy until very recently. The New Economy of the United States was not considered to begin until the recent developments in information technology as a new mode of production, specifically *utilization* of the PC and the Internet with accompanying software by business. But, an important point about the development in the new mode of production of computing technology is the interconnection of the PC and the Internet. The Internet needed the PC to be viewed. The Internet could not have been as user-friendly without the ability to view items online via a personal computer. Nor could e-commerce function to the same extent that it does today without the PC, an operating system, software with graphical user-interface, and an Internet connection with the proper software. The PC had to develop enough processing speed and storage capability to handle Internet connections. Additionally, software had to develop which would allow the ability to navigate around the Internet. The PC and Internet were technologies that developed separately, but had to develop to a point where

the two technologies could be used in tandem to produce a new mode of production. Another important factor was the lower cost of a PC that facilitated use of pairing the technology of the PC and Internet. Business took advantage of this unique combination of new technologies. In 1996, Tapscott (1996) predicted that the New Economy would come about as a result of linking personal computers to fibre optic communications to create networks, which Tapscott referred to as the "infostructure." Additionally, use of the PC and Internet together is fairly consistent with the Internet Hypothesis mentioned by Blinder (2000), who argued that the interconnectivity of the Internet increased productivity and cut costs by better knowledge of inventory, increased communication throughout the company, and the ability to cut costs in e-commerce with other businesses. The development of these two technologies to be used together allowed for expansion of the software industry. Thus, the combined use of the personal computer and Internet were necessary for the development of a New Economy mode of production. Therefore, the New Economy started in the mid-1990s when the Internet and personal computer were used on a wide scale by business as a new mode of production once the personal computer and Internet became user-friendly and affordable.

Information and knowledge are more extensive today and are utilized and processed more often today than in the past. New computing technology is utilized to handle and process this new information and knowledge. As a result, personal computers have become a central way of managing information and performing basic daily tasks within the organization. Workers also use the computer and Internet to perform activities done previously by typewriter, calculator, and other office technology as the computer has replaced older office technology. The Internet has increased the value of information

and knowledge by using the computer and phone line to enhance communication between actors in daily business activities, whether it is other workers in the company, customers, suppliers, or distributors. Thus, it is the combined use of computers and the Internet by workers that is central to performing everyday business operations in a fundamentally new way, which can be characterized as a new mode of production. The combined use of the computer and Internet are a new way of doing business in a similar manner as use of machines in mechanized large-scale production was a new way of doing business in the nineteenth century.

New Economy as a New Mode of Production

In connecting the new mode of production to a New Economy, I am taking the Marxian perspective that the mode of production is central to the economy. According to Marx ([1867] 1977), it was not until machinery was used in large-scale manufacturing did the economy become an industrial economy. In a similar manner, but on a broader scale, computers are used in all industries of the economy, and are in the process of changing the economy to a digital economy. Information and knowledge have become much more critical in the economy and new computing technology is used to handle and process the information and knowledge at work. Additionally, new computing technology has changed the way information and knowledge are handled and processed at work, which changes how work is performed and how business operate. For example, Litan (2001) claimed that new technology changes how businesses operate in the economy on a widespread basis. While workers are not directly part of the circulation and consumption of goods, they represent the wage earners in the economy that utilize

new technology in their work in a new mode of production. McNerney (1996) refers to the knowledge workers in the economy as the means of production. Knowledge workers use their skills and knowledge to produce information and knowledge in the economy, and they utilize computing technology in the process of creating and using information and knowledge in this new mode of production of computing technology.

However, before anyone can claim there is a New Economy, adoption of a new mode of production must occur on a mass scale. Minor adoption of new technology by business which is used by a limited number of workers is not representative of a New Economy, even if, like computers, adoption of new technology is occurring in all industries of the economy. Minor usage of new technology may constitute a new mode of production, but it must become dominant before it can be considered a New Economy. Thus, some criterion is needed to confirm that a new mode of production has experienced a significant enough adoption to conclude that there is a New Economy. In relation to the new adoption of manufacturing which was representative of the industrial economy, Braverman ([1974] 1998:164) presented U.S. data that showed that manufacturing and other goods producing industries represented nearly half to just over half of the workers in the economy starting in 1840 and continued for most of the nineteenth century. The level of 50% also comes up in the technology diffusion literature in relation to the adoption of electricity. David (1989) and Alcaly (2003) indicated that when 50% of factories in the early 1920s had adopted electrical power, thus replacing steam engine technology, productivity started to increase. Usage of the level of 50% to determine a New Economy is also consistent with Max Weber's discussion of a dominant capitalist mode of production. In *General Economic History*, Weber ([1981] 1995:276) drives

home the importance of considering the dominance of a mode of production: "A whole epoch can be designated as typically capitalistic only as the provision for wants is capitalistically organized to such a predominant degree that if we imagine this form of organization taken away the whole economic system must collapse." This statement is indicative of capitalism as a dominant mode of production, which I argue can be measured by at least 50% of the workers in the private sector utilizing technology. In relation to computers today, it could be argued that if computers were taken away, it would have a crippling effect on many types of jobs that utilize computers. Therefore, in a particular industry, if computer usage is 50% or above, the new mode of production of using new computing technology is a New Economy.

It should also be noted that my use of 50% in all industries is setting a higher bar than examination of 50% usage in manufacturing during the industrial revolution. However, use of 50% in all industries is appropriate here, since use of computer technology in this new mode of production has occurred in all industries and is not just restricted to manufacturing. Thus, examination of 50% computer usage can be assessed in each industry to determine whether each industry has adopted a new mode of production.

I am now ready to give my definition of the New Economy of the United States, which is: The New Economy consists of a new mode of production, in which, the PC and the Internet with associated software are adopted by business and used by workers on a wide scale basis within the context of late capitalism. As explained earlier, the context of late capitalism consists of expanding globalization, an expanding service economy, developing information technology, a blossoming finance arena, increasing competition,

continued economic restructuring, and increasing deregulation. Thus, I conceive of the New Economy as a new mode of production which refers to the adoption and use of the PC and Internet by business within the context of late capitalism.

Measurement of a New Mode of Production

I will test the new mode of production by an examination of employee computer usage at work across industries in the private sector. By examining computer technology as a new mode of production, I am examining whether workers are actually performing meaningful work with new computing technology. Examination of computer usage at the worker level is a more accurate measure of technology usage than firm level technology usage for two reasons. First, productivity is occurring at the individual level by workers acting productively, thus it is a better measure than usage at the firm level. Additionally, measurement of actual technology usage by workers is a more direct measure of a new mode of production than measurement of technology usage at the firm level. The result is that we more precisely pin down adoption of a new mode of production. Second, there is the possibility that since a very large number of firms could use computers, only a small percentage of skilled employees might actually use them, which would undermine the usefulness of firm-level computer adoption. For example, this would have been a likely scenario if mainframe technology had continued to expand in relevance, and only computer experts continued to use them.

In the Industrial Revolution, which was defined by how goods were produced, capitalist production was important for the development of capitalism. Essence is in the new way products are produced. In a similar manner, measurement of computer usage is

a direct measurement of the new mode of production instead of relying on indirect economic measures, such as productivity. The reason productivity is important and is often used by economists is that productivity is a measure of the economic health of an economy, since increased productivity is predictive of future economic growth. An advantage of this direct measurement of technology is it is an actual measurement of the technology in usage, rather than waiting for future productivity data and attempting to loosely tie it back to the time of the introduction and later expansion of the new technology.

The computer usage question in the Current Population Survey (CPS) is relevant for my dissertation because it assesses computer usage by workers. However, these measures do not assess adoption and replacement of particular computer models, which is more commonly used in assessment of technology diffusion. As a result, it is not possible to assess adoption of new computer models, since new computer models will replace older computer models. For example, computer users at work who used an earlier model that was later replaced were not counted as new computer users, even though they use a new computer model. Thus the aggregate numbers treat replacement as continued use of the computer, not as new computer usage. If data existed on diffusion of a particular computer model, only then would replacement become an issue because new adopters of a particular computer model might be a completely new computer user or they may have previously used an older model.

However, measurement of a new mode of production by computer usage will not include measurement of other types of related technologies in the workplace, such as networks, servers, which could be argued to be part of the new mode of production. For

example, there are non-PC related use of computing technology in the form of computer chips and other electronic technology in various parts of the organization, such as the use of computing technology in manufacturing and security that my study does not address. Essentially, computing technology is broader than just personal computers; however, computers are the main technology used by workers and are an excellent starting point at documenting this new mode of production.

However, I did not develop additional hypotheses for Internet usage because of a lack of available and consistent data across time. The first available year for Internet usage is 1993 as Bulletin Board use. What we know of as the Internet today was first measured in 1997. In 2001, Internet and email usage at work are combined into one question as an either/or question, which undermines any comparison with the other two years. In 1993 and 1997, the universe for Internet usage at work is computer usage at work. Data on Internet usage at work are available in 1998 and 2000; however, since there is no computer usage at work question in those years, the universe changes to Internet usage outside the home in these two years. The result is that Internet usage is higher in 1998 and 2000 than in 2001, which is strange because the 2001 measures includes both Internet or email usage, and Internet usage should have had a significant increase from 1998 to 2001. Thus, the measures of Internet usage in 1998 and 2000 are not comparable with other years. Additionally, by not measuring computer usage in 1998 and 2000, it undermines any joint comparison of computer and Internet usage, which was part of my argument about the mode of production as the simultaneous existence and connection of these two types of technology. As a result of these problems with Internet

usage at work, I did not produce separate hypotheses for Internet use at work. Rather I produced bivariate descriptive analysis of Internet usage only.

Development of Hypotheses: Diffusion of the New Economy in Different Industries

In this section, I intend to develop hypotheses within each of the major industries of the private economy, since computer usage would be expected to vary by industry. In particular, I will develop separate hypotheses which attempt to specify the rate of computer usage and the level of computer usage. The rate of computer usage will express the rate of increase in computer usage. The level of computer usage will measure the accumulated level of computer usage by 2001.

In the following discussion, I will develop the theoretical and empirical justification for differential use of computer usage by industry. Marx ([1867] 1977) indicated that adoption of the mode of production of large-scale manufacturing varied across industry as some businesses used new technology more readily than others. In essence, Marx argues that some were still using the old mode of production, when large-scale manufacturing was being newly adopted, thus, slowing the rate of adoption of large-scale manufacturing. In a similar vein today, each industry based on the type of work that the industry captures, will use computers to varying degrees. It would also be expected that the type of work in a particular industry will either facilitate or hinder adoption of computers. For example, computers are less likely to be used by construction workers than say accountants, because of the nature of the work itself. Taking the perspective of New Economy supporters, which claim that information and knowledge are a key aspect

of the New Economy (Atkinson and Court 1998; El Sawy, et al. 1999), New Economy jobs would be expected to more likely involve information and knowledge. Thus, work involving information and knowledge would be expected to be more likely to use computers. This is similar to the line of reasoning used by Levy (2002a), who explained that computers are not spread evenly throughout the working population. In particular, Levy (2002a) claimed that computers are used most often by educated workers. Additionally, one of his key points is that technology compliments educated workers, but substitutes the need for jobs for lower paid workers (Levy 2002a). Therefore, knowledge workers, who are also more likely to be educated than manual workers, would be expected to be more likely to use computers than manual workers. In relation to specific industries, those industries that have more knowledge workers, such as Finance, Insurance and Real Estate, and some areas of the service economy will be expected to have a higher percentage of computer usage. Work which involves creation or movement of physical objects, such as mining, construction, manufacturing, and trade, will have lower computer usage.

Since it would be expected that those industries that have a higher percentage of knowledge workers would have a higher percentage of computer usage, I will use the percentage of knowledge workers in each industry to predict computer usage. In other words, I will use criterion-related validity, which according to Babbie (1998), is established for an original variable, assuming it predicts an outcome variable as expected. For example, criterion-related validity would be established in this case for the classification of knowledge and manual workers, if those industries that have a higher percentage of knowledge workers, also have a higher level of computer usage. To obtain

a measure of the percentage of knowledge workers, I recoded the variable containing occupational codes in the CPS into a dummy variable of knowledge vs. manual workers to obtain the percentage of knowledge workers (see details of the recode in the methods section). I produced Table 1 which is a crosstabulation of the percentage of knowledge workers by major industry which will be used in both types of hypotheses to predict computer usage.

In presenting the percentage of knowledge workers in the hypotheses for each industry, I will give the percentage of knowledge workers relative to the average percentage of computer usage in all industries in a given year. However, I will not state specific hypotheses for each year, since the percentage of knowledge workers in a particular industry in all years is either above or below the average percentage of knowledge workers. For example, in every year, Agriculture has a below average level of computer usage; and for every year, 'Wholesale and Retail Trade' has an above average level of computer usage. Rather I will state general hypotheses from 1984 to 2001 for each industry.

In developing hypotheses that would test the adoption of a new mode of production, I chose two hypotheses that test the growth of the New Economy in each industry. The first set of hypotheses will test the rate of adoption of computer usage within each major industry. Testing the rate at which computer usage is adopted in each industry is key to demonstrating that adoption of this new mode of production is taking place. The second set of hypotheses will test the level of computer usage by 2001 in each

Table 1. Percentage of Knowledge Workers by Major Industry, 1984-2001
% within Major Industry Recode. Total in each industry in parentheses.

		Knowledge Workers				
Major Industry		1984	1989	1993	1997	2001
Agriculture	%	5.6	9.5	9.8	12.4	12.4
	count	(2,348)	(2,143)	(1,876)	(1,699)	(1,934)
Transportation, Communication & Public Utilities	%	45.5	46.0	49.5	48.4	48.5
	count	(3,853)	(3,735)	(3,782)	(3,415)	(4,105)
Wholesale & Retail Trade	%	63.5	64.8	63.4	63.6	63.9
	count	(13,404)	(13,274)	(12,814)	(11,240)	(13,195)
Finance, Insurance & Real Estate	%	93.7	93.7	93.5	94.3	93.7
	count	(4,114)	(4,467)	(4,192)	(3,609)	(4,363)
Services	%	60.0	64.5	65.1	67.3	68.3
	count	(15,017)	(16,839)	(17,414)	(16,832)	(20,541)
Mining, Construction, Manufacturing, Forestry & Fisheries	%	32.6	34.2	33.9	35.9	35.1
	count	(17,749)	(16,982)	(14,870)	(12,846)	(14,338)
	%	51.4	54.6	55.4	57.1	57.8
	Total	(56,485)	(57,440)	(54,948)	(49,641)	(58,476)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

industry. Testing the level of computer usage in 2001 demonstrates the degree to which the adoption of this new mode of production had taken place in each industry by 2001. These are two different hypotheses of adoption of a new mode of production because the rate of adoption of computer usage measures how quickly computer usage is adopted, whereas the level of computer usage measures the level of accumulated computer usage reached by 2001. Of course, there is a relationship between these two types of

hypotheses, since adoption of computer usage at a quicker rate should lead to a higher accumulated level of computer usage by 2001.

However, it should be noted that the percentage of knowledge workers in each industry is predicting *differential* computer usage by industry in each year. The percentage of knowledge workers in a given year cannot predict an increase in the adoption of computer usage in later years because I lack data of the same respondents over time in a panel study. As a result, I did not formulate hypotheses about the change in the rate of adoption of computer usage because it is impossible to formulate hypotheses on the change in the rate of computer usage in each industry.

Based upon the results of the percentage of knowledge workers in each industry in Table 1 above, I now present the first set of hypotheses on the rate of computer usage:

H1a: Since 'Agriculture' has a much lower percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of computer usage within 'Agriculture' will expected to be below the average rate of computer usage from 1984 to 2001.

H1b: Since 'Transportation, Communications, and Public Utilities' has a lower percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of computer usage will be expected to be below the average rate of computer usage from 1984 to 2001.

H1c: Since 'Wholesale and Retail Trade' has a higher percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of computer usage will be expected to be above the average rate of computer usage from 1984 to 2001.

H1d: Since 'Finance, Insurance, and Real Estate' has a higher percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of adoption of computer usage will be expected to be above the average rate of computer usage from 1984 to 2001.

H1e: Since the 'Service' industry has a higher percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of adoption of computer usage will be expected to be above the average rate of computer usage from 1984 to 2001.

H1f: Since 'Mining, Construction, Manufacturing, Forestry and Fisheries' has a lower percentage of knowledge workers than the average percentage of knowledge workers for the private sector from 1984 to 2001, the rate of computer usage for 'Mining, Construction, Manufacturing, Forestry and Fisheries' will be expected to be below the average rate of computer usage from 1984 to 2001.

We have theorized thus far that industries that utilize information and knowledge are more likely to adopt and use computers at a quicker rate than industries that are not knowledge intensive. The next question becomes to what extent have industries adopted the new mode of production? Has the new mode of production become dominant? To answer these questions I have formulated a second set of hypotheses about the level of diffusion by 2001 in each industry. The second set of hypotheses also uses the percentage of knowledge workers to predict computer usage by 2001. As previously discussed by David (1989, 1990) and Alcaly (2003), I will choose the level of 50% computer usage to determine whether the new mode of production has produced a New Economy. Those industries with more knowledge workers will be more likely to surpass

50% computer usage by 2001. If computer adoption has reached 50% computer usage in a particular industry by 2001, then I conclude that that particular industry has adopted a New Economy. Otherwise, any industry less than 50% computer usage by 2001 has not adopted a New Economy. I have hypotheses for each industry except for Finance, Insurance, and Real Estate, since the hypothesis for Finance, Insurance, and Real Estate is not falsifiable because computer usage was over 50% in 1984. Thus, the hypotheses about the percentage of workers utilizing computers by 2001 are as follows:

H2a: Since 'Agriculture' has a lower percentage of knowledge workers than the average percentage of knowledge workers in the private sector from 1984 to 2001, computer usage will be below 50% by 2001.

H2b: Since 'Transportation, Communications, and Public Utilities' have a lower percentage of knowledge workers than the average percentage of knowledge workers in the private sector from 1984 to 2001, computer usage will not reach 50% by 2001.

H2c: Since 'Wholesale and Retail Trade' have a higher percentage of knowledge workers than the average percentage of knowledge workers in the private sector from 1984 to 2001, computer usage should reach 50% 2001.

H2e: Since the 'Service' Industry has a higher percentage of knowledge workers than the average percentage of knowledge workers in the private sector from 1984 to 2001, computer usage should reach 50% by 2001.

H2f: Since 'Mining, Construction, Manufacturing, Forestry and Fisheries' have fewer knowledge workers than the average percentage of knowledge workers in the private sector from 1984 to 2001, the level of computer usage will be below 50% by 2001.

Chapter 4: Methods

The main goal of this dissertation is to test whether a new mode of production is being adopted and whether it has become a new dominant mode of production. The plan is to test this by examining the rate of computer usage each year and the accumulated level of computer usage by 2001 within each industry. The reason that I am examining computer usage within each industry is that computer usage would be expected to be different based on the type of work performed in each industry. In particular, those industries that are more likely to use information and knowledge, and thus are more likely to have a larger percentage of knowledge workers, will be more likely to use computers. To predict the rate of computer usage and level reached by 2001, I will use the percentage of knowledge workers in a particular industry in a specific year.

Introduction

To test whether the percentage of knowledge workers successfully predicts both the rate of computer usage and whether the level of computer usage reaches 50% by 2001, I will use data from the Current Population Survey (CPS). In particular, I will use CPS School Enrollment Supplement data from October 1984, October 1989, October 1993, October 1997, and the CPS Computer and Internet Use Supplement in September 2001. I got the data from the National Bureau of Economic Research, which is a depository for CPS data, which publicly offers CPS data at www.nber.org/cps. The variable measuring computer usage exists in October 1984, October 1989, October 1993, October 1997, and September 2001 CPS supplement data (U.S. Bureau of the Census 1984, 1989, 1993, 1997, 2001). I will use Internet usage for descriptive purposes only as

I will explain later. The variable measuring Internet usage that I will use exists in 1993, 1997, and 2001 CPS data (U.S. Bureau of the Census 1993, 1997, 2001).

In this study of the New Economy, I am examining computer usage over time, which makes this a trend study. Babbie (1998) indicated that a trend study examined a trend in the general population over time. A trend study also examines different people over time, where a panel study examines the same people over time (Babbie 1998). According to Babbie (1995), trend studies are only able to show net changes over time instead of showing changes in specific individuals over time as in panel studies. As a result, while I can show net changes over time, I cannot show causality.

Description of Data

The Current Population Survey

The Current Population Survey (CPS) is a monthly survey of households in the U.S. population that has been conducted since 1940. According to the October 1989 CPS documentation, the main goals of the CPS survey are to collect labor force data and demographic data beyond the data collected for the Decennial Census (U.S. Bureau of the Census 1989). The population is defined to include the contiguous 48 states, Alaska, Hawaii and the District of Columbia (Kominski 1988, Kominski 1991, Moore 1997, Moore 2001, Reed 1994). The sample is administered by the Bureau of the Census and results are given to the Bureau of Labor Statistics (BLS) (U.S. Bureau of Labor Statistics 2002). Each month, the CPS consists of a basic survey which focuses on labor force participation and a supplement, which asks questions on specific topics (Moore 1997, Moore 2001). In this study, data on computer and Internet usage come from data

collected in the supplement survey. The survey asks about the reference week prior to the actual week of the survey. The actual survey appears to be performed in the third week of each month (see Table 2). I did not locate the survey dates in the 1989 CPS documentation; however, after running a frequency distribution on interview date, I found that approximately 95% of the interviews took place during the survey week from Sunday through Saturday; however, the data does not indicate the actual week, nor actual dates in 1989. It is most likely the week from Sunday October 15 to Saturday October 21, 1989.

Table 2. Actual Dates of Current Population Survey

CPS Survey	Dates of Survey
Oct. 1984	October 15-20
Oct. 1989	(unlisted, occurred Sunday-Saturday)
Oct. 1993	October 17-23
Oct. 1997	October 19-25
Sept. 2001	September 16-22

Source: Current Population Survey Documentation, October 1984, 1989, 1993, 1997, and September 2001

Babbie (1998) would define the sampling procedure used in the CPS as multi-stage cluster sampling because of the sample of geographic areas chosen and the later process of subsampling within geographic units. The sample is gathered by identifying geographic areas from the last decennial Census for which information is available. These geographic areas are called primary sampling units (PSU), and these PSUs were

grouped into strata. Afterwards, one PSU was selected from each strata. PSUs consist of counties or civil divisions and independent cities. The probability of selection of a PSU within any strata is based on the size of the PSU. In some cases, certain strata had only one PSU, which meant certain selection of that PSU. Once PSUs were selected, eligible housing units were selected in each PSU. Table 3 gives a description of the total number of PSUs and the number selected. For the part of the sample in 1984 that used the sampling design from the 1970 Decennial Census, there were 1,924 PSUs, in which 629 PSUs were selected. In the part of the sample in 1984 and the full sample in 1989 and 1993, which used the sampling design from the 1980 Decennial Census, there were now 1,973 PSUs, where 729 PSUs were selected. In 1997 and 2001, which used the sampling design based on the 1990 Decennial Census, there were 2,007 PSUs, in which 754 PSUs were selected for interview.

Table 3. Description of Sampling Design in Current Population Survey

CPS	Sampling Design	Total Number PSUs	Number PSUs Selected
October 1984	1970	1,924	629
	1980	1,973	729
October 1989	1980	1,973	729
October 1993	1980	1,973	729
October 1997	1990	2,007	754
September 2001	1990	2,007	754

Source: Current Population Survey Documentation, October 1984, 1989, 1993, 1997, and September 2001

As a result of each new Census every ten years, the CPS updates their sampling design several years later to take into account changes in the population and to create more reliable and better estimate procedures. Thus, the sampling units of the data sets I used varied based on the Decennial Census used to produce the sampling units. In the 1984 CPS, use of the 1980 Decennial Census was in the process of being phased in, so the sample design was based on a combination of the 1970 design, which uses the 1970 metropolitan segments, and the 1980 design, which uses the 1983 metropolitan segments, which are based on the 1980 metropolitan segments and the addition of newly constructed housing units between 1980 and 1983 (U.S. Bureau of the Census 1984). The phase in of the new sampling design started in the April 1984 CPS and was completed in the July 1985 CPS (Creighton and Wilkinson 1984). The 1980 sampling design increased sample areas to get more accurate estimates of state data, areas selected replaced old areas and old address lists, and the sampling areas were redefined based on changes in metropolitan areas and to increase efficiency in conducting the survey (Creighton and Wilkinson 1984). The October 1989 CPS and October 1993 CPS used the 1980 sampling design while considering new residential construction (U.S. Bureau of the Census 1989, 1993). In October 1997 and September 2001 CPS, the sample design was based on the 1990 Decennial Census; however, the sampling units are continually updated for recent residential construction (U.S. Bureau of the Census 1997, 2001). According to the 1997 CPS documentation, changes in data collection, introduction of the 1990 Decennial data, use of new metropolitan definitions due to the new Census, estimation procedures for weighting to the population level, introduction of new definitional changes, and a new questionnaire were introduced in the new sampling

design from January 1994 to June 1995 (U.S. Bureau of the Census 1997). From comparison of the data sets to the definitions of importance in the documentation for each data set, I found no differences in the definitions for Age; Full-time (FT) worker; Hours of work; Household; Industry, Occupation, and Class of Worker; Employed under Labor Force; Part-time, economic reasons; and Part-time work.

So why does it take from April 1984 to July 1985 for the CPS to completely introduce a new sampling design? The answer lies in the use of the same rotated groups for four months one year and four months the next year. In both 1970 and 1980, eight rotated groups were used, where respondents are interviewed monthly for four months, were skipped and not part of the sample for eight months, and then were interviewed again for a four month period. Four rotated groups were introduced monthly as one group per month from April to July 1984, with no new phased in groups from July 1984 to April 1985, the eight month period they drop out of the survey. The remaining four months from April 1985 to July 1985 included the introduction of the remaining four rotated groups, one each month. The remaining 10% of the sample areas that were new PSUs under the 1980 design were introduced starting in November 1984 and one rotation per month received a new set of areas until February 1985. Beginning in March and ending in June 1985, new areas were introduced as two rotation groups (Creighton and Wilkinson 1984).

The unit of analysis in the CPS is the individual, which include those who live in housing units that are self-sufficient, such that living quarters are not shared with other housing units. Households are interviewed for four consecutive months one year and four consecutive months in the following year (Reed 1994). Data on each of the

members of the household are obtained through an interview with one person, usually the owner of the property, or their spouse (Reed 1997). Additionally, interviews are only obtained, if someone is available, and if they are eligible by being non-military and non-institutionalized. In October 1984 through October 1993, approximately 71,000 households were selected for interview, but only 57,000 to 58,000 households were actually interviewed (U.S. Bureau of the Census 1984, 1989, 1993). In 1997 and 2001, fewer households were selected for interview, approximately 57,000 to 60,000, out of which about 48,000 to 50,500 households were actually interviewed (U.S. Bureau of the Census 1997, 2001). The selected sample size differs from the number of households actually interviewed due to vacant residences, selection of non-residential buildings, ownership of secondary residences, inability to locate occupants, and lack of availability for some other reason (U.S. Bureau of the Census 1989).

The CPS attempts to calculate independent estimates of the civilian population figures with the sampled survey data by using a procedure referred to as "post-stratification ratio estimate," in which data is weighted and inflated to the appropriate population value (Moore 1997). The weight is determined by the probability of selection, adjustments due to non-response or subsampling, and the post-stratified ratio adjustment. In some cases, supplements will require additional adjustments to weighting (Dippo 2000). In post-stratification ratio estimate, the population is estimated by using age, sex, race, Hispanic origin, and state of residence from the most recent decennial Census for which information is available (Kominski 1988, 1991). The procedure also adjusts the decennial figures of age, sex, and race, etc. for each year since the last decennial Census by using major demographic data (births, deaths, immigration, and emigration) and the

number in the armed forces (Kominski 1988, 1991, Moore 2001). Bias due to undercoverage of the population is partially addressed in this procedure (Moore 2001). Undocumented immigrants are included, but coverage is not full (Moore 1997, 2001). Estimates of the civilian population have 90% confidence (Kominski 1988, U.S. Department of Labor 2001). Missing or inconsistent data points are imputed by a "hot deck" procedure where substitution of an invalid data point is made with another respondent's response, who is already in the sample, and has similar characteristics both economically and demographically (Dippo 2000).

Construction of the Data Sets

Evolution of the Current Population Survey

From 1984 to 2001, the format of the Current Population Survey has evolved. For example, the format of the data set changed with the addition of more variables, most variables have changed over time, the column location of existing variables has changed, and the discontinuation of the use of cards after 1984. Particular changes in variables were more columns allotted for a particular variable, discontinuation of particular variables, changes in existing variables, and regular changes in the variable name of continuing variables. These changes in the CPS in most cases occurred from 1984 to 1989 and from 1993 to 1997, which corresponds with changes in the sample design from the previous decennial Census. One noticeable change not mentioned before was the size of the data set changed over time. In October 1984, there were 690 columns, 464 columns in October 1989, 508 columns in October 1993, 1,137 columns in October 1997, and 1,144 columns in September 2001.

Reading in Raw Files

I only ran into trouble with the creation of one data set. In the 1984 October Current Population Survey data set, there were 75 missing cases prior to any filtering procedures that were implemented. The Demographic Survey Division and the Current Population Survey branch of the Census Bureau do not have the master file of the October 1984 data to replicate the problem and discover the source of the error. Tim Marshall (2005) of the Current Population Survey believes the problem occurred in the processing of the data. In telephone conversations and answering machine messages with Tim Marshall (2005), The Census Bureau is not going to go back and attempt to fix the problem because of the age of the file, the differences in computer platforms and media that the tape is stored on, issues related to retrieving the master file from the National Archives, and lack of resources at the Bureau to work on reprocessing the data to attempt to fix the problem. The master file is located at the National Archives at College Park, Maryland. The Census Bureau only collects the data, but does not store it. The National Bureau of Economic Research (NBER) at www.nber.org/cps receives the data from the Census Bureau and creates publicly available files in currently usable format(s). I discovered the problem in checking the frequencies of the supplement cases against the frequencies of the basic cases because there were 75 fewer cases in the supplement survey (165,415 cases) in comparison to the (165,490 cases) in the basic survey. The loss of these 75 cases will have little effect on the final frequencies and percentages for 1984 because they represent less than 0.05 percent of the total number of cases for 1984.

Unfortunately, the missing cases are not missing randomly. According to the region variable, 45 missing cases were from the Northeast region, 15 cases from the North Central region, and 15 cases from the South region. More specifically, 30 cases were missing from Massachusetts, 15 cases from New Jersey, 15 cases from Indiana, and 15 cases from Florida. However, with less than 0.05 percent of cases missing, there should not be a problem. To better characterize the 61 missing adult records, 12 records were unemployed, 35 records were private workers, 8 records were self-employed, and 6 records were government workers on the variable 'employed class of worker.' Examining the variable 'Full-time/Part-time/Unemployed,' 12 records were not in the labor force, 42 cases were employed full-time, 1 record was Part-time for Economic Reasons, and 6 respondents were employed part-time.

While the missing cases are not distributed randomly, the percent distributions of missing cases are similar to the overall distribution for specific variables of the data set. For example, the percentage difference between the distribution of the variable 'record type' for the missing 75 cases and the distribution of the variable 'record type' for the remaining 165,415 cases was not large. The 75 cases of the 'record' type variable consisted of 61 cases of interviewed adults and 14 cases of children. The 61 interviewed adults represented 81.3% of the 75 missing cases versus 72.1% for the rest of the sample and the children represented 18.6% among the missing cases versus 19.6% in the rest of the sample. Thus, there is some similarity between the missing data and the data in the remainder of the data set despite the fact the missing cases are non-random.

Data Experimentation

To experiment and learn more about the data sets, I first developed and ran statistical programs to create the data sets on only the 1984 and 2001 data sets. This afforded me time to work out the bugs in the statistical programming before running the statistical program to create permanent data files for every year. Part of this process allowed me to examine and choose from a wider selection of variables to determine which variables in the codebook were most appropriate for the data analysis. It also allowed me to recode variables and run descriptive statistics on the recodes to help determine which recodes might be best, as I could test out various scenarios, such as different possibilities for recoding industry categories, which I will explain later.

Filtered Responses

In the process of creating data sets for each year of CPS data, I filtered some respondents out of the analysis. The goal was to only include records in which respondents were interviewed, adults who were at least 18 years of age, those respondents who were civilians, those respondents who were employed, and private workers. In actual application of the filters, I had to perform them in a specific order based on the universes of the variables as the earlier filtered variables had more inclusive universes. The variable filtering on interviewed respondents was filtered first, since the universe was all civilians that were interviewed that were 15 years or older. Starting in 1997, this first filter was done with two variables, first, all those who were interviewed, and second, civilians at least 15 years of age. The next filter was on age, as only those at least 18 years old were filtered to get adults. This was done because adult records were

14 years and older in 1984, fifteen years old and older in 1989, 1993, 1997, and 2001. The next filter was those who were employed, and the final filter were private sector workers. These filters created a more limited universe in the CPS data of adult civilians, age 18 or older, who were employed in the private sector in the United States, who lived in households, were not institutionalized, and were interviewed for the CPS. This contrasts with the intended universe of the CPS due to the limited sample, which is: "The universe consists of all persons in the civilian noninstitutional population of the United States living in households" (U.S. Bureau of the Census 1989:1-1). I checked the frequencies of the variables that I filtered upon prior to each step of the filtering process against the frequency of the variable after each step of the filtering process to make sure that I properly filtered cases prior to statistical analysis. This was done by producing a frequency of the variable to be filtered on before performing the filter, and then producing a frequency after the filter, and comparing the frequency of the category filtered on before filtering to the total frequency count after filtering. The result was the same each time, which provided a continual check of my filtering process to prevent error in filtering.

First, I chose to analyze interviewed respondents. From 1984 to 1993, the CPS referred to interviewed respondents as those who were defined in a conjoined manner with adult records that started with age 14 in 1984 and age 15 and older in 1989 and 1993. Other types of records consisted of children ages 0 to 13 in 1984 and ages 0 to 14 in 1989 to 1993; 'Type A Noninterview records,' which were eligible households where interviews could not take place because no one was at home or they were temporarily absent; 'Type B/C Noninterview records,' which consisted of ineligible households

because they were vacant, demolished, non-residential, etc; and Armed Forces records that were age 14 and above in 1984 and age 15 and above in 1989 to 1993. These Armed Forces records were transcribed from CPS control cards and consisted of individual records within households. In 1997 and 2001, interviewed records were determined separately from age and thus were not defined in relation to children and adult records. Records consisted only of one type of interview records and three types of non-interview records. Between 1984 and 1993, I chose interviewed respondents coterminously with choosing adult respondents. In variable 'word 1, character 1' in October 1984, and variable 'H-RECTYP' in column location 101 in both October 1989 and October 1993, I chose the response 'Interviewed Adult' to filter responses on. In October 1997 and September 2001, selecting interview and adult were achieved in separate variables. In 1997 and 2001, to select the interviewed respondents, I selected the category 'Interview' from variable 'HRINTSTA' located in columns 57 to 58.

Second, my goal was to only include respondents who were adults age 18 and over. I chose adults that were age 18 and over because I desired to study computer usage of adults in the population. I used age 18 to be consistent with the legal and cultural conception of an adult as age 18 or above. Additionally, those who are under age 18 are often in school, have lower overall levels of employment, and when they do have employment, they are more likely to be in contingent positions that are part-time. The result is that their level of computer usage is lower than other age groups. In the CPS, age was defined as age at last birth date (Kominski 1988, 1991), so I chose respondents 18 or older to include in the analysis. Age was top coded at age 99 in 1984 and age 90 there afterwards. To choose adults, I did this process in two steps to assure accuracy,

since adults in the CPS are defined as starting between 14 to 15 years of age depending on the survey. For example, the Census Bureau defines the civilian labor force as age 16 and above (U.S. Bureau of the Census 1993). To choose the adult civilian household population, I chose the category 'Adult Civilian Household Member' in variable 'PRPERTYP' in columns 161 to 162 in both 1997 and 2001. In choosing to filter on age, I chose those respondents from 18 to 99 years of age in variable 'word 17, character 1-2' in October 1984, ages 18 to 90 in variable 'A-AGE' in columns 120 to 121 in 1989 and 1993, and ages 18 to 90 in variable 'PEAGE' in columns 122 to 123 in 1997 and 2001.

Third, I chose to restrict analysis to civilians because I did not want to include those who were in the active armed forces because they do not work directly for the private sector. Civilians were already selected in the previous two filters. From 1984 to 1993, civilians were selected by choosing interviewed adults in the record type variable. As I just explained in number two, civilians were captured with the filter on adults in 1997 and 2001.

Fourth, since the focus is on how workers in the private capitalist economy use computers, I chose to restrict analysis to employed individuals only. In the CPS, employed individuals were defined as employed if they are civilians and they worked last week for pay, performed 15 hours or more of unpaid labor for their family business, or are taking time off from work for some reason (U.S. Bureau of the Census 1984, 1989, 1993, 1997, 2001). In variable 'word 19, character 1' in October 1984, and variable 'A-LFSR' in column 198 in October 1989 and October 1993, I filtered on code 1 'Working' and code 2 'With job, not at work.' In 1997 and 2001, I used variable 'PEMLR' in columns 180 to 181, which changed the value labels of these same responses above to

code 1 ‘Employed-At Work’ and code 2 ‘Employed-Absent.’ To filter on employed workers in each year, I had to recode the two employment responses just mentioned into one employed response. The recode was achieved by re-coding response 1 ‘Working’ and response 2 ‘With a Job’ to the recoded response ‘1,’ which represented working, and was subsequently filtered upon. The remaining responses were copied and thus the original responses remained the same and were not recoded, nor selected in the filtering process. The response -1 ‘Not in universe’ was filtered out in all years.

Fifth, I filtered on employed workers in the private sector, since my argument is about capitalists adopting a new mode of production. Government workers were not included in the analysis as they were filtered out. In the October 1984 CPS, I recoded the class of worker variable, which was located in position ‘word 29, character 2’ (U.S. Bureau of the Census 1984). Responses 1 ‘Private,’ 3 ‘Self-employed,’ and 4 ‘Unpaid family’ were coded as ‘1’ representing employed workers in the labor force. The response ‘Unpaid family’ represented those who worked at least 15 hours at no pay for a family farm. Response 0 ‘Not Employed’ was filtered out by choosing employed workers previously. Since employed workers had been chosen in the last filter, the only respondents left were government employees, which were represented in response 2 ‘Government,’ which I coded as ‘0.’ In the October 1989 and 1993 CPS, I used class of worker variable ‘A-CLSWKR’ in position 166 (U.S. Bureau of the Census 1989, 1993). Responses 1 ‘Private,’ 5 ‘Self-employed-incorporated,’ 6 ‘Self-employed-not incorporated’ and 7 ‘Without pay’ were recoded as ‘1’ representing employed workers. Responses 2 ‘Federal government,’ 3 ‘State government,’ and 4 ‘Local government’ were recoded as ‘0’ representing government workers. Responses -1 ‘Not in universe’ and 8

'Never worked' were filtered out in the previous employment filter. In the October 1997 and September 2001 CPS, I chose the class of worker variable 'PEIO1COW' located in columns 432 to 433 (U.S. Bureau of the Census 1997, 2001). I recoded responses 4 'Private, For Profit,' 5 'Private, Nonprofit,' 6 'Self-Employed, Incorporated,' 7 'Self-Employed, Unincorporated,' and 8 'Without Pay' as '1,' which represented private employees. I recoded responses 1 'Government – Federal,' 2 'Government – State,' and 3 'Government – Local' as '0' representing government workers. Response -1 'Not in universe' was filtered out in the filtering process. After the recoding of these variables in each data set, I chose recoded response '1,' which represented employed workers to filter the data on.

To summarize my various filtering processes, I am including Table 4, which indicates the total number of records before filtering, and the number of records after each part of the filtering process:

Table 4. Number of Records in Data Set Before and After Filtering

Data Set	Total Records	Record Type (Interviewed)	Age (18+)	Employment (Employed)	Private Workers
Oct. 1984	165,415	119,344	109,496	67,190	56,485
Oct. 1989	161,750	113,478	107,243	68,316	57,440
Oct. 1993	157,154	110,365	104,579	65,640	54,948
Oct. 1997	135,599	95,105	89,461	58,157	49,641
Sep. 2001	158,865	111,778	105,387	68,892	58,478
Total	778,783	550,070	516,166	328,195	276,992

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Creation and Checking of Data Sets

In beginning the process of creation of the data sets for analysis, I made much smaller data sets including less than 40 variables each. In developing the statistical programs to read in the data in the creation of each of the individual data sets, I made sure that I had the correct columns for each variable, and that all variables and value labels were included and were correct for each variable. This included standardizing the same variable names and labels across surveys, and checking to make sure they were correct. Once this was done, I ran the statistical programs to create data sets for individual years.

To check the data sets after reading in the data, I did not use comparison of the weighted frequencies of the data set against the published data as a means of checking the data sets because the CPS indicates that they will not be equal. According to the October 1989, 1993, and 1997 CPS documentation, labor force estimates will not equal published sources because of the use of a composite estimator in the published estimates of non-seasonally adjusted data (U.S. Bureau of the Census 1989, 1993, 1997). The composite estimator is the average of the results under the ratio estimation procedure and the addition of estimated changes to the previous month's composite estimate for those common to both samples. Additionally, variation can exist with published sources because published sources are often seasonally adjusted estimates. To check the frequencies, I tried to use Data Ferrett, which can be downloaded with other information at 'dataferrett.census.gov' to help compare the frequencies of the data sets I created to the frequencies of the weighted data sets with Data Ferrett. However, this proved difficult because data on the School Enrollment supplement only exists for 1997 and 2001, and I

had already checked these two years with comparison of the basic versus the supplement surveys (see details below).

At this point, I decided to compare the percent distributions for particular variables across years. I checked the percentages in the frequencies for the industry measure across years for consistency in the supplement data sets and they were very similar. I also did this type of matching for other variables and the percent distributions seemed very similar. Additionally, the number of records in the codebook equaled those in the data sets in each case. I figured that if the percent distributions were nearly the same in each year, it is extremely unlikely that all the data sets were incorrect.

Additionally, I created separate data sets with the basic employment data only to compare to the supplement data sets, which also included the basic employment data. I checked the frequencies of Age, Total Hours Worked Last Week, and Government Workers in the basic data set against the frequencies of the variables in the supplement data sets except for the 1989 and 1993 basic data sets, which I could not successfully read in on repeated tries despite following proper instructions. Except for the missing 75 cases in the supplement data set in 1984, the frequencies of the variables in the basic data set matched the frequencies of the variables in the supplement data set for 1984, 1997, and 2001.

After the data sets were created, I standardized each of the smaller data sets prior to merging the different years by making sure that the data sets were consistent in every way. In this process, I made sure that each of the variables had zero decimal places in my standardization of variables to preserve hard-drive space and format the Statistical Package for the Social Sciences (SPSS) output beforehand. I also made sure that the

variables had the same number of columns prior to concatenation. Also, I made sure that the scale (ex. ordinal) of the variables was the same across data sets. I also made sure that the variables had the same width across the years prior to concatenation. I also made sure that the same variables were numeric across all years. Additionally, I gave the same variable name and the same variable label for each variable. In relation to the recodes (see next section for more details), I made sure that the recoded variables in each data set were consistent. I checked the frequencies of each of the recoded variables against the frequencies of the original variables for each year. Afterwards, I concatenated the data sets, which were used for most of the analysis.

To facilitate comparisons over time, I concatenated the October 1984, October 1989, October 1993, October 1997, and September 2001 data sets into one larger data set with all the years. I checked the process of concatenation by comparing the frequencies of the recoded variables for the concatenated data set against the addition of the frequencies of the recoded variables for each of the individual years. In every case, they matched, which supported the decision to move ahead with the statistical analysis.

To produce the crosstabulations including the percentage of knowledge workers that is utilized for the hypotheses, I had to create new data sets because the original data set did not include the variable for occupational code. However, I created completely new data sets with a limited number of variables, which included record type, age, employed class of worker, Employment Status Recode (ESR) equivalent, Part-time/Full-time, major industry, computer at work, and the addition of interview status separately in 1997 and 2001 in case I desired to do additional analysis. In the creation of these new data sets, I checked the frequencies of the variables in the original data sets prior to

filtering against the frequencies of the same variables in this data set prior to filtering, and they matched. I also checked the frequencies at each stage of the filtering process by checking the frequency of the filtered response before the filtering process against the total number of cases after that stage of the filtering process. Once again, they matched. Additionally, I checked the frequencies for the recoded variables after the filtering process was done against the frequencies for the same recoded variables in the original data set after filtering. To save time in producing the crosstabulation of knowledge workers by computer usage in each year, I did not try to standardize variables except for the knowledge worker recode because first, I had no plan of any other type of analysis involving the other variables; however, I could standardize the variables later if I decided to perform additional analysis. Second, I had no plan of concatenating the variables, since the crosstabulation between computer usage and knowledge workers occurs separately in each year.

Variables Utilized in Current Population Survey

Some of the variables in the CPS come directly from questions asked in the survey, while many other variables are edited recodes created by the CPS from responses to multiple questions in the questionnaire. These recodes are created during the editing process and are referred to as "processing recode(s)." According to the 2001 CPS documentation, a processing recode is a recoded variable created from different items in the questionnaire (U.S. Bureau of the Census 2001). Processing recodes are created for the convenience of users of the CPS. In particular, the variables of industry classification; full-time, part-time, unemployed; and employed status recode are

"processing recodes." Unfortunately, the codebook does not contain a record of which questions were manipulated to produce these new variables in the data set. Thus, it is not possible to compare questions in the codebook from different years; only comparison of the data description can be made. Among the variables that I used, this occurred often, so I only was able to compare the data description of the variables across years and not the questions utilized in the processing recodes. Other variables, such as interviewed respondents, year, and adult civilian, are data set variables that neither come directly from CPS questions, nor directly from recoding other variables, but are related to the data set itself.

Socio-Economic Variables

From 1984 to 1993, the variable 'class of worker' (item 23E) comes directly from an actual question in the supplement questionnaire. The class of worker variable item 23E is as follows:

> Was this person
> An employee of a PRIVATE Co., bus., or individual for wages, salary or comm…. P
> A FEDERAL government employee…..F
> A STATE government employee…..S
> A LOCAL government employee…..L
> Self-empl. in OWN bus., prof. practice, or farm
> Is the business incorporated? Yes….I
> No……SE
> Working WITHOUT PAY in fam.bus.or farm…WP
> NEVER WORKED……NEV

(U.S. Bureau of the Census 1984:Appendix, p.4; 1989:11-10; 1993:12-8). The codebooks in October 1997 and September 2001 did not indicate which question items were used to produce variables in the data set, thus we can only assume that the same

question above produced the 'class of worker' variable in 1997 and 2001. Nor were questionnaires available with the codebooks in 1997 and 2001.

Item Age (item 18D) was coded in the questionnaire and did not represent an actual question in the CPS.

Industry Recodes

Before I explain the detailed considerations given to classifying the major industry recodes in the CPS, I want to explain how industry was determined in the CPS. Respondents were classified by industry based on the job they held during the reference week. If respondents held two jobs in the reference week with an equal number of hours, then the length of tenure was the determining factor in industry classification (U.S. Bureau of the Census 1989, 1993, 1997, 2001). In recoding industry categories, I had to determine the appropriate level of aggregation of the data first. Too much aggregation of industry codes leads to a few industry codes, which do not differentiate well enough between industries both empirically and theoretically. On the other hand, disaggregated data produces too many industry categories, which complicates presentation and interpretation of the overall trend of the data, and prevents useful summarization of the data. However, disaggregated industry categories would make finer distinctions between industries, thus creating a more theoretically justifiable set of industry classifications, but less interpretable. I considered both a disaggregated classification of industries and also a very aggregated classification of industries, which I will share now to help explain why I chose my final industry classification system. First, a disaggregated division of industries

as follows produces fine distinctions between industries theoretically, but makes interpretation difficult:

1) Extractive industries, which includes agriculture, forestry, fisheries, and mining,
2) Use of Natural resources to make physical products, which includes construction and manufacturing,
3) Transport of physical and non-physical objects – transportation, communications, and public utilities,
4) Economic trade and distribution of physical objects – wholesale and retail trade
5) Economic trade of money, information, and use of legal contracts – finance, insurance, and real estate,

Separation of service industries by type of service offered:

6) Business and repair services,
7) Personal services,
8) Entertainment and recreation services,
9) Professional and related services,

The advantage of this categorization system is that it is justifiable, as agriculture, forestry, fisheries, and mining are seen as extractive industries and services are separated into four distinct industries based on type of service offered. The main problem with this categorization of industries is that it is difficult to interpret a graph with nine different lines. Additionally, the classification of mining here is different from traditional classification schemes because mining is traditionally combined with construction and manufacturing.

While the above industry classification system was quite disaggregated, I also considered a very aggregated system of industry classifications into two major categories of goods and services as follows: 1) Good producing industries of: agriculture, forestry, fisheries, mining, construction, and manufacturing, transportation, communications, utilities, wholesale and retail trade, and 2) Service industries of: finance, insurance, real estate, and services. However, theoretically, this industry classification scheme is problematic because some industries include both services and goods producing industries. Additionally, it does not take into account that computer usage varies considerably by industry.

As a result of these considerations in determining which industry classification system was most appropriate, I chose a recoding scheme with six industry categories. An industry categorization with six industry categories forfeited some theoretical rigor in classification, since broad categories do not sufficiently specify differences in industry classification and computer usage. However, with some level of detail in the use of six industry categories and not having too many industry categories, it facilitated summarization and interpretation of results. In producing an industry classification system with six industries, I attempted to follow the traditional conception of industry classification given in the codebooks for the CPS (U.S. Bureau of the Census 1989, 1993, 1997, 1998, 2000, 2001). I view this as a benefit because this research can be compared to research which has used a similar classification of industries in the CPS. I will now explain how I classified industries theoretically.

The first industry consists of agriculture, which is commonly separated from mining, construction, and manufacturing despite having a similar extractive nature. The

reason for the traditional separation of agriculture from other extractive industries is likely due to agriculture being the first major mode of production historically. The second category consisted of combining the industries of transportation, communications, and utilities and sanitary services. Each of these industries transport items, whether it be physical objects, people, electricity, radio waves, water, or utility power. The third category consists of a combination of wholesale and retail trade. These industries consist of economic trade of physical objects. The fourth category consists of finance, insurance, and real estate. Each of these industries involves the economic trade of real estate, money, information, and legal contracts, which contain either information or legal contracts for transactions. The fifth category combines all of the service industries into one category, thus representing the complete service industry. The service industry consists of private household services; business and repair services; personal services, except private household; entertainment; hospital services; medical, except hospital; educational; social services; and other professional services. According to the 'Industry Classification Codes for Detailed Industry' sections of the 1993 to 2001 CPS documentation, 'Other Professional Services' consists of "Museums, art galleries and zoos; Labor unions; Religious organizations; Membership organizations; Engineering, architectural, and surveying services; Accounting, auditing, and bookkeeping services; Research, development, and testing services; Management and public relations services; Miscellaneous professional and related services, and Legal services" (U.S. Bureau of the Census 1989, 1993:13-7, 1997:Attachment 10, 2001:10-7--10-8). I will break out computer usage by each of the industries included within the service industry to give a better idea of how disparate and wide ranging this category really is. The sixth industry

category I chose was a recoding of mining, construction, manufacturing, forestry, and fisheries into one main category because each of these industries is either extractive because physical resources are extracted from the natural environment, such as fisheries, forestry, and mining; or they use extracted resources, such as construction and manufacturing. Historically, these industries are similar in that they are ancient industries, as they have existed for centuries in one form or another. I will also divide 'Mining, Construction, Manufacturing, Forestry, and Fisheries' into separate industries due to the potential heterogeneity of this category. Note, even though there are differences in computer usage within each of these six industries, I used a relatively small number of broad industries to facilitate summarization of data and subsequent comparison across these broad industries. However, to demonstrate diversity in computer usage within each industry, I will later provide Tables 17 and 30, which provide computer usage and rate of computer usage within each of the 21 major industry categories respectively. This is especially important in the second hypothesis, since I use just over 50% computer usage by 2001 as a criterion for determining a New Economy. Thus, I am able to clarify my conclusions about a New Economy within each major industry category.

The CPS has three different industry classifications, which starts with the 'Detailed Industry Classification Codes' and includes hundreds of industry categories which range from 0 to 991. These categories are subsequently recoded into just over 50 industry codes to create another variable consisting of 'Detailed Industry Recodes.' These 50+ 'Detailed Industry Recodes' are further recoded into a variable of 20+ 'Major

Industry' codes. In recoding industry to conform to my industry classification scheme, I used the variable 'Major Industry' codes to recode industry into six industry categories.

Utilizing the variable 'Major Industry' (word 62, characters 2-3) in the October 1984 CPS (U.S. Bureau of the Census 1984), I will demonstrate the recoding process (also see Table 5 for summary). Code 01 'Agriculture' represented code 1 'Agriculture' in the recode; codes 06 'Transportation,' 07 'Communications,' and 08 'Utilities and Sanitary Services' were recoded into code 2 'Transportation, Communications, and Public Utilities;' codes 09 'Wholesale Trade' and 10 'Retail Trade' were recoded into code 3 'Wholesale and Retail Trade;' code 11 'Finance, Insurance and Real Estate' was recoded as code 4 'Finance, Insurance, and Real Estate;' codes 12 'Private Households,' 13 'Business and Repair,' 14 'Personal Services, Except Private Household,' 15 'Entertainment and Recreations,' 16 'Hospitals,' 17 'Medical, Except Hospitals,' 18 'Educational,' 19 'Social Services,' and 20 'Other Professional' were recoded into code 5 'Services;' and codes 02 'Mining,' 03 'Construction,' 04 'Manufacturing – Durable Goods,' 05 'Manufacturing – Nondurable Goods,' and 21 'Forestry and Fisheries' were recoded as code 6 'Mining, Construction, Manufacturing, Forestry, and Fisheries.' Code 22 'Public Administration' was filtered out in the selection of private workers in the filtering process in 1984 to 2001 and code 23 'Armed Forces' was filtered out in the interviewed adults filter in 1984 to 1993 and the adult civilian filter in 1997 to 2001. Response -1 'Not in universe' was also filtered out in the filtering process of interviewed, adult, age 18+, employed, and private respondents in each year.

Table 5. Recode of Major Industry

Original Major Industry Categories		Recode Major Industry Categories	
01	Agriculture	1	Agriculture
06	Transportation	2	Transportation, Communications and Public Utilities
07	Communications		
08	Utilities and Sanitary Services		
09	Wholesale Trade	3	Wholesale and Retail Trade
10	Retail Trade		
11	Finance, Insurance and Real Estate	4	Finance, Insurance and Real Estate
12	Private Households	5	Services
13	Business and Repair		
14	Personal Services, Except Private Household		
15	Entertainment and Recreations		
16	Hospitals		
17	Medical, except Hospitals		
18	Educational		
19	Social Services		
20	Other Professional		
02	Mining	6	Mining, Construction, Manufacturing, Forestry, and Fisheries
03	Construction		
04	Manufacturing – Durable Goods		
05	Manufacturing – Nondurable Goods		
21	Forestry and Fisheries		

Source: Current Population Survey, October 1984

The same re-coding scheme was used for the industry variable in the remaining years, but there were adjustments in the value labels of the other years, but not the industries constituting the responses. For example, in the October 1989 and October 1993 CPS, the variable 'A-MJIND' in column 216 to 217, had the same value labels for the categories as above, except for code 15, which was 'Entertainment' in 1989 and 1993 (U.S. Bureau of the Census 1989, 1993). In October 1997 CPS and September 2001

CPS, variable 'PRMJIND1' in column 482 to 483, had code 13 'Business and Repair' changed to code 13 'Business, Auto and Repair Services;' and code 15 'Entertainment' was changed to code 15 'Entertainment and Recreation Services' (U.S. Bureau of the Census 1997, 2001). Despite these differences in terms, the same detailed industries were represented except for differences mentioned earlier. From this recode, I produced the recode of the dummy industry variables. In the industry recode dummy variables, I chose the category '1' to represent the industry, and category '0' to represent all other industries.

In the process of checking my industry recodes, I checked the industry categories which constitute the 'Major Industry' codes. First, I checked the 'Detailed Industry Recodes' against one another by comparing each year to the next year to make sure that the same industry categories were used in the CPS. Among the Detailed Industry Recodes, the same 51 codes were used from 1984 to 1997; however, starting in 1998, code 33 'Retail Trade' was divided up into code 33 'Eating and Drinking Places' and code 34 'Other Retail Trade' resulting in 52 codes. The remaining codes after code 33 were the same characteristic, but the code number was n + 1. Thus, the September 2001 CPS was the only survey with 52 Detailed Industry categories. The Detailed Industry Recodes represent the same industry categories across surveys despite this minor difference. Next, I checked the codebook of 'Detailed Industry Classification Codes' under each 'Major Industry' code from one year against the next year to see if the same industry codes and classifications constituted the same industries across years. In comparing the three digit Industry 'Detailed Industry Classification Codes' from one data set to the next, there were only differences from 1989 to 1993. This means the industry

codes for 1984 and 1989 were the same, but were different from 1993 to 2001. In comparison of the industry codes in October 1984 versus October 1989, I used the March 1985 CPS 'Detailed Industry Classification Codes' (U.S. Bureau of the Census 1985) because the codebook for the October 1984 CPS did not contain 'Detailed Industry Classification Codes.' The 'Detailed Industry Classification Codes' utilized the same codes in October 1984 and October 1989.

Focusing more specifically on the differences from 1989 to 1993, code 382 'Not Specified Professional Equipment' under Durable Goods and code 522 'Not Specified Electrical and Hardware Products' under Wholesale Trade were included in 1989, but were dropped in 1993. Code 640 'Household Appliances, TV, and Radio Stores' under Retail Trade in 1989 was separated into three codes in 1993, specifically, codes 632 'Household Appliance Stores,' 633 'Radio, TV, and Computer Stores,' and 640 'Music Stores.' In 1993, the code 661 'Gift, Novelty, and Souvenir Shops' was added under Retail Trade. Code 730 'Commercial Research, Development, and Testing Labs' appeared to be dropped in 1993. Code 730 'Commercial Research, Development, and Testing Labs' under Business and Repair Services and code 891 'Noncommercial Educational and Scientific Research' under Professional and Related Services in 1989 are likely combined into one code, code 891 'Research, Development, and Testing Services,' which was added under Other Professional Services in 1993. In comparison of 1989 to 1993, code 732 'Business Management and Consulting Services' under Business and Repair Services appeared to be dropped. However, code 892 'Management and Public Relations Services' was added under Professional and Related Services in 1993 and maybe a replacement for 'Business Management and Consulting Services' under

Business and Repair Services in 1989. The code for industry 'Computer and Data Processing Services' was adjusted from code 740 in 1989 to code 732 in 1993. Automotive repair services were equivalent in 1989 and 1993 according to the Standard Industrial Classification (SIC) codes, but they had different industry codes in 1989 and 1993 as follows: codes 750 'Automotive Services, except Repair,' 751 'Automotive Repair Shops' in 1989, and codes 742 'Automotive Rental and Leasing, without Drivers,' 750 'Automotive Parking and Carwashes,' and 751 'Automotive Repair and Related Services' in 1993. Under Entertainment and Recreation Services, the 1989 industry code 801 'Bowling Alleys, Billiard and Pool Parlors' is reduced to code 802 'Bowling Centers' in 1993. Also, code 801 'Video Tape Rental' was added in 1993, which according to the SIC codes appeared to be under code 800 'Theaters and Motion Pictures' in 1989. Under Social Services, code 863 'Family Child Care Homes' appeared to be added in 1993, but was probably due to the separation of code 862 'Child Day Care Services' in 1989 into codes 862 'Child Day Care Services' and 863 'Family Child Care Homes' in 1993 according to the SIC codes. Under Other Professional Services, code 873 'Labor Unions' was added in 1993, and it appears that 'Labor Unions' was under code 881 'Membership Organizations' in 1989 according to the SIC codes.

Percentage of Knowledge Workers

I used the variable of occupational codes to create the dummy variable of knowledge workers to determine the percentage of knowledge workers in a particular industry. In 1984, the variable for occupational codes was located in 'word 63, characters 5 to 6 and word 64 character 1.' In 1989 and 1993, the variable occupational code (A-

OCC) was located in columns 163 to 165. In 1997 and 2001, the variable occupational code (PEIO1OCD) was located in columns 439 to 441. The occupational variables from 1984 to 1993 came from question 23C in the CPS questionnaire, which was: "What kind of work was …doing? (For example: electrical engineer, stock clerk, typist, farmer.)" (U.S. Bureau of the Census 1984, 1989, 1993). In both 1997 and 2001, a computer program was used by interviewers to guide them through the interview process. As a result there was no standard question numbers used in the 1997 and 2001 CPS because question numbers varied based on which questions were applicable to certain types of respondents. As a result, questionnaires are not provided with the CPS documentation in 1997 and 2001. Based on the Census website 'www.bls.census.gov/cps/intmanc4.htm#C4B2,' I ascertained that the occupational codes were obtained from the following question under section 4.E.6 "What kind of work do you do, that is, what is your occupation? (For example: plumber, typist, farmer)" (Reed 1997). At the website above, I did find variable labels, but these variable labels were not consistent with the variable labels in the CPS documentation for 1997 and 2001 (U.S. Bureau of the Census 1997, 2001). Thus, there is no way to attach questions from the online questionnaire to the CPS documentation.

The occupational codes can be found in the CPS codebook under the attachment of 'Occupational Classification Codes for Detailed Occupational Categories,' which is a detailed list of occupations with associated three digit codes. The 'Occupational Classification Codes for Detailed Occupational Categories' are organized by type of occupation with six major occupational categories: 1) Managerial and Professional Specialty Occupations, 2) Technical, Sales, and Administrative Support Occupations, 3)

Service Occupations, 4) Farming, Forestry, and Fishing Occupations, 5) Precision Production, Craft, and Repair Occupations, and 6) Operators, Fabricators, and Laborers. I classified knowledge workers as those who were part of the occupations in 1) Managerial and Professional Specialty Occupations and 2) Technical, Sales, and Administrative Support Occupations. I chose these occupations as knowledge workers because these occupations deal with information and knowledge. These two broad occupational categories encompassed codes 003 to 389 in 1984 to 1993 and 004 to 389 in 1997 to 2001. In 1984 to 1993 (U.S. Bureau of the Census 1984, 1989, 1993), codes 000 to 002 were not used by the CPS to classify occupations, and codes 000 to 003 were not used by the CPS to classify occupations from 1997 to 2001 (U.S. Bureau of the Census 1997, 2001). In the recode, codes 003 to 389 were coded as '1' to represent knowledge workers. However, codes 003 to 006 in 1984 to 1993, codes 004 to 006 in 1997, and codes 004 to 005 in 2001 had been filtered out in the filtering process. I recoded code 006 to missing in 2001. In 1984 to 1993, codes 003 to 006 consisted of: code 003 'Legislators,' code 004 'Chief Executives and General Administrators, Public Administration,' code 005 'Administrators and Officials, Public Administration,' and code 006 'Administrators, Protective Services.' In 1997 to 2001, codes 004 to 006 consisted of: 004 'Chief Executives and General Administrators, Public Administration,' code 005 'Administrators and Officials, Public Administration,' and code 006 'Administrators, Protective Services.' Manual workers were classified under occupational categories 3 to 6, which were: 3) Service Occupations, 4) Farming, Forestry, and Fishing Occupations, 5) Precision Production, Craft, and Repair Occupations, and 6) Operators, Fabricators, and Laborers. While information and knowledge are utilized in

some of these occupations, these occupations are considerably more likely to utilize physical products rather than knowledge and information. These occupations encompassed codes 403 to 889 in 1984 to 2001, which I recoded as '0' to represent manual workers. The codes actually go to 905, but the filtering process left us with occupational codes no higher than 889. Additionally, the response -1 'Not in universe' of the occupational code variable was filtered out in all years during the filtering process of interviewed, adult civilians, age 18+, employed and private workers. In 1989 and 1993, I noticed a code 000 'Old not in universe,' which did not appear directly in the frequencies before and after the filtering process, which suggests that if any cases were classified as 000, they were designated system missing in the occupational variables prior to the filtering process.

The next question is: "Did the three digit occupational codes that make up the six larger categories change at all from 1984 to 2001?" The answer is yes in a limited number of cases that I will now present in relation to the preceding survey. As a result, there are differences that exist between one survey and the next that will carry over to later surveys. For example, if there are differences found when the occupational codes for 1993 are compared to occupational codes for 1989, then these same differences also exist between 1989 and 1993 to 2001.

In comparison of the October 1984 and October 1989 'Occupational Classification Codes For Detailed Occupational Categories,' I found three trivial differences. First, in code 033 'Purchasing agents and buyers, n.e.c.' in both October 1984 and October 1989, the Standard Occupational Classification (SOC) equivalent codes were slightly different. In 1984, the SOC code was 1449, and in 1989, the SOC

code was 144. Second, for code 303 'Supervisors, general office,' SOC code equivalent 4515 was added to the existing codes in 1984. Third, in October 1984, a title existed for codes 675 to 684 called 'Precision Workers, Assorted Materials,' which did not exist in 1989.

In comparison of the October 1989 to October 1993 'Occupational Classification Codes For Detailed Occupational Categories,' there were over 20 identifiable differences, which can be categorized into five types of differences. First, there were several situations where the code number changed from 1989 to 1993. The best way to express these changes from 1989 to 1993 is in a table in Table 6.

Table 6. Changes in Occupational Classification Codes from 1989 to 1993

Occupational Classification Code	1989 Code #	1993 Code #
Managers, properties and real estate	016	018
Postmasters and mail superintendents	017	016
Funeral Directors	018	019
Managers and administrators, n.e.c.*	019	022
Supervisors, production occupations	633	628
Supervisors, handlers, equipment cleaners, and laborers, n.e.c.*	863	864
Helpers, mechanics and repairers	864	865
Helpers, construction trades	865	866
Helpers, surveyor	866	867
Helpers, extractive occupations	867	868
Production helpers	873	874
Guides	463	461
Ushers	464	462
Public transportation attendants	465	463
Baggage porters and bellhops	466	464
Welfare service aides	467	465

*n.e.c. was 'not elsewhere classified'

Source: Current Population Survey Documentation, October 1989 and 1993

The second type of change from 1989 to 1993 was the addition of new occupational classification codes in 1993. These new codes in 1993 were: code 017 'Managers, food serving and lodging establishments,' code 021 'Managers, service organizations, n.e.c.,' code 022 'Managers and administrators, n.e.c.,' code 466 'Family child care providers,' and code 467 'Early childhood teacher's assistants.'

The third type of change from 1989 to 1993 is the apparent use of at least one or more different SOC equivalent(s). In 'Managers and administrators, n.e.c.,' SOC equivalent codes 127, 1345 to 135 excluding 1344, 1353, and 1359 were used in 1989, but not in 1993. 'Managers, Service Organizations, n.e.c.' was not an occupational category in 1989, but SOC equivalents 127, 1352, 1354, and part 1359 were used in code 021 'Managers, service organizations, n.e.c.' in 1993. In code 033 'Purchasing agents and buyers, n.e.c.,' SOC equivalent 144 was used in 1989, but 1449 was used in 1993. In code 303 'Supervisors, general office,' SOC equivalent code 4515 was used in 1989, but not in 1993. In code 353 'Communications equipment operators, n.e.c.,' SOC equivalent code 4733 was added in 1993. In code 565 'Tile setters, hard and soft,' only part of 6414 was used in 1993 versus all of 6414 in 1989. Possibly they only used part of 6414 in 1989, as they may have left out the word 'part' in front of code 6414, as I did I find minor errors in the list of occupational classification codes.

The fourth type of change from 1989 to 1993 was a change in the title of the code. Code 098 'Inhalation therapists' (3031) was changed to code 098 'Respiratory therapists' (3031) in 1993. Code 468 'Child care workers, except private household' (5264) was changed to 'Child care workers, n.e.c.' (part 5264) in 1993. Use of "part" before SOC equivalent code 5264 in 1993, but not 1989, might be an example of the last type of error,

or it could be a minor error of omission of the word 'part.' In the title 'Material Recording, Scheduling, and Distributing Clerks, n.e.c.' for codes 359 to 374 in 1989, 'n.e.c.' – not elsewhere classified was dropped from the title in 1993. In code 734, the title changed from 'Printing Machine Operators' in 1989 to 'Printing Press Operators' in 1993.

The fifth type of change from 1989 to 1993 was the combination of separate codes in 1989 into one code in 1993. In 1989, codes 368 'Weighers, measurers, and checkers' and 369 'Samplers' were separate, but were combined into one category in 1993 as code 368 'Weighers, measurers, checkers, and samplers' based on the SOC equivalents used. In 1989, codes 436 'Cooks, except short order' and 437 'Short-order cooks' were separate, but were combined into code 436 'Cooks' in 1993 based on the SOC equivalents used. In 1989, codes 673 'Apparel and fabric patternmakers' and 674 'Miscellaneous precision apparel and fabric workers' were separate codes, but were combined into code 674 'Miscellaneous precision apparel and fabric workers' in 1993 according to the SOC equivalents used. In 1989, codes 794 'Hand grinding and polishing occupations' and 795 'Miscellaneous hand working occupations' were separate, but were combined into code 795 'Miscellaneous hand working occupations' in 1993 based on the SOC equivalents used. In 1989, codes 804 'Truck drivers, heavy' and 805 'Truck drivers, light' were separate codes, but were combined into code 804 'Truck drivers' in 1993 based on the SOC equivalents used.

In comparing the 'Occupational Classification Codes For Detailed Occupational Categories' in 1993 to 1997, I found only three differences. First, it appeared that code 003 'Legislators' was dropped in 1997. Second, code 016 'Postmasters and mail

superintendents' also appeared to be dropped in 1997. Third, codes 178 'Lawyers' and 179 'Judges' were separate codes in 1993, but were combined into code 178 'Lawyers and Judges' in 1997 according to the SOC equivalents used. According to Attachment 6 of the 1997 CPS Documentation online at www.bls.census.gov/cps/intmanc4.htm#C4B2, code 003 'Legislators' and code 016 'Postmasters and mail superintendents' were placed into code 22 'Managers and administrators, N.E.C.'

In comparison of the 'Occupational Classification Codes For Detailed Occupational Categories' in 1997 and 2001, I found no differences in occupational classification codes from 1997 to 2001.

Year Recodes

I recoded the year variable for the CPS, which was variable 'word 20, character 6' in 1984, 'H-YEAR' in column 5 in both 1989 and 1993, variable 'HRYEAR' located in columns 67 to 68 in 1997, and variable 'HRYEAR4' located in columns 18 to 21 in 2001. In the variable year, there was a single digit for 1984 to 1993, which represented the last digit of the chronological year. For example, if the year was 1989, every record in the data set would have a response '9' for the variable year. In 1997, year was the final two digits in the variable HRYEAR, so each record had a '97' for year. In 2001, in the year variable HRYEAR4, all four digits were used for year. To produce continuity across data sets, I recoded year to four digits in all years based on the year of the survey.

Part-Time and Full-Time Workers

Full-time workers consisted of those who worked at least 35 hours in the reference week; worked less than 35 hours, but usually work 35 hours or more; or were not at work in the reference week, but have a full-time job (U.S. Bureau of the Census 1984, 1989, 1993, 1997, 2001). To create the variable containing full-time and part-time employees, I used the recoded variable of full-time and part-time workers instead of use of a recode of hours worked by employees because hours worked only includes those who actually worked last week, which would not include those who worked last week, but were not at work for some reason.

The variable representing full-time/part-time workers varied over time as the answer responses became more specific over time. Despite this greater specificity in answer responses, I was able to collapse the responses into a dummy of full-time/part-time employment. In creation of the dummy variable, I chose '1' for full-time workers and '0' for part-time workers. In the October 1984 CPS in variable 'word 28, character 5' (U.S. Bureau of the Census 1984), codes 0 'Not in Labor Force,' 3 'Unemployed full time,' and 5 'Unemployed part time' were filtered out when I used the filter for employed workers. The code 1 'Employed full time' was coded as '1' to represent full-time employment. Codes 2 'Part time for economic reasons' and 4 'Employed part time' were coded as '0' representing part-time employment. In variable 'A-WKSTAT' column location 202 for October 1989 and October 1993 CPS (U.S. Bureau of the Census 1989, 1993), codes 1 'Not in labor force,' 6 'Unemployed full-time,' and 7 'Unemployed part-time' were filtered out due to the use of the employment filter. Codes 2 'Full-time schedules' and 3 'Part-time for economic reasons, usually full-time' were recoded as '1'

representing full-time employment. Codes 4 'Part-time for non-economic reasons, usually part-time' and 5 'Part-time for economic reasons, usually part-time' were coded as '0' representing part-time employment. In the variable 'PRWKSTAT' in October 1997 and September 2001 CPS (U.S. Bureau of the Census 1997, 2001), codes 1 'Not in Labor Force,' 11 'Unemployed FT' and 12 'Unemployed PT' were filtered out during the application of the employment filter. Codes 2 'FT Hours (35+), Usually FT,' 3 'PT for Economic Reasons, Usually FT,' 4 'PT for non-Economic Reasons, Usually FT,' and 5 'Not at Work, Usually FT' were coded as '1' representing full-time employment. Codes 6 'PT Hrs, Usually PT for Economic Reasons,' 7 'PT Hrs, Usually PT for non-Economic Reasons,' 8 'FT Hours, Usually PT for Economic Reasons,' 9 'FT Hours, Usually PT for Non-Economic,' and 10 'Not at Work, Usually Part-Time' were recoded as '0' for part-time employment. In all years, -1 'Not in universe' was filtered out during the application of the interviewed, adults, age 18+, employed, and private employed filters. Table 7 gives a summary of the recode of part-time/full-time employment into a dummy variable.

Table 7. Recode of Part-Time/Full-Time Employment into Dummy Variable

CPS Survey	Original Variable		Recoded Variable	
October 1984	0	Not in Labor Force	Filtered out on employed	
	1	Employed full-time	1	Full-time employment
	2	Part-time for economic reasons	0	Part-time employment
	3	Unemployed full-time	Filtered out on employed	
	4	Employed part-time	0	Part-time employment
	5	Unemployed part-time	Filtered out on employed	
October 1989 & 1993	1	Not in labor force	Filtered out on employed	
	2	Full-time schedules	1	Full-time employment
	3	Part-time for economic Reasons, usually full-time	1	Full-time employment
	4	Part-time for non-economic Reasons, usually part-time	0	Part-time employment
	5	Part-time for economic Reasons, usually part-time	0	Part-time employment
	6	Unemployed full-time	Filtered out on employed	
	7	Unemployed part-time	Filtered out on employed	
October 1997 & September 2001	1	Not in labor force	Filtered out on employed	
	2	FT Hours (35+), Usually FT	1	Full-time employment
	3	PT for economic reasons, Usually FT	1	Full-time employment
	4	PT for non-economic reasons, Usually FT	1	Full-time employment
	5	Not at work, usually FT	1	Full-time employment
	6	PT Hrs, usually PT for Economic reasons	0	Part-time employment
	7	PT Hrs, usually PT for Non-economic reasons	0	Part-time employment
	8	FT Hours, usually PT for Economic reasons	0	Part-time employment
	9	FT Hours, usually PT for Non-economic reasons	0	Part-time employment
	10	Not at work, usually Part-time	0	Part-time employment

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Computer Usage Questions and Data

Carnoy (2000:33) claimed that the national "stock of computer hardware and software per worker" in the economy would be an excellent measure for IT diffusion, but this data is rarely available, and is not available in the CPS either. By using computer usage at work in the CPS, I am attempting to get as close as possible to measuring Carnoy's suggestion of an excellent measure for IT diffusion, which is "computer hardware and software per worker." Additionally, use of individual computer usage in the CPS is a direct measurement of actual computer usage.

Computer usage at work in the CPS was measured in October 1984, 1989, 1993, 1997, and September 2001. I will now describe how computer usage was measured (also see Table 8 for summary). In 1984 to 1997, respondents were asked the following question: "Does…directly use a computer at work?"

In 1984, the answer responses were 1 'Yes,' 2 'No,' 9 'NA,' (not applicable) and I 'N.I.U.' (not in universe) (U.S. Bureau of the Census 1984:Appendix, p. 5). In 1989, the answer responses were 1 'Yes,' 2 'No,' 9 'No response,' and -1 'Blank' (U.S. Bureau of the Census 1989:9-4). In 1993, the answer responses were 1 'Yes,' 2 'No,' 9 'No response,' and -1 'Out of universe' (U.S. Bureau of the Census 1993:9-9). In 1997, the answer responses were 1 'Yes,' 2 'No,' and -1 'Out of universe' (U.S. Bureau of the Census 1997:Attachment 8).

Table 8. Recode of Computer Usage into Dummy Variable

CPS Survey	Original Responses		Recoded Responses	
October 1984	1	Yes	1	Yes
	2	No	0	No
	9	NA (not applicable)	Missing cases	
	I	NIU (not in universe)	Filtered out	
October 1989	1	Yes	1	Yes
	2	No	0	No
	9	No response	Missing cases	
	-1	Blank	Filtered out	
October 1993	1	Yes	1	Yes
	2	No	0	No
	9	No response	Missing cases	
	-1	Out of universe	Filtered out	
October 1997	1	Yes	1	Yes
	2	No	0	No
	-1	Out of universe	Filtered out	
September 2001	1	Yes	1	Yes
	2	No	0	No
	-1	Out of universe	Filtered out	

Source: Current Population Survey Documentation, October 1984, 1989, 1993, 1997, and September 2001

In recoding of variable ‘word 82, character 4’ in 1984 (U.S. Bureau of the Census 1984), response 1 ‘Yes’ was set equal to ‘1’ and response 2 ‘No’ was set equal to ‘0.’ Response 9 ‘N.A.’ was recoded to missing. Response I ‘N.I.U.’ (not in universe) was filtered out during the application of the interviewed adult, age 18+, employed, and private worker filters. In recoding variable ‘A-S48’ in column 389 in 1989 (U.S. Bureau of the Census 1989), response 1 ‘Yes’ was set equal to ‘1’ and response 2 ‘No’ was set equal to ‘0.’ Response 9 ‘No response’ was recoded to missing. Response -1 ‘Blank’ was filtered out during the application of the interviewed adult, age 18+, employed, and

private worker filters. In recoding variable 'A-S53' in column 425 in 1993 (U.S. Bureau of the Census 1993), response 1 'Yes' was set equal to '1' and response 2 'No' was set equal to '0.' Response 9 'No response' was recoded to missing. Response -1 'Out of Universe' was filtered out during the application of interviewed adult, age 18+, employed, and private worker filters. In recoding variable 'PESCU8' in columns 944 to 945 in 1997 (U.S. Bureau of the Census 1997), response 1 'Yes' was set equal to '1,' response 2 'No' was set equal to '0,' and response -1 'Out of universe' was filtered out in the filtering process involving application of the interviewed, adult civilian, age 18+, employed, and private worker filters. In 2001, the question was altered to:

"(Does NAME/Do you) use a computer at (his/her/your) MAIN job?"

The answer responses were 1 'Yes,' 2 'No,' and -1 'Out of universe' (U.S. Bureau of the Census 2001:8-11). In recoding variable 'PESCW' in columns 923 to 924 in 2001, response 1 'Yes' was set equal to '1' and response 2 'No' was set equal to '0.' Response -1 'Out of universe' was filtered out during the application of interviewed, adult civilian, age 18+, employed, and private worker filters.

In the 'Computer at Work' measure that I just described, there are some missing cases in 1984 to 1993, but no missing cases in 1997 to 2001. After examination of the difference in missing cases, I found that the response 'NA' (not applicable) in 1984 was included in the employment universe, which the computer usage at work variable depends on. In 1989 and 1993, the response 'No Response' was also included in the employment universe underlying computer usage. The response 'NA' or 'No Response' was not included in the employment universe from 1997 to 2001, thus there were no missing cases for the 'Computer at Work' measure in 1997 and 2001.

After the CPS data was collected, the computer answer responses were edited. Between 1984 and 1993, a consistency edit of the supplement data was used to make sure the questions followed the correct skip pattern and the computer at work variable was part of this process (U.S. Bureau of the Census 1984, 1989, 1993). However, in 1984, when inconsistencies arose in answers to questions, they were forced to be consistent. Additionally, for a few cases, missing values were assigned values based on known information (U.S. Bureau of the Census 1984). In 2001 and possibly 1997 (the codebook does not indicate with certainty), both a consistency edit to check for the correct skip pattern and a "hot deck" editing procedure were used on the computer at work question (U.S. Bureau of the Census 1997, 2001). A "hot deck" procedure involves assigning a value to the missing response of a respondent based on another respondent with the same economic and demographic characteristics (U.S. Bureau of the Census 2001). According to the October 1997 CPS documentation, supplement items were imputed between 7% and 8% of the time (U.S. Bureau of the Census 1997). The imputation rate was not mentioned in the September 2001 CPS documentation. As a result, some caution should be taken when comparing the 1997 and 2001 data to the earlier data sets because of the use of a "hot deck" editing procedure and as mentioned elsewhere, the sampling design uses the 1990 Decennial Census information versus use of the 1980 Decennial Census information in the sampling designs of earlier data sets. An additional word of caution is that small differences may be due to large standard errors, a sample size below 75,000, and nonsampling error (Kominski 1988, Moore 1997, 2001).

Internet Usage Questions and Data

Measures for Internet usage in the CPS exist for 1993, 1997, 1998, 2000, and 2001. In 1998 and 2000, the universe for Internet questions are not use of computer at work like in the other years, rather the universe is use of the Internet outside the home. I decided against using the Internet data for 1998 and 2000 after running descriptive analysis for 1998 and 2000. I realized the sample was considerably smaller (about half the size) than the other years which had the universe of computer use at work. Additionally, the percent who used the Internet in both 1998 and 2000 was definitely higher than the 2001 Internet usage by about 10%, which was very surprising, since 1998 and 2000 focused on Internet usage and 2001 was a combination of both Internet and email usage. Obviously, the two samples in 1998 and 2000 are noticeably different from the other years, so I will only use 1993, 1997 and 2001 data, since they have comparable samples and universes. Since email and Internet usage are combined in the same question in 2001, I will present Internet usage for 2001 in the same table with the earlier years of 1993 and 1997, but with an extra column space between the earlier years and 2001.

It should be noted that the reason the Internet questions for most years are worded as 'What does … do?' is because anyone over fourteen, fifteen, or sixteen years old (depending on the survey) can be interviewed as the respondent for the household. The interviewers try to interview the householder or the spouse because they have greater knowledge. However, if the person cannot answer the questions, then the interviewer comes back when a more knowledgeable household member is present (Reed 1997).

In 1993, I will use bulletin board usage for Internet usage because in 1993, bulletin boards were the Internet in the early 1990s. According to the October 1993 CPS documentation, the Internet question in 1993 was:

"At work, what does … use the computer for?"

The possible answer responses on the flashcard were:

Analysis
Bookkeeping
Bulletin boards
Calendar/scheduling
Communications
Computer-Assisted Design (CAD)
Databases
Desktop publishing/newsletters
Educational programs
Electronic mail
Games
Graphics
Inventory control
Invoicing
Learning to use the computer
Programming
Sales
Spread sheets
Telemarketing
Word processing
Other
Don't know

(U.S. Bureau of the Census 1993:12-5). Multiple responses could be checked. However, the responses to this general question are separated into different variables within the data set, thus the response 'Bulletin boards' represents a separate variable in the data set and has the following responses in variable 'A-S54C' according to the CPS Documentation (U.S. Bureau of the Census 1993:9-9): -1 'Out of universe,' 1 'Bulletin Boards,' and 9 'No response.' Response -1 'Out of universe' was set to missing.

In 1997, Internet usage was measured in variable 'Pescu12b' as:

'Does … use the INTERNET (or another on-line service) at work?'

The answer responses were 1 'Yes' and 2 'No.' The response -1 'Out of universe' was recoded as missing (U.S. Bureau of the Census 1997:Attachment 8).

In 2001, the question 'PESCW2' in columns 927 to 928, covered Internet usage and email usage as follows:

> '(At work, do you/does s/he) (For work, do you/does s/he) Connect to the Internet or use e-mail?'

The answer responses were 1 'Yes' and 2 'No' (U.S. Bureau of the Census 2001:9-7). The response -1 'Out of universe' was recoded as missing.

In the original Internet variable for 1993, the universe is not computer users. Thus, I recoded the Internet variable to create a universe of computer users, where '1' equals use of the Internet among computer users at work and '0' means non-usage of the Internet. In the codebook, the Internet variable is expressed as Internet usage (Yes) vs. (No response), which consists of 110 responses that do not represent non-users of the Internet. All other responses were system missing as 'Out of universe.' To avoid this problem, a recode to a sample of computer users was needed. I created the recode using both the computer and Internet (Bulletin Board) variables by a series of if, then statements as follows:

> if computer = 1 and bulletin = 1 then Internet = 1.
>
> if computer = 1 and bulletin = 4 then Internet = 0.
>
> if computer = 1 and bulletin = 9 then Internet = 0.

Note that response '4' is 'Out of universe' and is used to recapture computer users to obtain a universe of Internet users among actual computer users. In 1997 and 2001, the universe for Internet usage was computer users at work, so the adjustment to 1993 made the universes consistent across time.

Analysis

Regression Analysis

I had originally planned to use logistic regression to show computer usage over time; however, I ran into many problems and thus decided in the end not to use logistic regression analysis. In use of logistic regression analysis to show net change over time from one data point to the next, since the CPS has different respondents in each of the surveys that I used, I tried to create a logistic regression model with interaction dummies between each industry by each year. Such a regression model should include industry dummies except for the excluded group and dummy variables of each industry by each year except for the excluded group. With six industries and five years, a very large regression model is produced that is not easily interpretable. Additionally, to examine net change from one data point to the next, there needs to be four regression models comparing 1984 to 1989, 1989 to 1993, 1993 to 1997, and 1997 to 2001, which further complicates interpretation. To avoid this complication in interpretation, I created one logistic regression model that had coefficients comparable to the base year of 1984. At this point two concerns arose, first, how can I easily interpret this model? Second, industries are compared to their base year of computer usage in 1984 in the dummy interactions, which is different for each industry, thus making comparison across industries impossible. To solve this problem, I transformed the logistic regression beta coefficients into probabilities that could be graphed with the hope that the industries could be compared to one another (for an example of use of this method in practice see Figure B.6 'The Effects of Older and Younger Children on the Odds of Employment of Middle-Class Wives, Aged 25 to 44, by Race' on page 201 in Appendix B in Landry

(2000)). The plan was to calculate the rate of adoption in computer usage over time in each industry and these rates could be compared to one another to compare computer usage within industries. To calculate the percentage in the transformation of the odds ratio, the formula for an odds ratio is used, as (odds given x = 1 for variable X1) in the numerator divided by (odds given x = 0 for variable X1) in the denominator, which can better be expressed as follows: $\frac{(p/(1-p))}{(p/(1-p))}$. The percentages calculated in each industry in each year could then be used in the calculation of rates of increase from one time point to the next. However, use of this method to calculate rates of computer adoption for each industry was doomed from the start because the size of the base coefficient influenced the rate of adoption of computer usage. More specifically, in transformation of the odds ratios given in the logistic regression model to percentages that could be more easily interpreted, could be graphed over time, and more importantly, could be used to create rates of computer adoption, the bias of the odds ratios due to the use of the tails of the logit function were carried over to the calculated percentages and ultimately the rates based on these percentages. In other words, the odds ratios in the logistic regression model are calculated based on the tails of the logit function, where the probability is near p = 0 or p = 1. In other words, the shape of the logit function is something like the shape of an S, with the ends of the S being in the tails of the distribution near 0 or 1 with low probabilities. As a result of using the tails of the logit function, differences can be magnified, since the tails represent low values in the curve. This is the exact same mathematical paradox of a low base of computer usage from 1984 to 1993 creating larger percent increases from 1984 to 1993 than after 1993 that I will describe in the results section. In other words, the tails of the logit function show relative change, not absolute

change. The mathematical problem remains when the percentages are used in the calculation of rates. For example, 'Agriculture' had a much higher rate of adoption than 'Finance, Insurance, and Real Estate,' which failed to give an accurate picture of actual computer usage in these two industries.

One way around this problem is to attempt to use the center of the logit-function (see Steve Martin's website www.bsos.umd.edu/socy/smartin/709/ for more details if interested). I was able to do this by using the same percentage of p = 0.5 for all variables in 1984 for all industries. More specifically, to calculate the percentage when the odds given x = 1, I used 0.5 in odds given x = 0, which simplifies the odds to one as follows: (0.5)/(1-0.5) = 1, which is no difference, since the odds is one. Thus, the formula of odds ratio in this case is p(1-p)/1, which simplifies to $p = \frac{oddsratio}{1+oddsratio}$. The advantage of using a percentage of 0.5 in 1984 for all industries is that it should then be possible to not only compare percentages within a particular industry, but also across industries since the base of 0.5 is the same for each percentage. While the bias of the tails was reduced, the problem still remained because the problem with this method is that it still uses the original odds ratio to calculate the percentage, thus maintaining some of the original bias of relative change in the odds ratio. The only reasonable way to solve this problem is to either calculate the logistic regression model by hand (which is nearly impossible), or somehow manipulate the statistical program to use the middle of the logit function to calculate the odds ratios. With the standardization of statistical software packages, I have checked into it and I am not sure how it is possible to calculate the odds ratios from the middle of the curve to avoid the bias of relative change. As a result, I decided against using logistics regression analysis to show change over time in computer usage across

industry. Therefore, I dropped the logistic regression models from the analysis and I decided instead to use bivariate and multivariate tables. Despite the limitations of statistical control with bivariate and multivariate tables, they gave a more interpretable picture of computer adoption and also gave a better picture of actual computer usage over time.

My analysis will start with univariate descriptive statistics that will include frequencies, means and standard deviations for the variables that will be later involved in the analysis. After I complete the presentation and description of the univariate descriptive statistics, I will present and describe the bivariate and multivariate crosstabulations.

Hypotheses and Rate of Computer Usage

I will test two sets of hypotheses. In the first set of hypotheses, I am using the percentage of knowledge workers in Table 1 as a prediction of the rate of adoption of computer usage by workers in the private sector in each industry. I calculate rate of computer usage in a particular industry in a manner similar to age-specific birth rate. It is similar to an age-specific birth rate because in an age-specific birth rate the number of births to the population in a particular age group is divided by the population in that age group and multiplied by 1000. The notable difference between the calculation of the rate of computer usage in each industry and the calculation of age-specific fertility rate is that in the formula for the age-specific fertility rate, the mid-year population is used to accommodate the differences in birth dates rather than the population in each industry as measured at the time of the CPS survey. In the case of calculating industry-specific rates

of computer usage here, I am dividing the number of computer users in a particular industry by the population in that same industry and then multiplying by 1000. Thus, I calculate the rate of computer usage in each industry as follows:

$$rate_i = \frac{computerusageindustry_i}{populationindustry_i} \text{ x } 1000$$

The numerator in the rate formula is the frequency of the population of computer users in the CPS sample for the industry in question divided by the denominator that includes the population of the particular industry. I calculated the population of a particular industry by using the variable final weight in the CPS in each year. The variable final weight applies to the labor force items. A supplement weight did exist for 1984 to 1993 data sets only, but it is supposed to be applied in the calculation of frequencies for the supplement data only, not the labor force variable industry. For consistency sake, I used the final weight across both variables for all years in the crosstabulations to figure the number of computer users in each industry. Afterwards, I multiplied the result by 1,000 to get the number of computer users per 1,000 workers in a particular industry. I chose to calculate the rate this way for a variety of reasons. First, use of the rate of increase formula $\frac{X_2 - X_1}{X_1}$ from one year to the next was influenced by the size of the base year and thus was unacceptable because the rate may be due to the influence of the size of a base rather than an actual effect. Second, I ran into the problem of an inability to compare across industries because there were different bases in 1984 and change was relative to 1984 within a specific industry in the regression model rather than a comparison across industries. This came to fruition when I considered calculating rates based on the percentage change from one data set to the next by using the percentages calculated from

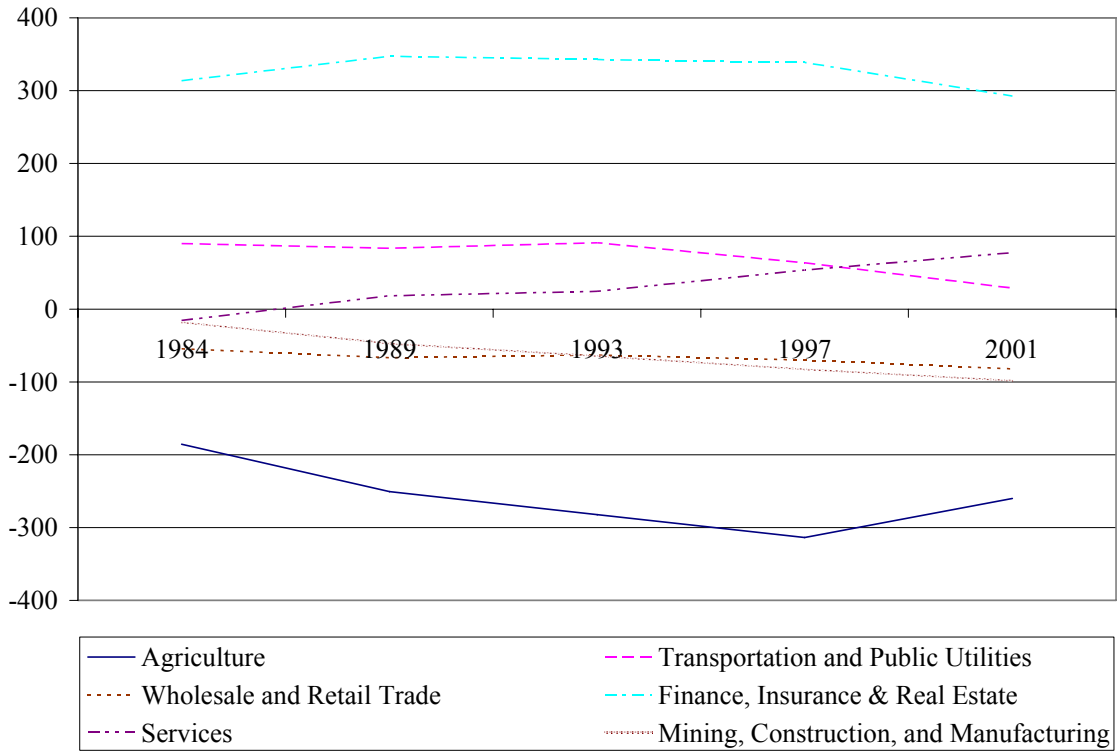
the odds ratios of the beta coefficients in a logistic regression model. In creation of these logistic regression models, I calculated separate interaction terms of industry multiplied by each year. The excluded group was the base year of 1984. Third, use of a formula to calculate rates that are similar to calculation of demographic birth and death rates showed continuity with an established method for calculating a rate (Pollard, Yusuf and Pollard 1974; Newell 1988; Palmore and Gardner 1994). Fourth, the calculation of rate is restricted to one particular year. In previous calculations involving rate of change from one year to the next, I ran into the problem of having to use data from more than one year to calculate a rate of increase.

In the second set of hypotheses, I will use the percentage of knowledge workers in each industry from 1984 to 2001 to predict whether the accumulation of computer usage in a particular industry has reached 50% by 2001. I used the percentage of knowledge workers in each industry from 1984 to 2001 for two reasons. First, computer usage increased over time and has some influence on the eventual percentage in 2001. Second, there was no concern about the percentage of knowledge workers in a particular industry being above the average percentage of knowledge workers in some years and below the average percentage of knowledge workers in other years.

In both sets of hypotheses, I am using the percentage of knowledge workers in Table 1 to predict computer usage in a particular industry in a particular year. To predict computer usage, I compare the percentage of knowledge workers to the average percentage of knowledge workers for a particular year. For example, for the first hypothesis, if the percentage of knowledge workers for agriculture is below the average percentage of knowledge workers for all industries for 1984, then I predict the rate of

computer usage in Agriculture will be below the average rate of computer usage for all industries in 1984. Hence, I am using knowledge work to predict computer usage because it is a key component of the New Economy. Additionally, I also have Figure 2 which graphs the difference between the rate of computer usage in a particular industry and the average rate of computer usage for each year.

Figure 2. Difference in Computer Usage from Overall Rate by Industry in the Private Sector, 1984-2001



Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Weighting

I decided to use the unweighted cases of the CPS as a large sample instead of weighting to the population level in the bivariate and multivariate crosstabulations except for the calculation of the rates. I did not weight individual records to estimate the population as is commonly done with CPS data for three reasons. First, the purpose of the weighting procedure is to capture those who are ages 16 and over; however, in one part of the ratio estimate ages 15 and over are used. Thus, the weighting procedure is not as restrictive as my filtered sample that begins at age 18. Second, the weight in the CPS is only applicable if applied to all cases. With my filtering process, it is not possible to estimate frequencies at the population level. By filtering cases, I am destroying the sample design and weighting system based on it. Third, the CPS surveys are samples, not populations, and should be treated as such.

Chapter 5 Results: A New Mode of Production

Introduction

Certain critics of the New Economy viewed the New Economy as short-lived as either over-hyped by the growth of technology firms and the stock market in the late 1990s, or only in existence because of the economic boom of the economy in the late 1990s. My perspective on the New Economy views the New Economy as a long-term economic phenomenon, where the adoption and usage of new technology by workers in the private sector is a new method of performing work. Hence, I view the New Economy as a new mode of production, where businesses have adopted new computing technology for use by employees, for example, the computer and Internet. My position on the New Economy is more permanent as technology usage is maintained, replaced, and expanded over time until that point in time, if it ever comes, that a new type of technology is adopted and replaces computing technology. To demonstrate this new mode of production, I am examining computer usage by employees in the private sector in each major industry from 1984 to 2001, and will attempt to demonstrate the adoption of a new mode of production. Computer adoption should vary across industry as certain industries will be more likely to adopt computers. Thus, adoption of computers is not uniform, and examination of computer usage across industry is necessary. In particular, I will examine the rate of adoption at each time period in each industry and determine whether the level of adoption has reached 50% in each industry by 2001. To empirically and theoretically distinguish each industry from one another for the purpose of predicting differential computer usage in each industry, I will use the percentage of knowledge workers in each industry as a guide in predicting computer usage in each industry for each year. In a

subsequent hypothesis, I will use the percentage of knowledge workers in each industry to predict whether the level of computer adoption has reached 50% by 2001 in each industry. Those industries that have a larger percentage of knowledge workers will be more likely to have a higher level of computer usage at a particular time period and cumulatively will be more likely to have reached the critical level of 50% usage by 2001 that is associated with increases in productivity.

Descriptive Analysis of Key Variables across Time

Before I introduce the descriptive analysis of computer and Internet usage, I want to take this time to introduce and examine the frequency distributions for the variables of Major Industry presented in Table 9, Major Industry recode presented in Table 10, and Full-time/Part-time Employment recode shown in Table 11.

I will examine the frequency distributions for major industry for both the un-recoded and recoded variables. As shown in Table 9, the percentage in each industry varies. In particular, 'Manufacturing – Durable Goods' and 'Retail Trade' have the highest percentage of workers. The industries of 'Manufacturing, Non-Durable Goods' from 1984 to 1997, 'Construction,' 'Finance, Insurance, and Real Estate,' and 'Business and Repair Services' in 1989 and 1997 to 2001 had over 7% of the workforce. On the other hand, 'Mining' from 1989 to 2001; 'Utilities and Sanitary Services' from 1997 to 2001; 'Private Household Service' from 1989 to 2001; and 'Forestry and Fisheries' from 1984 to 2001 had 1.0% or fewer workers of the total workforce.

Table 9. Frequency Distribution of All Major Industries in the Private Sector, 1984-2001
% within Year

		Year				
Major Industry		1984	1989	1993	1997	2001
Agriculture	Count	2,348	2,143	1,876	1,699	1,934
	%	4.2	3.7	3.4	3.4	3.3
Mining	Count	709	489	434	376	406
	%	1.3	0.9	0.8	0.8	0.7
Construction	Count	4,139	4,319	3,834	3,498	4,819
	%	7.3	7.5	7.0	7.0	8.2
Manufacturing, Durable Goods	Count	7,732	7,097	6,055	5,305	5,583
	%	13.7	12.4	11.0	10.7	9.5
Manufacturing, Non-Durable Goods	Count	5,109	5,007	4,485	3,621	3,460
	%	9.0	8.7	8.2	7.3	5.9
Transportation	Count	2,244	2,270	2,325	2,119	2,557
	%	4.0	4.0	4.2	4.3	4.4
Communications	Count	936	853	850	799	1,006
	%	1.7	1.5	1.5	1.6	1.7
Utilities and Sanitary Services	Count	673	612	607	497	543
	%	1.2	1.1	1.1	1.0	0.9
Wholesale Trade	Count	2,682	2,801	2,480	2,261	2,466
	%	4.7	4.9	4.5	4.6	4.2
Retail Trade	Count	10,722	10,473	10,334	8,979	10,729
	%	19.0	18.2	18.8	18.1	18.3
Finance, Insurance, and Real Estate	Count	4,114	4,467	4,192	3,609	4,364
	%	7.3	7.8	7.6	7.3	7.5
Private Household Service	Count	724	509	572	395	371
	%	1.3	0.9	1.0	0.8	0.6
Business and Repair Services	Count	3,314	4,055	3,604	3,730	4,758
	%	5.9	7.1	6.6	7.5	8.1
Personal, Except Private Household Services	Count	2,070	2,043	1,803	1,648	2,032
	%	3.7	3.6	3.3	3.3	3.5

Table 9. Frequency Distribution of All Major Industries in the Private Sector, 1984-2001 (continued)

% within Year

Major Industry		1984	1989	1993	1997	2001
Entertainment and Recreation	Count	720	706	797	833	1,068
	%	1.3	1.2	1.5	1.7	1.8
Hospitals	Count	2,027	2,220	2,352	2,001	2,421
	%	3.6	3.9	4.3	4.0	4.1
Medical, except hospitals	Count	2,071	2,442	2,774	2,787	3,348
	%	3.7	4.3	5.0	5.6	5.7
Educational	Count	1,152	1,238	1,247	1,311	1,630
	%	2.0	2.2	2.3	2.6	2.8
Social Services	Count	697	999	1,247	1,332	1,570
	%	1.2	1.7	2.3	2.7	2.7
Other Professional Services	Count	2,242	2,627	3,018	2,795	3,343
	%	4.0	4.6	5.5	5.6	5.7
Forestry and Fisheries	Count	60	70	62	46	70
	%	0.1	0.1	0.1	0.1	0.1
Total	Count	56,485	57,440	54,948	49,641	58,478
	%	100	100	100	100	100

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

I will now examine decreases in the share of the labor force by industry first and then examine increases in the share of the labor force by industry next. As shown in Table 9, there appears to be consistent increases or decreases, or fluctuating increases or decreases over time from 1984 to 2001 for the frequency distributions of each of the 21 industries that constitute 'Major Industry.' The industries of 'Agriculture,' 'Mining,' 'Manufacturing-Durable Goods,' 'Manufacturing, Non-Durable Goods,' and 'Utilities and Sanitary Services' appear to consistently decrease over time except for no change in a

few cases as follows: 3.4% of workers in 'Agriculture' in both 1993 and 1997, 0.8% of workers in 'Mining' in both 1993 and 1997, and 1.1% of workers in 'Utilities and Sanitary Services' in both 1989 and 1993.

As presented in Table 9, the industries of 'Wholesale Trade,' 'Retail Trade,' 'Private Household Services,' and 'Personal, except Private Household Services' were industries that showed an overall decrease in their percentage of workers from 1984 to 2001. However, the percentage of workers in these industries experienced small fluctuations in either direction from one data set to the next. While the overall trend of a decreasing share of the labor force occurred from 1984 to 2001, each industry experienced a different pattern of fluctuation; however, the increase or decrease from one data set to the next was never more than 0.8%.

In examination of the increase in the percentage within Major Industry from 1984 to 2001 as shown in Table 9, the industries of 'Transportation,' 'Medical, except Hospitals,' 'Educational,' 'Social Services,' and 'Other Professional Services' experienced a continual increase in the percentage of workers in the total labor force except for 'Transportation' in 1984 and 1989, and for 'Social Services' in 1997 and 2001. The industries of 'Construction,' 'Finance, Insurance, and Real Estate,' 'Business and Repair Services,' 'Entertainment and Recreation,' and 'Hospitals' experienced an overall increase in the share of the labor force from 1984 to 2001, but fluctuations occurred in the percentage of workers in each industry from 1984 to 2001. However, there is no consistent pattern in the fluctuations over time; but they are relatively small, never increasing or decreasing more than 1.2% from one data set to the next. The two industries with no difference in the percentage of workers in the workforce from 1984 to

2001 were ‘Communications’ at 1.7% and ‘Forestry and Fisheries’ at 0.1%. However, ‘Communications’ decreased to 1.5% in 1989 and 1993 and increased to 1.6% in 1997. The industry of ‘Forestry and Fisheries’ remained constant at 0.1% from 1984 to 2001.

Thus, I have just examined the un-recoded major industry variable that consists of 21 major industry categories. I will now examine the frequency distribution of the six major industries that constitute the recode of the 21 major industry categories as shown in Table 10. The industries of ‘Wholesale and Retail Trade,’ ‘Services,’ and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ had over 20% of all workers in each year; and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ in 1984 and in ‘Services’ in 1993 to 2001 had over 30% of all workers as shown in Table 10. Thus, about 82% of all private workers from 1984 to 2001 are located in the industries of ‘Wholesale and Retail Trade,’ ‘Services,’ and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries.’ As a result, the industries of ‘Agriculture,’ ‘Transportation, Communications, and Public Utilities,’ and ‘Finance, Insurance, and Real Estate’ make up less than 20% of all workers.

Table 10. Frequency Distribution of Major Industry in the Private Sector, 1984-2001

% within Year

		Year				
Major Industry		1984	1989	1993	1997	2001
Agriculture	Count	2,348	2,143	1,876	1,699	1,934
	%	4.2	3.7	3.4	3.4	3.3
Transportation, Communications, & Public Utilities	Count	3,853	3,735	3,782	3,415	4,106
	%	6.8	6.5	6.9	6.9	7.0
Wholesale & Retail Trade	Count	13,404	13,274	12,814	11,240	13,195
	%	23.7	23.1	23.3	22.6	22.6
Finance, Insurance & Real Estate	Count	4,114	4,467	4,192	3,609	4,364
	%	7.3	7.8	7.6	7.3	7.5
Services	Count	15,017	16,839	17,414	16,832	20,541
	%	26.6	29.3	31.7	33.9	35.1
Mining, Construction, Manufacturing, Forestry & Fisheries	Count	17,749	16,982	14,870	12,846	14,338
	%	31.4	29.6	27.1	25.9	24.5
Total	Count	56,485	57,440	54,948	49,641	58,478
	%	100	100	100	100	100

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

In examination of the variable consisting of full-time and part-time workers as shown in Table 11, the percentage of both full-time and part-time workers in the private sector is fairly consistent over time. The percentage of full-time workers ranges from just over 81% in 1984 to almost 84% in 1989. The percentage of part-time workers ranges from just over 16% in 1989 to nearly 19% in 1984.

Table 11. Frequency Distribution of Full-Time and Part-Time Workers in the Private Sector

% within Year

		Year				
		1984	1989	1993	1997	2001
PT	Count	10,606	9,254	9,399	8,654	9,776
	%	18.8	16.1	17.1	17.4	16.7
FT	Count	45,879	48,186	45,549	40,987	48,702
	%	81.2	83.9	82.9	82.6	83.3
Total	Count	(56,485)	(57,440)	(54,948)	(49,641)	(58,478)

Source: October 1984, 1989, 1993, 1997, and September 2001

Descriptive Analysis: Computer and Internet Usage over Time

Diffusion of Computer Usage over Time

As shown in Table 12, overall computer usage increased from 1984 to 2001. This increase is indicative of continual adoption and diffusion of new computing technology over time as a new mode of production. However, this increase is not a steady increase. The largest increase in computer usage occurred from 1984 to 1993. Computer usage increased at a slower pace after 1993. This seems bizarre at first observation because technological advancements in information technology, such as quicker computers due to better chip technology, increased Random Access Memory (RAM) capacity and hardware space, adoption of network technology, the domination of Windows operating

Table 12. Computer Usage at Work in the Private Sector, 1984-2001
diff is % difference from previous time point
% within Year

		Year				
		1984	1989	1993	1997	2001
Computer Usage at Work	Count	12,294	18,842	22,345	23,759	30,792
	%	23.0	34.6	43.2	47.9	52.7
Total	Count	(53,352)	(54,408)	(51,678)	(49,641)	(58,478)
	% diff	-	11.6	8.6	4.6	4.8

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

system and the decreasing cost of computers should have increased later adoption of the computer. Additionally, the New Economy and technology boom in the IT field occurred after 1993. Despite these conditions that should produce greater adoption of computers later on, there are reasonable explanations for this noticeable disparity. First, there is a difference between the number of additional computer users and the rate of computer adoption. While the percentage of workers using computers did not increase much from 1997 to 2001, the actual number of users increased by over 7,000 workers, which is larger than the over 6,000 worker increase from 1984 to 1989 and just over 3,500 worker increase from 1989 to 1993. Thus, in terms of actual numbers, it appears the New Economy in the late 1990s was having a larger effect on increasing computer adoption than during earlier time periods; however, the percentage increase was much lower due to the impact of a larger base. As diffusion of new computing technology increased over time, the percentage of employees in the private sector using computers increased as well, making it difficult to have subsequent large percentage increases as the relative base is larger after new adoption has taken place. For example, if there are 1,000 people using the computer in 1984, and by 1989, there are 8,000, the addition of 7,000 new users equates to an 800% increase in computer usage from 1984 to 1989. To continue this same rate of increase of 800% from 1989 to 1993, there would need to be 64,000 users by 1993, which is an increase of 56,000 new users since 1989. While this is possible, it is a much larger than the 7,000 new users that started using the computer from 1984 to 1989. Second, in relation to Table 12, smaller percentage increases after 1993 occurred because there were fewer possible people to adopt as many businesses had already adopted computers. Third, there are potential theoretical reasons for a larger rate of increase in

early computer adoption that goes beyond natural statistical reasons. The foundation of office technology already existed in the office, which facilitated early adoption of computers. Also, the rate of increase in computer usage may be lower after 1993 due to an inability to quickly find new ways to utilize computers for tasks for the existing workforce.

Diffusion of Internet Usage over Time

Due to problems of consistent available data on Internet usage, comparison of Internet usage over time is restricted to 1993 to 1997 as shown in Table 13. The variable measuring Internet usage in 2001 includes both email and Internet usage, which if used as a proxy for Internet usage would overestimate Internet usage in 2001. Data for 1998 and 2000 exist, but they are not comparable to other years due to use of a different universe. As explained earlier in the methods section, Internet usage in 1998 and 2000 was significantly overestimated due to the use of Internet usage outside the home as the universe in the CPS rather than computer usage at work as in other years of the CPS. As a result, I did not use Internet usage in 1998 and 2000.

Table 13. Internet Usage at Work in the Private Sector, 1993-2001
% within Year

			Year		
			1993	1997	2001
Internet Usage at Work		Count	1,702	7,618	21,718
		%	7.6	32.1	70.5
	Total	Count	(22,345)	(23,759)	(30,792)

Source: Current Population Survey, October 1993, 1997, and September 2001

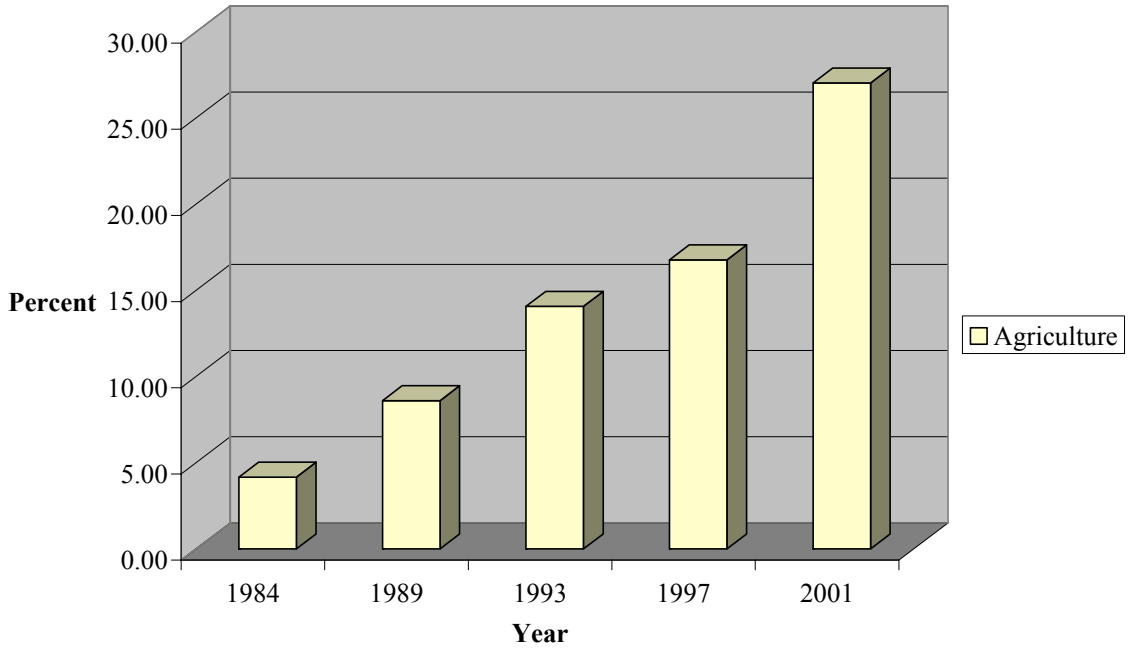
From examination of Table 13, overall Internet usage at work increased very significantly from 7.6% in 1993 to 32.1% in 1997. This was an increase of over 24 percentage points, which demonstrates that adoption of Internet usage happened very quickly and quicker than the adoption of computers. When Internet usage in 2001 is examined, Internet usage appears to have increased by over 38 percentage points from 1997 to 2001; however, it is possible that much of this increase is a result of email usage. Thus, the actual percentage point increase might possibly be closer to the increase of over 24 percentage points from 1993 to 1997; however, no one knows for certain. As was the case with the decrease in the percentage point gain in computer usage despite more new users in computer usage at work, the percentage increase from 1997 to 2001 was probably less than 24 percentage points because of a larger base in 2001 than in 1993 and 1997. Either way the very quick early adoption of the Internet at work is unusual relative to past technological revolutions. Wolcott and Goodman (2003) mentioned that among adoption of advanced technology, the Internet was one of the quickest and most completed adoptions in history. However, this is no surprise when we consider the speed at which the Internet developed for commercial use from 1995 to 2000. But there were several reasons why Internet adoption might have occurred more quickly than past technological revolutions. First, the existence of personal computers, networks, and the infrastructure for communication connections by computer provided the technological framework for the quick adoption of the Internet. Second, the economic boom of the 1990s provided the necessary capital to pay for Internet hookups and the necessary spending on infrastructure for the Internet. Third, hooking up to the Internet was

relatively cheap in comparison to the adoption of past technologies. Fourth, competition was fierce, so businesses were happy to adopt the new technology to keep up with competitors. Fifth, the Internet provided an apparent endless market and growth potential in a completely new economic medium; however, such optimism was later tempered.

Diffusion of Computer Usage over Time by Industry

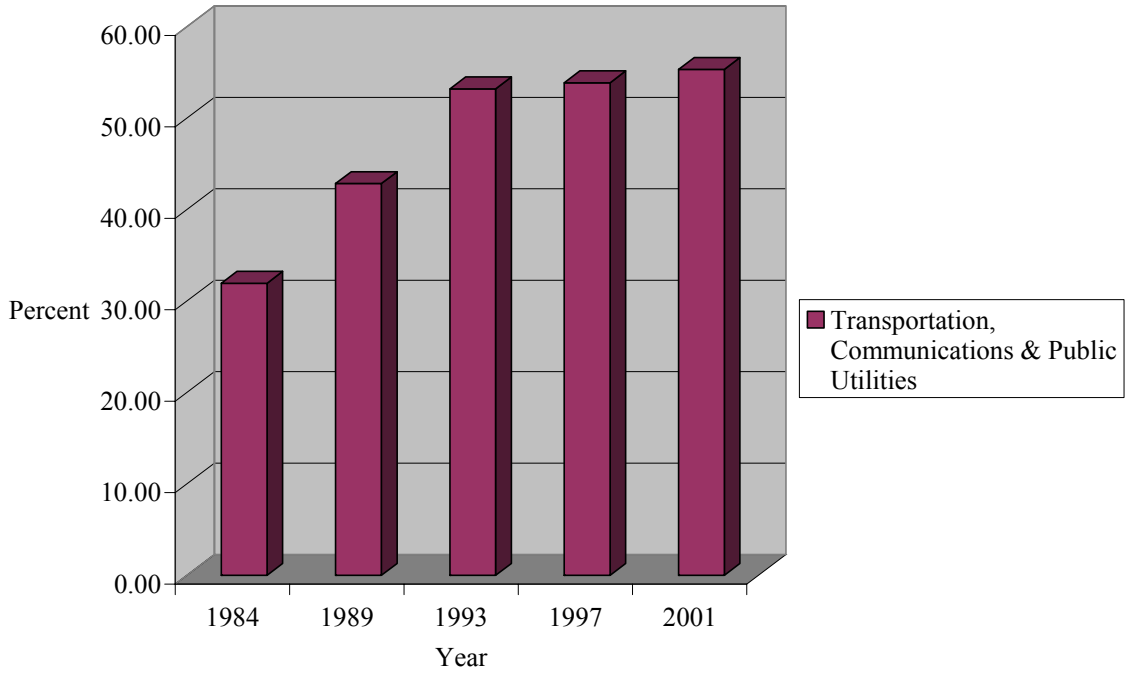
I have previously shown in Table 12 that overall computer usage has increased from 1984 to 2001. The next question is to examine computer usage in more detail by looking at computer usage within each major industry as presented in Table 14 or Figures 3 to 8, which will show the degree of diffusion of computer usage within each industry. This will also include examining computer usage in the two heterogeneous industries of 'Services' as shown in Table 15 and 'Mining, Construction, Manufacturing, Forestry, and Fisheries' as presented in Table 16. For those who would like to view the details of computer usage within each of the 21 major industries, I include Table 17, which includes computer usage for all 21 industries utilized within the six major industries in this study. This table will also be relevant for clarifying the results of hypothesis two later on, as computer usage in 2001 can be examined in each industry in greater detail. In the next section, I will also examine Internet usage within each major industry. Additionally, in later sections, I will examine computer usage and Internet usage by part-time and full-time workers in each industry.

Figure 3. Percent Computer Usage in Agriculture, 1984-2001



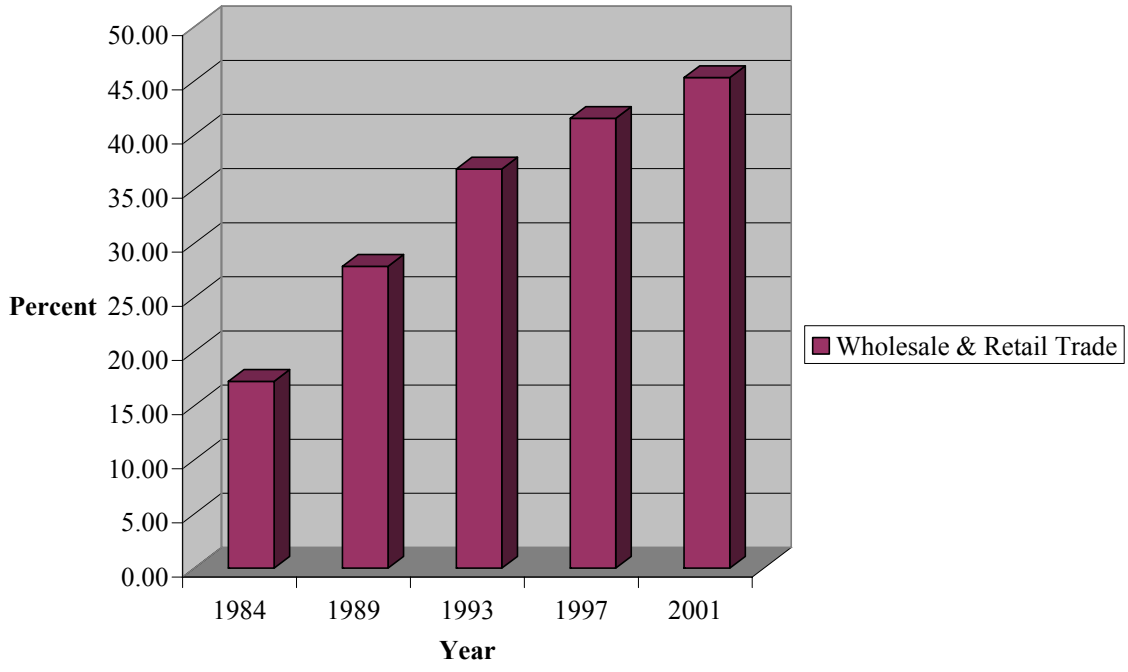
Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Figure 4. Percent Computer Usage in Transportation, Communications & Public Utilities, 1984-2001



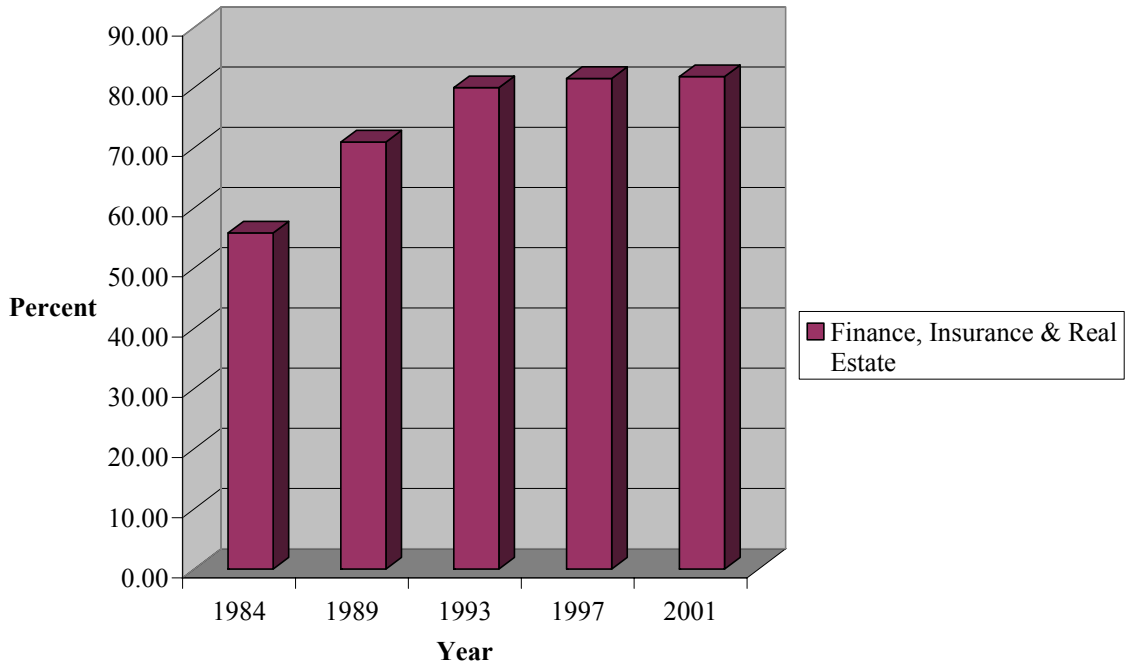
Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Figure 5. Percent Computer Usage in Wholesale & Retail Trade, 1984-2001



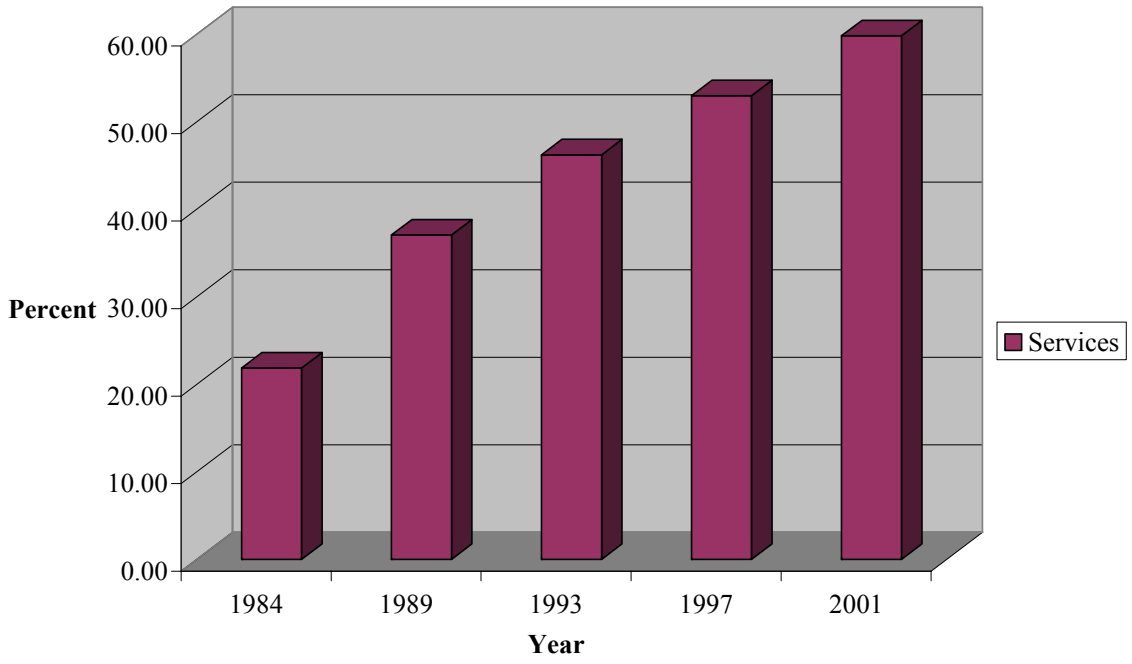
Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Figure 6. Percent Computer Usage in Finance, Insurance & Real Estate, 1984-2001



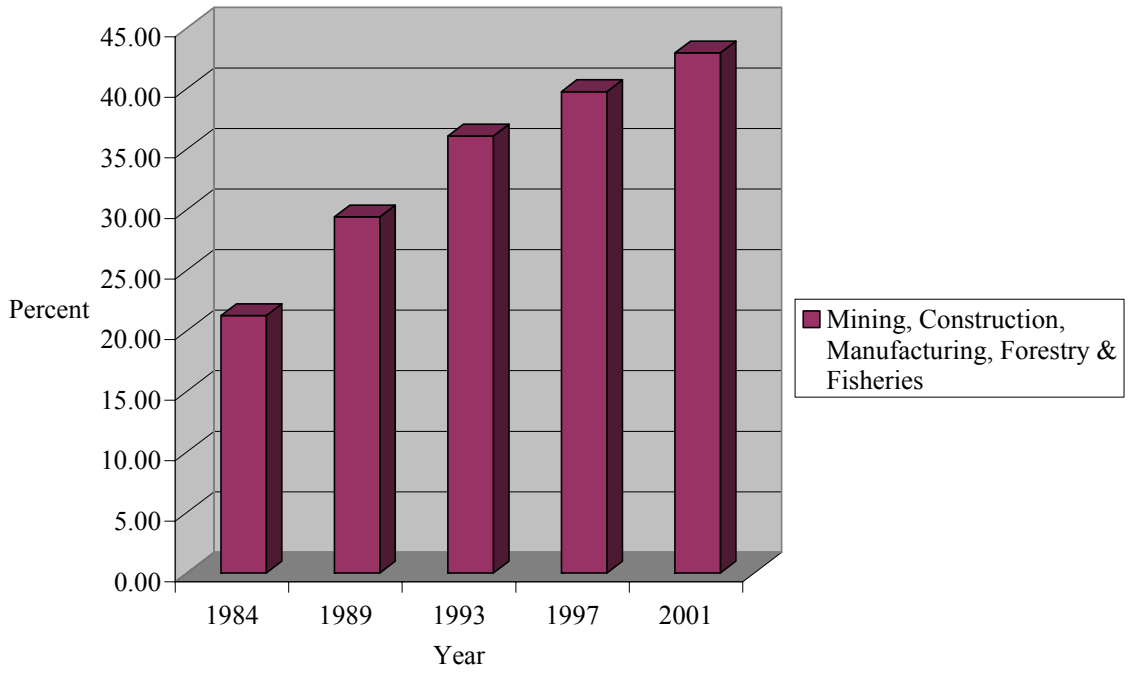
Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Figure 7. Percent Computer Usage in Services, 1984-2001



Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Figure 8. Percent Computer Usage in Mining, Construction, Manufacturing, Forestry & Fisheries, 1984-2001



Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Table 14. Computer Usage at Work by Industry in the Private Sector, 1984-2001

diff is % difference from previous time point
% within Year

		Year				
Major Industry		1984	1989	1993	1997	2001
Agriculture	Count	92	175	251	285	523
	%	4.2	8.6	14.1	16.8	27.0
	Total	(2,210)	(2,035)	(1,783)	(1,699)	(1,934)
	% diff	-	4.4	5.5	2.7	10.3
Transportation, Communications & Public Utilities	Count	1,168	1,502	1,877	1,839	2,271
	%	31.9	42.8	53.2	53.9	55.3
	Total	(3,658)	(3,507)	(3,529)	(3,415)	(4,106)
	% diff	-	10.9	10.4	0.7	1.5
Wholesale & Retail Trade	Count	2,183	3,507	4,434	4,669	5,979
	%	17.3	27.9	36.9	41.5	45.3
	Total	(12,651)	(12,578)	(12,027)	(11,240)	(13,195)
	% diff	-	10.6	9.0	4.7	3.8
Finance, Insurance & Real Estate	Count	2,201	3,023	3,153	2,941	3,570
	%	55.8	70.9	80.0	81.5	81.8
	Total	(3,942)	(4,261)	(3,943)	(3,609)	(4,364)
	% diff	-	15.1	9.0	1.5	0.3
Services	Count	3,084	5,893	7,568	8,919	12,292
	%	21.9	37.1	46.2	53.0	59.8
	Total	(14,103)	(15,896)	(16,367)	(16,832)	(20,541)
	% diff	-	15.2	9.2	6.7	6.9
Mining, Construction, Manufacturing, Forestry and Fisheries	Count	3,566	4,742	5,062	5,106	6,157
	%	21.2	29.4	36.1	39.7	42.9
	Total	(16,788)	(16,131)	(14,029)	(12,846)	(14,338)
	% diff	-	8.2	6.7	3.7	3.2

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Table 15. Computer Usage at Work in the Service Industry in the Private Sector, 1984-2001. % within Year

		Year				
Major Industry		1984	1989	1993	1997	2001
Private Household Service	Count	6	5	11	15	34
	%	0.9	1.1	2.1	3.8	9.2
	Total	(653)	(454)	(513)	(395)	(371)
Business and Repair Services	Count	803	1,507	1,581	2,013	2,829
	%	25.7	39.4	46.7	54.0	59.5
	Total	(3,122)	(3,825)	(3,384)	(3,730)	(4,758)
Personal, Except Private Household Services	Count	152	262	376	486	723
	%	7.9	13.8	22.3	29.5	35.6
	Total	(1,926)	(1,898)	(1,687)	(1,648)	(2,032)
Entertainment and Recreation	Count	86	160	244	329	517
	%	12.7	24.2	32.6	39.5	48.4
	Total	(677)	(662)	(749)	(833)	(1,068)
Hospitals	Count	654	1,148	1,440	1,377	1,740
	%	34.5	54.3	64.3	68.8	71.9
	Total	(1,897)	(2,115)	(2,239)	(2,001)	(2,421)
Medical, except hospitals	Count	262	675	987	1,327	1,864
	%	13.4	29.2	38.1	47.6	55.7
	Total	(1,961)	(2,315)	(2,588)	(2,787)	(3,348)
Educational	Count	319	524	624	821	1,155
	%	29.3	44.7	53.2	62.6	70.9
	Total	(1,090)	(1,172)	(1,174)	(1,311)	(1,630)
Social Services	Count	51	180	296	417	690
	%	7.8	19.1	25.1	31.3	43.9
	Total	(657)	(940)	(1,178)	(1,332)	(1,570)
Other Professional Services	Count	751	1,432	2,009	2,134	2,740
	%	35.4	56.9	70.4	76.4	82.0
	Total	(2,120)	(2,515)	(2,855)	(2,795)	(3,343)
Overall	Count	3,084	5,893	7,568	8,919	12,292
	%	21.9	37.1	46.2	53.0	59.8
	Total	(14,103)	(15,896)	(16,367)	(16,832)	(20,541)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Table 16. Computer Usage at Work by the Industries of Mining, Construction, Manufacturing, Forestry and Fisheries in the Private Sector, 1984-2001
% within Year

		Year				
Major Industry		1984	1989	1993	1997	2001
Mining	Count	176	151	186	170	177
	%	25.8	32.1	44.7	45.2	43.6
	Total	(683)	(471)	(416)	(376)	(406)
Construction	Count	252	469	543	679	1,251
	%	6.5	11.5	15.2	19.4	26.0
	Total	(3,894)	(4,085)	(3,572)	(3,498)	(4,819)
Manufacturing, Durable Goods	Count	2,102	2,600	2,589	2,579	2,921
	%	28.8	38.5	45.0	48.6	52.3
	Total	(7,310)	(6,746)	(5,757)	(5,305)	(5,583)
Manufacturing, Non-Durable Goods	Count	1,032	1,513	1,736	1,664	1,783
	%	21.3	31.7	41.0	46.0	51.5
	Total	(4,847)	(4,766)	(4,229)	(3,621)	(3,460)
Forestry and Fisheries	Count	4	9	8	14	25
	%	7.4	14.3	14.5	30.4	35.7
	Total	(54)	(63)	(55)	(46)	(70)
Mining, Construction, Manufacturing, Forestry and Fisheries	Count	3,566	4,742	5,062	5,106	6,157
	%	21.2	29.4	36.1	39.7	42.9
	Total	(16,788)	(16,131)	(14,029)	(12,846)	(14,338)

Source: Current Population Surveys, October 1984, 1989, 1993, 1997, and September 2001

Table 17. Computer Usage in All Major Industries in the Private Sector, 1984-2001
% within Major Industry

		1984	1989	1993	1997	2001
Agriculture	Count	92	175	251	285	523
	%	4.2	8.6	14.1	16.8	27.0
	Total	(2,210)	(2,035)	(1,783)	(1,699)	(1,934)
Mining	Count	176	151	186	170	177
	%	25.8	32.1	44.7	45.2	43.6
	Total	(683)	(471)	(416)	(376)	(406)
Construction	Count	252	469	543	679	1,251
	%	6.5	11.5	15.2	19.4	26.0
	Total	(3,894)	(4,085)	(3,572)	(3,498)	(4,819)
Manufacturing,	Count	2,102	2,600	2,589	2,579	2,921
Durable Goods	%	28.8	38.5	45.0	48.6	52.3
	Total	(7,310)	(6,746)	(5,757)	(5,305)	(5,583)
Manufacturing,	Count	1,032	1,513	1,736	1,664	1,783
Non-Durable Goods	%	21.3	31.7	41.0	46.0	51.5
	Total	(4,847)	(4,766)	(4,229)	(3,621)	(3,460)
Transportation	Count	444	633	852	865	1,093
	%	21.1	29.9	39.9	40.8	42.7
	Total	(2,109)	(2,115)	(2,137)	(2,119)	(2,557)
Communications	Count	494	583	659	656	831
	%	54.3	72.4	81.4	82.1	82.6
	Total	(909)	(805)	(810)	(799)	(1,006)
Utilities and	Count	230	286	366	318	347
Sanitary Services	%	35.9	48.7	62.9	64.0	63.9
	Total	(640)	(587)	(582)	(497)	(543)
Wholesale Trade	Count	716	1,093	1,219	1,263	1,490
	%	28.0	41.2	52.0	55.9	60.4
	Total	(2,559)	(2,650)	(2,345)	(2,261)	(2,466)
Retail Trade	Count	1,467	2,414	3,215	3,406	4,489
	%	14.5	24.3	33.2	37.9	41.8
	Total	(10,092)	(9,928)	(9,682)	(8,979)	(10,729)
Finance, Insurance,	Count	2,201	3,023	3,153	2,941	3,570
and Real Estate	%	55.8	70.9	80.0	81.5	81.8
	Total	(3,942)	(4,261)	(3,943)	(3,609)	(4,364)

Table 17. Computer Usage in All Major Industries in the Private Sector, 1984-2001 (Continued)
% within Major Industry

Private Household Service	Count	6	5	11	15	34
	%	0.9	1.1	2.1	3.8	9.2
	Total	(653)	(454)	(513)	(395)	(371)
Business and Repair Services	Count	803	1,507	1,581	2,013	2,829
	%	25.7	39.4	46.7	54.0	59.5
	Total	(3,122)	(3,825)	(3,384)	(3,730)	(4,758)
Personal, Except Private Household Services	Count	152	262	376	486	723
	%	7.9	13.8	22.3	29.5	35.6
	Total	(1,926)	(1,898)	(1,687)	(1,648)	(2,032)
Entertainment and Recreation	Count	86	160	244	329	517
	%	12.7	24.2	32.6	39.5	48.4
	Total	(677)	(662)	(749)	(833)	(1,068)
Hospitals	Count	654	1,148	1,440	1,377	1,740
	%	34.5	54.3	64.3	68.8	71.9
	Total	(1,897)	(2,115)	(2,239)	(2,001)	(2,421)
Medical, except hospitals	Count	262	675	987	1,327	1,864
	%	13.4	29.2	38.1	47.6	55.7
	Total	(1,961)	(2,315)	(2,588)	(2,787)	(3,348)
Educational	Count	319	524	624	821	1,155
	%	29.3	44.7	53.2	62.6	70.9
	Total	(1,090)	(1,172)	(1,174)	(1,311)	(1,630)
Social Services	Count	51	180	296	417	690
	%	7.8	19.1	25.1	31.3	43.9
	Total	(657)	(940)	(1,178)	(1,332)	(1,570)
Other Professional Services	Count	751	1,432	2,009	2,134	2,740
	%	35.4	56.9	70.4	76.4	82.0
	Total	(2,120)	(2,515)	(2,855)	(2,795)	(3,343)
Forestry and Fisheries	Count	4	9	8	14	25
	%	7.4	14.3	14.5	30.4	35.7
	Total	(54)	(63)	(55)	(46)	(70)
	Count	12,294	18,842	22,345	23,759	30,792
	%	23.0	34.6	43.2	47.9	52.7
	Total	(53,352)	(54,408)	(51,678)	(49,641)	(58,478)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Before I look at the trend in computer usage in each industry over time, I want to examine the base year of 1984 because computer usage existed prior to 1984 and our earliest date is 1984, which in effect captures the accumulation of computer usage prior to 1984. In other words, some industries were early adopters of computers likely due to the type of work being done, the percentage of knowledge workers, and the amount of information utilized in these industries. Thus, I will indicate the level of computer usage in 1984 as shown in Table 14 to identify early adopters of computer usage. As presented in Table 14, the industries of 'Finance, Insurance, and Real Estate' and 'Transportation, Communications, and Public Utilities' were clearly the early users of computers as 'Finance, Insurance, and Real Estate' had almost 56% of their workforce using computers in 1984 and 'Transportation, Communications, and Public Utilities' had almost 32% of workers using computers in 1984. Zaslow (1985) reported multiple reasons for quick adoption of computers in the finance industry. In brokerages, computers made it easier to take financial orders, give customer account history, and reduce the process of completing trades. In the futures and options industries, competition, lower profits, and an increased volume of orders led to computer adoption (Zaslow 1985). In real estate, Swallow (1985) claimed that computers had less application as they were mainly used for records, lists, and billing; however, a large number of computer programs have been developed to do all sorts of things from appraisals to mortgages to financial predictions. In Insurance, Prial (1982) claimed that computers had influenced the industry. Therefore, the industries of 'Finance, Insurance, and Real Estate' were early adopters of computers, since these industries are information and knowledge-related industries with a higher

percentage of knowledge workers. Further examining computer usage in 1984 as shown in Table 14, the mid-range adopters of computers were the industries of 'Services' at almost 22%, 'Mining, Construction, Manufacturing, Forestry, and Fisheries' above 21%, and 'Wholesale and Retail Trade' above 17%. Not surprisingly, 'Agriculture' was a weak early adopter with over 4% of agricultural workers using the computer in 1984. This was due to the nature of agricultural work that is often outside and is often physical in nature. Additionally, there are factors which limit the adoption of computers in Agriculture. Putler and Zilberman (1988) found that farmers with smaller farms, older farmers, farmers with lower education, and farmers who do not own a farm-related business are less likely to adopt computers. Ascough, Jr., et al. (1999) also found that older farmers, farmers with more experience, less education, farmers with lower gross incomes, and farmers with smaller operations were less likely to adopt computers. However, the cost and the lack of need (not necessary) were attitudinal reasons not to adopt computers.

Examining computer usage within each industry, Table 14 or Figures 3 to 8 showed that computer usage increased over time within each major industry. Examining computer usage over two time periods from 1984 to 1993 and 1993 to 2001, there was a definitive percentage increase in all industries from 1984 to 1993. However, from 1993 to 2001, the percentage increased more slowly in all industries except 'Agriculture' in 2001. Additionally, the nature of the increase in computer usage varied across industry from 1993 to 2001. For example, the increase in computer usage in 'Transportation, Communications, and Public Utilities' and 'Finance, Insurance, and Real Estate' from 1993 to 2001 were slight (Table 14 or Figures 4 and 6), but these industries had early adoption and established a larger base of computer users. It is also possible that

computers had reached near full application at this point in both of these industries. As a result, there was little new adoption of computers that took place from 1993 to 2001 in these two industries. However, as technology develops in the future and is applied to new tasks, computer adoption may increase once again in 'Finance, Insurance, and Real Estate' and 'Transportation, Communications, and Public Utilities.'

In the industries of 'Agriculture,' 'Wholesale and Retail Trade,' 'Services,' and 'Mining, Construction, Manufacturing, Forestry and Fisheries,' the increases in computer usage from 1993 to 2001 were larger. The percentage increase in computer usage at each time point from 1993 to 2001 ranged from above 3% to below 5% in the industries of 'Wholesale and Retail Trade' and 'Mining, Construction, Manufacturing, Forestry and Fisheries' as shown in Table 14. In 'Services,' the increase at each time point from 1993 to 2001 ranged from 6.5 to 7.0 percent as shown in Table 14. The industry of 'Agriculture' was more unusual with an increase of 2.7% from 1993 to 1997 and an increase of 10.3% from 1997 to 2001 as shown in Table 14. Additionally, these industries also had not reached 50% computer usage by 1993 unlike 'Finance, Insurance, and Real Estate' and 'Transportation, Communications, and Public Utilities;' thus allowing for the possibility of larger percentage gains in computer usage after 1993. In 'Agriculture,' adoption of computers was delayed before 1993 due to the nature of agricultural work. So with a lower base of computer usage and common adoption of computers still in the process of taking place, it was possible to have a larger percentage increase from 1993 to 2001. A similar argument applies for the mid-range adopters in the industries of 'Wholesale and Retail Trade,' 'Mining, Construction, Manufacturing, Forestry, and Fisheries,' and 'Services.' These industries were also later adopters of computers with

lower bases from 1984 to 1993, which allowed for larger percentage point gains from 1993 to 2001. Thus, the increase in computer usage in each industry was never steady from 1984 to 2001. Noticeable gains in computer usage were made from 1984 to 1993 in all industries in Table 14; but slowed in all industries except 'Agriculture' after 1993. Variation in computer usage by industry is very likely due to different degrees of knowledge work in each industry. The existence of knowledge work can also influence the applicability of computers to different types of tasks, as computers are more applicable to work tasks involving knowledge.

In Tables 15 and 16, I break out the heterogeneous industries of 'Services' and 'Mining, Construction, Manufacturing, Forestry, and Fisheries' to show the variation in computer usage within these industries from 1984 to 2001. As presented in Table 15, there is great variation in the percentage of computer usage based on the different industries that compose the service industry. Particularly 'Private Household Service,' but also 'Personal, Except Private Household Services' and 'Social Services,' had lower computer usage than the other industries that compose the service industry. Those service industries with higher rates of computer usage in 1984, representing 20% or more, also had higher computer usage by reaching 50% by 2001. These industries were as follows: 1) Business and Repair Services, 2) Hospitals, 3) Educational, and 4) Other Professional Services. Each of these service industries except Repair Services requires professional skills, requires formal educational training for job placement, and requires mental labor to perform duties. The lone exception is 'Medical, Except Hospitals' that reached 50% by 2001, but had just over 13% computer usage in 1984. Such a large increase is likely due to the use of knowledge and information in the medical profession

as well as the significant technological developments in the medical field in the past 20 years. Otherwise, those service industries that had computer usage below 20% in 1984, failed to reach 50% computer usage by 2001. They were: 1) Private Household Service, 2) Personal, Except Private Household Services, 3) Entertainment and Recreation, and 4) Social Services.

In Table 16, I break up each of the industries of 'Mining, Construction, Manufacturing, Forestry, and Fisheries' into: 1) Mining, 2) Construction, 3) Manufacturing, Durable Goods, 4) Manufacturing, Non-Durable Goods, and 5) Forestry and Fisheries to more closely examine computer usage within each industry. In every case except 'Mining,' computer usage increased at each time point to the next from 1984 to 2001. Mining experienced a decrease in computer usage from 1997 to 2001, but otherwise experienced increases in computer usage. Comparing across industries, Construction in all years and Forestry and Fisheries have noticeably lower computer usage than Mining and the two categories of Manufacturing. They were the only two industries not to reach 40% computer usage by 1993; however, Forestry and Fisheries did reach 30% computer usage by 1997. Construction was the only industry to fail to reach 30% computer usage by 2001. Construction is less likely to utilize computers because the tasks involve the process of building structures or operating heavy machinery, such as compactors, off highway trucks, multi-terrain loaders, and backhoes, neither of which utilize personal computers. The same is true of forestry that deals with growing and harvesting trees. Additionally, much of the work in these two industries occurs outside away from an indoor environment, where computers operate. Because of the outside nature of these industries, it will be difficult for computer usage to become dominant both

in terms of whether a worker uses the computer and the amount of time spent on the computer. While Mining occurs outdoors, it often can occur underground, as Mining can use computers to search for minerals and gems. For example, Barkume (1992/93) noted that in mining computers are used in firms and also are used in the actual mining process, such as analysis of ore samples. In relation to manufacturing, Barkume (1992/93) claimed that manufacturing used computer-integrated manufacturing (CIM) to computerize the whole manufacturing process from design to inventory. Thus, computers have been integrated into the process of Manufacturing, and manufacturing occurs indoors which facilitates computer usage, which would explain why manufacturing was the only industry in its industry category to reach 50% computer usage by 2001.

Diffusion of Internet Usage by Industry

As shown in Table 18, examination of Internet usage within each major industry reveals the same significant increase as the increase in the overall trend. In particular in Table 18, Internet usage increased from 3.6% in 1993 to 21.4% in 1997 in 'Agriculture;' increased from 10.3% in 1993 to 33.4% in 1997 in 'Transportation, Communications, and Public Utilities;' increased from 4.9% in 1993 to 21.9% in 1997 in 'Wholesale and Retail Trade;' increased from 8.6% in 1993 to 30.4% in 1997 in 'Finance, Insurance, and Real Estate;' increased from 8.2% in 1993 to 36.1% in 1997 in 'Services;' and increased from 7.6% in 1993 to 35.3% in 1997 in 'Mining, Construction, Manufacturing, Forestry, and Fisheries.' Therefore, Internet usage had a very significant increase in percent usage from 1993 to 1997 in all industries. When 2001 is considered, the same large increase occurs from 1997 to 2001 as was expressed in the overall trend. More specifically in

Table 18, 62.1% of workers in 'Agriculture' used the Internet or email in 2001 compared to 21.4% that used the Internet only in 1997; 72.9% of workers in 'Transportation, Communications, and Public Utilities' used the Internet or email in 2001 compared to 33.4% that used the Internet only in 1997; 58.7% of workers in 'Wholesale and Retail Trade' used the Internet or email in 2001 compared to 21.9% who used the Internet only in 1997; 81.7% of workers used the Internet or email in 'Finance, Insurance, and Real Estate' relative to 30.4% of workers that used the Internet only in 1997; 72.0% of workers in 'Services' used the Internet or email in 2001 relative to 36.1% who used the Internet in 1997; and 72.4% of workers used the Internet or email in 'Mining, Construction, Manufacturing, Forestry, and Fisheries' in 2001 relative to 35.3% of workers that used the Internet only in 1997. While the Internet measure for 2001 consists of both Internet or email usage, the results within each industry also show an increase from 1997 to 2001. Additionally, it shows that Internet usage was continually adopted at a very quick pace from 1993 to 2001. Existing computer usage provided the technological foundation for very quick adoption of the Internet. Additionally, the occurrence of the economic boom in the late 1990s; the existence and expansion of the telecommunication infrastructure; the desire to remain competitive; and the optimism of incredible market growth in the new economic medium of the Internet were other factors that were important for the very fast adoption of the Internet. Therefore, the Internet was uniformly adopted at a very quick pace relative to past technological revolutions and this was true in each industry.

Table 18. Internet Usage by Industry for Private Employees, 1993-2001
% within Year

		Year		
Major Industry		1993	1997	2001
Agriculture	Count	9	61	325
	%	3.6	21.4	62.1
	Total	(251)	(285)	(523)
Transportation, Communications, & Public Utilities	Count	193	614	1,656
	%	10.3	33.4	72.9
	Total	(1,877)	(1,839)	(2,271)
Wholesale and Retail Trade	Count	219	1,023	3,511
	%	4.9	21.9	58.7
	Total	(4,434)	(4,669)	(5,979)
Finance, Insurance & Real Estate	Count	270	894	2,917
	%	8.6	30.4	81.7
	Total	(3,153)	(2,941)	(3,570)
Services	Count	624	3,223	8,849
	%	8.2	36.1	72.0
	Total	(7,568)	(8,919)	(12,292)
Mining, Construction, Manufacturing, Forestry & Fisheries	Count	387	1,803	4,460
	%	7.6	35.3	72.4
	Total	(5,062)	(5,106)	(6,157)

Source: Current Population Survey, October 1993, 1997, and September 2001

Diffusion of Computer Usage by Part-Time and Full-Time Workers

In the CPS, full-time workers were defined as those who either worked 35 or more hours per week; those who did not work 35 hours, but typically do; or those not at work, but usually work 35 hours or more. Part-time workers were defined as those who typically work less than 35 hours per week. As presented in Table 19, computer usage increases over time for both part-time and full-time workers from 1984 to 2001.

However, there is quite a disparity in the percent computer usage between part-time and full-time workers, as part-time workers are considerably less likely to use the computer at work than full-time workers in all years. The difference in computer usage between part-time and full-time workers is 14.6% or higher in all years, and is over 18% from 1989 to 1997. The difference in computer usage between full-time and part-time workers is likely due to greater investment and trust in full-time workers than part-time workers, the potential of full-time positions to take on greater responsibility, and the performance of more critical tasks related to the organization that requires use of a computer by full-time workers.

Table 19. Computer Usage at Work for Full-Time and Part-Time Workers in the Private Sector, 1984-2001

diff is % difference between part-time and full-time workers
% within Year

		Year				
FT/PT Employment		1984	1989	1993	1997	2001
Part-Time	Count	1,086	1,676	2,418	2,838	3,958
	%	10.9	19.2	27.6	32.8	40.5
	Total	(9,956)	(8,730)	(8,756)	(8,654)	(9,776)
Full-Time	Count	11,208	17,166	19,927	20,921	26,834
	%	25.8	37.6	46.4	51.0	55.1
	Total	(43,396)	(45,678)	(42,922)	(40,987)	(48,702)
	% diff	14.9	18.4	18.8	18.2	14.6

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

As shown in Table 20, I have computer usage at work by industry for part-time and full-time workers from 1984 to 2001. Except for a minuscule decrease in the

percentage of full-time workers in 'Finance, Insurance, and Real Estate' from 1997 to 2001, computer usage increased from 1984 to 2001 among both part-time and full-time workers in each major industry, which corresponds with the overall trend. Full-time workers are considerably more likely to use computers at work than part-time workers from 1984 to 2001 except for the industries of 'Agriculture' from 1989 to 2001; 'Transportation, Communications, and Public Utilities' in 2001; and 'Mining, Construction, Manufacturing, Forestry and Fisheries' in 2001. Even though the overall difference in computer usage between full-time and part-time workers varies from nearly 15% to nearly 19% as shown in Table 20, there is greater variation within industry. I will examine the decrease in the difference between full-time and part-time workers over time first, then no change in the difference between full-time and part-time workers, and finally the increase in the difference between full-time and part-time workers over time (for specific details see Table 20). The gap in computer usage among part-time and full-time workers has increased in some industries and it has decreased in other industries. This suggests that use of computers among part-time and full-time workers varies in nature based on the type of industry, the type of work performed in each industry, and how the work is organized in a specific industry.

Table 20. Computer Usage at Work by Industry for Full-Time and Part-Time Workers in the Private Sector. % within Major Industry and diff is % difference between part-time and full-time workers

		Computer at Work					
		1984		1989		1993	
Major Industry		PT	FT	PT	FT	PT	FT
Agriculture	Count	10	82	26	149	38	213
	%	2.4	4.6	8.2	8.7	13.2	14.2
	n	(414)	(1,796)	(318)	(1,717)	(287)	(1,496)
	% diff		2.2		0.5		1.0
Transportation,	Count	60	1,108	88	1,414	116	1,761
Communications	%	19.0	33.1	29.3	44.1	37.7	54.7
& Public Utilities	n	(315)	(3,343)	(300)	(3,207)	(308)	(3,221)
	% diff		14.1		14.8		17.0
Wholesale &	Count	286	1,897	389	3,118	635	3,799
Retail Trade	%	8.2	20.7	13.1	32.5	20.9	42.2
	n	(3,487)	(9,164)	(2,979)	(9,599)	(3,033)	(8,994)
	% diff		12.5		19.4		21.3
Finance,	Count	175	2,026	216	2,807	280	2,873
Insurance &	%	36.2	58.6	45.9	74.1	58.6	82.9
Real Estate	n	(483)	(3,459)	(471)	(3,790)	(478)	(3,465)
	% diff		22.3		28.2		24.3
Services	Count	446	2,638	803	5,090	1,159	6,409
	%	11.4	25.9	21.2	42.0	30.2	51.1
	n	(3,919)	(10,184)	(3,783)	(12,113)	(3,835)	(12,532)
	% diff		14.5		20.8		20.9
Mining,	Count	109	3,457	154	4,588	190	4,872
Construction,	%	8.1	22.4	17.5	30.1	23.3	36.9
Manufacturing,	n	(1,338)	(15,450)	(879)	(15,252)	(815)	(13,214)
Forestry & Fish.	% diff		14.2		12.6		13.6
All	Count	1,086	11,208	1,676	17,166	2,418	19,927
Industries	%	10.9	25.8	19.2	37.6	27.6	46.4
	n	(9,956)	(43,396)	(8,730)	(45,678)	(8,756)	(42,922)
	% diff		14.9		18.4		18.8

Table 20. Computer Usage at Work by Industry for Full-Time and Part-Time Workers
in the Private Sector (continued)

	Computer at Work			
	1997		2001	
Major Industry	PT	FT	PT	FT
Agriculture	54	231	105	418
	14.6	17.4	27.3	27.0
	(371)	(1,328)	(385)	(1,549)
		2.8		-0.3
Transportation,	127	1,712	173	2,098
Communications	40.6	55.2	48.3	56.0
& Public Utilities	(313)	(3,102)	(358)	(3,748)
		14.6		7.7
Wholesale &	671	3,998	937	5,042
Retail Trade	24.2	47.2	29.5	50.3
	(2,771)	(8,469)	(3,179)	(10,016)
		23.0		20.9
Finance,	285	2,656	392	3,178
Insurance &	64.3	83.9	69.1	83.7
Real Estate	(443)	(3,166)	(567)	(3,797)
		19.6		14.6
Services	1,466	7,453	2,040	10,252
	37.0	57.9	46.0	63.7
	(3,966)	(12,866)	(4,438)	(16,103)
		21.0		17.7
Mining,	235	4,871	311	5,846
Construction,	29.7	40.4	36.6	43.3
Manufacturing,	(790)	(12,056)	(849)	(13,489)
Forestry &				
Fisheries		10.7		6.7
All	2,838	20,921	3,958	26,834
Industries	32.8	51.0	40.5	55.1
	(8,654)	(40,987)	(9,776)	(48,702)
		18.2		14.6

Source: Current Population Survey, October 1984, 1989, 1993, 1997 and September 2001

As shown in 'Finance, Insurance, and Real Estate' in Table 20, the difference between full-time and part-time workers is over 20% between 1984 to 1993, but drops to a difference of 19.6% in 1997 and further drops to over 14.6% in 2001. Thus, the difference in computer usage between part-time and full-time workers in 'Finance, Insurance, and Real Estate' reaches a zenith in 1989 and decreases steadily there afterwards. The reason for the decrease in the difference in computer usage between part-time and full-time workers in 'Finance, Insurance, and Real Estate' is unknown. One possibility might be that as computer usage expanded and reached full potential in the industries of 'Finance, Insurance, and Real Estate,' part-time workers were more likely to use computers. However, as computer usage reached 80% in 'Finance, Insurance, and Real Estate' in 1993, the difference in computer usage between part-time and full-time workers in 1993 was approximately 24%, the largest difference in all industries in 1993. This demonstrates that such a proposition is indeed false, since if 'Finance, Insurance, and Real Estate' had reached full potential, part-time workers would be expected to have been more involved in computer usage.

As presented in Table 20, 'Transportation, Communications, and Public Utilities' also experienced a decrease in the difference in computer usage between part-time and full-time workers from 1984 to 2001; however, the decrease did not happen until 2001 when the percent difference dropped to just over 7% versus under 15% from 1984 to 1997 except for 1993, when it was 17%. The reduction in the difference in computer usage between part-time and full-time workers cannot be explained by a rising percentage in overall computer usage, since there has been little increase in computer usage in

'Transportation, Communications, and Public Utilities' from 1993 to 2001. Thus, the decrease in computer usage between part-time and full-time workers is unknown and is not a result of computer usage becoming dominant with the consequence that part-time workers would have greater computer access.

As presented in Table 20, the difference in computer usage among part-time and full-time workers in 'Mining, Construction, Manufacturing, Forestry, and Fisheries' experienced a decrease from a high of just over 14% in 1984 to a low of 6.7% in 2001. However, the difference did stabilize at about 13% from 1989 to 1993. Since overall computer usage has continued to increase from 1984 to 2001, it is possible that the decrease in the difference in computer usage between part-time and full-time workers is due to continued adoption which has recently benefited part-time workers more as adoption has evened out among both part-time and full-time workers; however, why it took until 2001 to reduce the difference in computer usage between part-time and full-time workers is a mystery.

As shown in Table 20, Agriculture was the only industry that I term as having 'no difference' in computer usage between part-time and full-time workers from 1984 to 2001. Agriculture was unusual as the difference in computer usage between part-time and full-time workers ranged from -0.3% in 2001 to 2.8% in 1997, far below the difference in computer usage between part-time and full-time workers in comparison to the other industries. Agriculture is unusual for a few reasons. First, it is less likely to use computers than any other industry and thus will take the longest time to adopt computers. This is likely due to the type of work that is done, where growth and maintenance of crops and taking regular care of live stock are less likely to use computers than other

industries. Second, lack of early adoption due to limitations in the ability to find use for the computer may also explain why there is little difference in computer usage between part-time and full-time workers. However, there is evidence that future application of the computer may make the computer more useable in 'Agriculture.' For example, application of computing technology to agriculture is being developed, such as identification of apples by robotic harvesting (Bulanon, et al. 2002); use of 'Land Resource Geographic Information System (LR-GIS)' to appraise land resources (Cochrane and Cochrane 2001); computer programs to examine physiology and biochemistry data to identify yeast in food (Velanzquez, et al. 2001); and acoustic technology to detect cracks in egg shells (Cho, Choi and Paek 2000).

Now we get to those industries that experienced an increase in the difference in computer usage between part-time and full-time workers from 1984 to 2001 (Table 20). The industries of 'Wholesale and Retail Trade' and 'Services' experienced an increase in the difference in computer usage among part-time and full-time workers from 1984 to 2001. In 'Wholesale and Retail Trade,' which consisted of industry codes 09 'Wholesale Trade' and 10 'Retail Trade,' the difference in computer usage between part-time and full-time workers was 12.5% in 1984, but increased to 19.4% in 1989, and increases to over 20% from 1993 to 2001. In the 'Service' industry, the difference in computer usage between part-time and full-time workers was 14.5% in 1984, but quickly jumped to about 21% in 1989 to 1997, and subsequently decreased to below 18% in 2001. The 'Service' industry was defined to include industry codes 12 'Private Households,' 13 'Business and Repair,' 14 'Personal Services, Except Private Household,' 15 'Entertainment and Recreations,' 16 'Hospitals,' 17 'Medical, Except Hospitals,' 18 'Educational,' 19 'Social

Services,' and 20 'Other Professional.' I am not sure why there is an increase in the difference in computer usage between part-time and full-time workers. But for some reason, computer adoption is favoring full-time workers in both 'Wholesale and Retail Trade' and the 'Service' industry.

One possibility is that the industries of 'Wholesale and Retail Trade' and 'Services' are more likely to be in the secondary labor market. According to Andersen and Taylor (2005:405), the secondary labor market includes jobs that have "…low wages, few benefits, high turnover, poor working conditions, little opportunity for advancement, no job protection, and arbitrary treatment of workers." Growth of a secondary labor market would be consistent for the Service industry. For example, Howell and Wolff (1991) examined 64 industries from 1960 to 1985 and found that low-skill jobs were growing more quickly in the service industry (Henwood 2003). Growth in low-skilled jobs in either the industries of 'Services' or 'Wholesale and Retail Trade' could be conceived as part of the process of economic restructuring. In other words, economic restructuring is producing both full-time jobs with more responsibility and necessary skill sets, and part-time positions with less skill, less responsibility, and fewer benefits. Table 21 showed that the industries of 'Wholesale and Retail Trade' and 'Services' had a greater relative percentage of part-time workers than all other industries. Likewise, the industries of 'Transportation, Communications, and Public Utilities,' 'Finance, Insurance, and Real Estate,' and 'Mining, Construction, Manufacturing, Forestry, and Fisheries' employed a greater relative percentage of full-time employees (Table 22). Since the industries of 'Wholesale and Retail Trade' and 'Services' also have a higher percentage of part-time workers and had an increase in the percent difference in computer usage over

time between part-time and full-time workers, this suggests that there is an increasing tendency to treat part-time workers in the 'Service' and 'Wholesale and Retail Trade' industries as contingent workers in the secondary labor market with less need to use the computer.

Table 21. Percentage of Part-Time Workers in the Private Sector by Major Industry, 1984-2001. % within Major Industry

		Percentage of Part-Time Workers				
		1984	1989	1993	1997	2001
Agriculture	Count	457	344	313	371	385
	n	(2,348)	(2,143)	(1,876)	(1,699)	(1,934)
	%	19.5	16.1	16.7	21.8	19.9
Transportation,	Count	332	315	333	313	358
Communication &	n	(3,853)	(3,735)	(3,782)	(3,415)	(4,106)
Public Utilities	%	8.6	8.4	8.8	9.2	8.7
Wholesale &	Count	3,700	3,142	3,245	2,771	3,179
Retail Trade	n	(13,404)	(13,274)	(12,814)	(11,240)	(13,195)
	%	27.6	23.7	25.3	24.7	24.1
Finance,	Count	517	492	513	443	567
Insurance &	n	(4,114)	(4,467)	(4,192)	(3,609)	(4,364)
Real Estate	%	12.6	11.0	12.2	12.3	13.0
Services	Count	4,175	4,030	4,111	3,966	4,438
	n	(15,017)	(16,839)	(17,414)	(16,832)	(20,541)
	%	27.8	23.9	23.6	23.6	21.6
Mining, Construction,	Count	1,425	931	884	790	849
Manufacturing, Forestry	n	(17,749)	(16,982)	(14,870)	(12,846)	(14,338)
& Fisheries	%	8.0	5.5	5.9	6.1	5.9
Total	Count	10,606	9,254	9,399	8,654	9,776
	n	(56,485)	(57,440)	(54,948)	(49,641)	(58,478)
	%	18.8	16.1	17.1	17.4	16.7

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Table 22. Percentage of Full-Time Workers in the Private Sector by Major Industry, 1984-2001
% within Major Industry

Major Industry		1984	1989	1993	1997	2001
Agriculture	Count	1,891	1,799	1,563	1,328	1,549
	%	80.5	83.9	83.3	78.2	80.1
	Total	(2,348)	(2,143)	(1,876)	(1,699)	(1,934)
Transportation,	Count	3,521	3,420	3,449	3,102	3,748
Communications	%	91.4	91.6	91.2	90.8	91.3
& Public Utilities	Total	(3,853)	(3,735)	(3,782)	(3,415)	(4,106)
Wholesale & Retail	Count	9,704	10,132	9,569	8,469	10,016
Trade	%	72.4	76.3	74.7	75.3	75.9
	Total	(13,404)	(13,274)	(12,814)	(11,240)	(13,195)
Finance, Insurance &	Count	3,597	3,975	3,679	3,166	3,797
Real Estate	%	87.4	89.0	87.8	87.7	87.0
	Total	(4,114)	(4,467)	(4,192)	(3,609)	(4,364)
Services	Count	10,842	12,809	13,303	12,866	16,103
	%	72.2	76.1	76.4	76.4	78.4
	Total	(15,017)	(16,839)	(17,414)	(16,832)	(20,541)
Mining, Construction,	Count	16,324	16,051	13,986	12,056	13,489
Manufacturing,	%	92.0	94.5	94.1	93.9	94.1
Forestry & Fisheries	Total	(17,749)	(16,982)	(14,870)	(12,846)	(14,338)
All Industries	Count	45,879	48,186	45,549	40,987	48,702
	%	81.2	83.9	82.9	82.6	83.3
	Total	(56,485)	(57,440)	(54,948)	(49,641)	(58,478)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

To further examine this suggestion that part-time workers are more likely to be contingent workers in the secondary labor market, let us examine the percentage of part-time knowledge workers in the industries of 'Services' and 'Wholesale and Retail Trade.' Part-time knowledge workers were defined as part-time employees in the occupations of: 1) Managerial and Professional Specialty Occupations and 2) Technical, Sales, and Administrative Support Occupations. Table 23 examined the percentage of part-time

knowledge workers by industry, and showed that over 20% knowledge workers worked part-time in 'Wholesale and Retail Trade' from 1984 to 2001, and over 20% of knowledge workers worked part-time in the 'Services' industry except for 2001, which was nearly 20%. Agriculture was the only other industry to have above 20% of part-time workers be knowledge workers. The percentage of knowledge workers in 'Wholesale and Retail Trade' and 'Services' supports the suggestion that part-time workers in the industries of 'Service' and 'Wholesale and Retail Trade' are more likely to be treated as part of the secondary labor market.

Table 23. Percentage of Part-Time Knowledge Workers in the Private Sector by Industry, 1984-2001

% within Knowledge Workers		1984	1989	1993	1997	2001
Agriculture	Count	34	43	42	57	67
	%	26.0	21.2	23.0	27.1	27.9
	Total	(131)	(203)	(183)	(210)	(240)
Transportation, Communications & Public Utilities	Count	120	139	168	161	169
	%	6.8	8.1	9.0	9.7	8.5
	Total	(1,754)	(1,719)	(1,873)	(1,654)	(1,990)
Wholesale & Retail Trade	Count	2,119	1,838	1,848	1,586	1,810
	%	24.9	21.4	22.8	22.2	21.5
		(8,506)	(8,603)	(8,121)	(7,154)	(8,427)
Finance, Insurance & Real Estate	Count	467	434	468	408	520
	%	12.1	10.4	11.9	12.0	12.7
		(3,856)	(4,184)	(3,920)	(3,403)	(4,088)
Services	Count	2,081	2,299	2,317	2,397	2,740
	%	23.1	21.2	20.4	21.2	19.5
		(9,008)	(10,857)	(11,337)	(11,329)	(14,027)
Mining, Construction, Manufacturing, Fisheries & Forestry	Count	387	377	349	366	386
	%	6.7	6.5	6.9	7.9	7.7
		(5,791)	(5,811)	(5,034)	(4,614)	(5,035)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Diffusion of Internet Usage by Part-Time and Full-Time Workers

Since one needs the computer to use the Internet, it is not surprising that the same pattern of full-time workers being more likely to use the computer than part-time workers is also true for Internet usage. In Table 24, the percentage of Internet users among full-time workers in 1993 was nearly twice the percentage of Internet users among part-time workers. However, the ratio of Internet users between full-time and part-time workers (33.3% to 22.9%) was not as large in 1997 as it was in 1993 (8.0% to 4.1%) due to a larger base among part-time workers in 1997 (22.9% to 4.1%). The percent difference between full-time and part-time employees was still noticeable at 10.4% in 1997. The percentage increase in Internet usage for both part-time and full-time workers between 1993 and 1997 was large and corresponds with the large increases in Internet usage from 1993 to 1997 for all private employees shown in Table 13 and for all private employees within industry shown in Table 18. Examining Internet usage from 1997 to 2001 in Table 24, for both part-time and full-time workers, there is a large increase in the percentage of Internet usage from 1997 to 2001, which corresponds with the large increase in overall Internet usage in Table 13 and Internet usage within industry in Table 18. However, this increase is partly due to email usage as explained earlier. Once again this demonstrates how incredibly quick and pervasive the adoption of the Internet was in the economy.

Table 24. Internet Usage by Full-Time and Part-Time Private Employees, 1993-2001
% within Year

		Year			
		1993	1997	2001	All Years
Part-Time	Count	100	650	2,261	3,011
	%	4.1	22.9	57.1	32.7
	Total	(2,418)	(2,838)	(3,958)	(9,214)
Full-Time	Count	1,602	6,968	19,457	28,027
	%	8.0	33.3	72.5	41.4
	Total	(19,927)	(20,921)	(26,834)	(67,682)

Source: Current Population Survey, October 1993 and 1997, and September 2001

Hypotheses

The goal of the first set of hypotheses is to test to what extent the rate of computer adoption varies by industry, which would signify to what extent the rate of adoption of a new mode of production varies by industry. To predict the rate of adoption in each industry at each time period, I will use the percentage of knowledge workers in each industry at each time period in Table 1. For example, those industries that have an above average percentage of knowledge workers in 1984 would be expected to have an above average rate of computer usage in 1984. The connection between knowledge work and computer usage depends on the fact that knowledge workers produce and use information

and knowledge, and subsequently communicate it to others. In this process of producing and using information and knowledge, knowledge workers utilize computers to perform their work.

The purpose of the second set of hypotheses is to test whether a New Economy exists by industry by examining the accumulation of computer diffusion over time. In the process of the adoption of a new mode of production, computer adoption is expected to continue to increase and accumulate. By examining the last data point of 2001 in Table 14, we can see the accumulated level of diffusion of computer usage over time. To show whether a New Economy exists in each major industry, computer usage must have surpassed the percentage of 50% by 2001, which represents a dominant mode of production. Once again, I used the percentage of knowledge workers in each industry to predict whether computer usage will surpass 50% by 2001 in each industry. For example, those industries that have an above average percentage of knowledge workers at each time point from 1984 to 2001 would be expected to surpass 50% computer usage by 2001. For those who are concerned that the percentage of knowledge workers will be above the average percentage of knowledge workers in some years and below the average percentage of knowledge workers in other years, need not worry, since the percentage of knowledge workers in each industry was either above the average percentage of knowledge workers for all years or was below the average percentage of knowledge workers for all years.

Hypothesis I: Rate of Increase

Description of Rates

In Table 25, rates are expressed as computer users per 1,000 workers in a particular industry. In every case in Table 25, except for 'Finance, Insurance, and Real Estate' in 2001, the rate of computer users per 1,000 workers increases from one time point to the next. The rate of computer users per 1,000 workers varies considerably between industries. In every year, 'Agriculture' has the lowest rate of computer usage and 'Finance, Insurance, and Real Estate' has the highest rate of computer usage. For example, in 1984, Agriculture has a rate of 39 computer users per 1,000 workers compared to 'Finance, Insurance, and Real Estate,' which has 538 computer users per 1,000 workers. Large variations in the number of computer users per 1,000 workers across industry exist in other years too. 'Transportation, Communications, and Public Utilities' has the second highest rate from 1984 to 1997 until 'Services' moved up one place holder to capture second place in 2001. 'Mining, Construction, Manufacturing, Forestry, and Fisheries' had the fourth highest rate from 1984 to 1993 until 'Wholesale and Retail Trade' moved up one place holder to take over the fourth place spot in 1997 to 2001.

Table 25. Rates of Computer Usage in the Private Sector by Industry, 1984-2001

Weighted to the Population

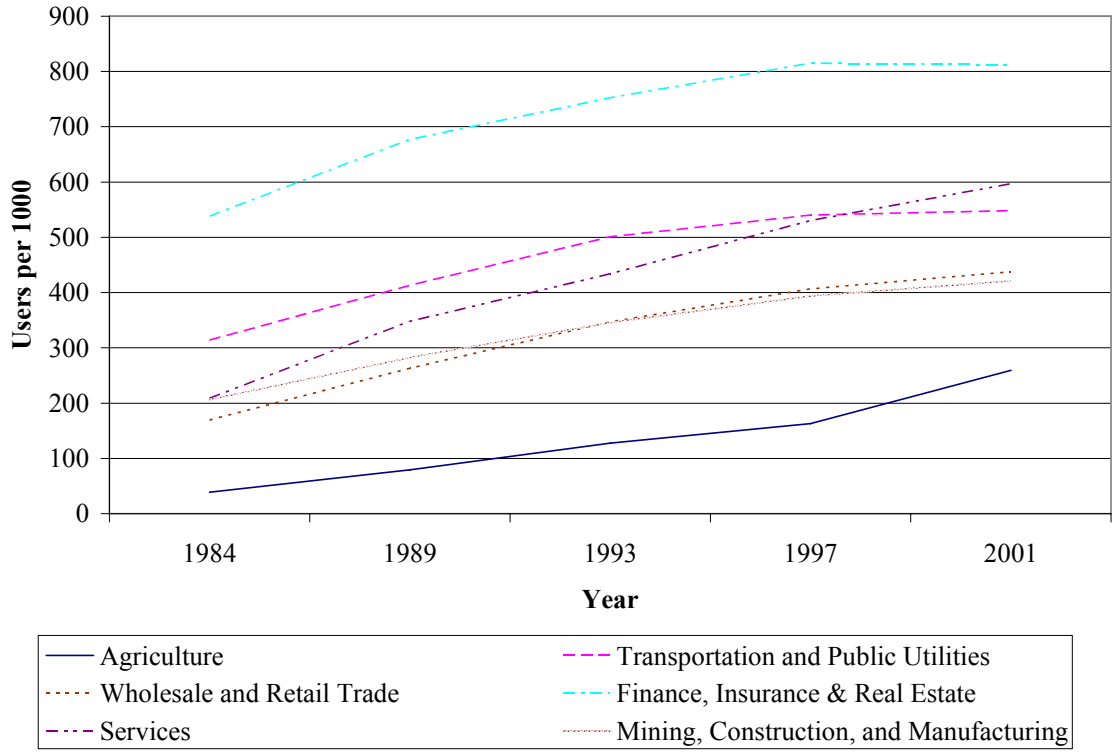
	Rate				
Industry	1984	1989	1993	1997	2001
Agriculture	39	79	128	163	259
Transportation and Public Utilities	314	413	501	540	548
Wholesale and Retail Trade	170	263	347	406	438
Finance, Insurance & Real Estate	538	677	753	815	812
Services	209	348	434	530	597
Mining, Construction, Manufacturing, Forestry and Fisheries	206	283	345	394	421
Overall Rate	224	330	410	477	520

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

In Figure 9, I have graphed the rate of computer usage in each industry from 1984 to 2001 that was expressed numerically in Table 25. One advantage of graphing the rates of computer usage by industry in Figure 9 is that the shape of the increase in the rate of computer usage can better be examined as the variation in the rate of computer usage in each industry over time. Overall, the shape of the curves for 'Transportation, Communications, and Public Utilities' and 'Wholesale and Retail Trade' in Figure 9 is very similar to noticeable increases from 1984 to 1993 and a leveling off of the rate of computer usage from 1993 to 2001 except for 'Agriculture.' A similar leveling off of the rate of computer usage occurred in 1997 for 'Finance, Insurance, and Real Estate,' but 'Finance, Insurance, and Real Estate' had continued increases from 1984 to 1997. The 'Service' industry showed the quickest and sustained increase from 1984 to 2001.

'Mining, Construction, Manufacturing, Forestry, and Fisheries' also appeared to have a sustained increase from 1984 to 2001, but the increase was small from one data point to the next. The shape of the curve for 'Agriculture' is different from the other industries because there is a noticeable increase from 1997 to 2001. In the other industries except 'Services' and 'Agriculture,' there is a leveling off of the rate of computer usage from 1997 to 2001.

Figure 9. Rates of Computer Usage in the Private Sector by Industry, 1984-2001



Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

In terms of size of the rate in Figure 9, 'Transportation, Communications, and Public Utilities' and 'Services' are fairly close to one another. However, the shapes of the

curve are different for both ‘Services’ and ‘Transportation, Communications, and Public Utilities.’ The shape of the curve for ‘Transportation, Communications, and Public Utilities’ is flatter than the curve for ‘Services.’ The rate of computer usage for ‘Transportation, Communications, and Public Utilities’ begins above the rate for ‘Services.’ However, the difference between the curves decreases over time from 1984 to 1997 when the curve for ‘Transportation, Communications, and Public Utilities’ flattens out and the curve for ‘Services’ continues to increase. The curves converge in 1997, and afterwards, the curve for ‘Transportation, Communication, and Public Utilities’ flattened out and the curve for ‘Services’ continued to increase.

In terms of size of the rate in Figure 9, ‘Wholesale and Retail Trade’ and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ are positioned very close to one another. The rate of computer usage for ‘Wholesale and Retail Trade’ grew at a quicker rate than the rate of computer usage for ‘Mining, Construction, Manufacturing, Forestry, and Fisheries.’ This can be seen in the lower rate of computer usage in ‘Wholesale and Retail Trade’ relative to ’Mining, Construction, Manufacturing, Forestry and Fisheries’ in 1984 and 1989, and the higher rate of computer usage in ‘Wholesale and Retail Trade’ relative to ’Mining, Construction, Manufacturing, Forestry and Fisheries’ in 1997 and 2001 in Figure 9.

I also created Figure 2, which demonstrates whether the industry is above or below the mean rate of computer usage for a particular year. Figure 2 will also be useful to assessing the evidence for hypothesis 1, as it shows computer usage for an industry relative to the overall computer usage for the private sector. More specifically in Figure 2, ‘Finance, Insurance, and Real Estate,’ ‘Transportation, Communications, and Utilities,’

and ‘Services’ except for 1984 are above the overall rate of computer usage for each year. As expected, ‘Finance, Insurance, and Real Estate’ is well above the mean rate of computer usage in all industries in all years, since ‘Finance, Insurance, and Real Estate’ has very high computer usage. Computer usage in ‘Finance, Insurance, and Real Estate’ was nearly 300 users above the mean in 2001 and more than 300 users above the mean from 1984 to 1997 (see Figure 2). The industries of ‘Transportation, Communications, and Public Utilities’ and ‘Services’ from 1989 to 2001 are much closer to the overall rate of computer usage. In the case of both ‘Services’ from 1989 to 2001 and ‘Transportation, Communications, and Public Utilities’ from 1984 to 2001, the rate of computer usage was less than 100 users from the mean rate of computer users in Figure 2. The industries of ‘Wholesale and Retail Trade,’ ‘Mining, Construction, Manufacturing, Forestry, and Fisheries,’ and ‘Agriculture’ are all below the overall rate of computer usage for every year. Not surprisingly, the rate of computer usage in ‘Agriculture’ was well below the average rate of computer usage for all years. Agriculture also had the greatest variation from the mean rate of computer usage over time. Agriculture ranged from under 200 computer users below the mean rate of computer usage in 1984 to over 300 computer users below the mean rate of computer usage in 1997 in Figure 2. The industries of ‘Wholesale and Retail Trade’ and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ are much closer to the mean rate of computer usage in all years. In the industries of ‘Wholesale and Retail Trade’ and ‘Mining, Construction, Manufacturing, Forestry, and Fisheries,’ the rate of computer users was under 100 computer users below the mean rate of computer users in all years in Figure 2.

Support for Hypothesis I

In relation to determining support for the first set of hypotheses, I will compare the percentage of knowledge workers in a particular industry in a given year relative to the mean percentage of knowledge workers for all private workers in a particular year. Thus, in any given year, I am assuming that if the percentage of knowledge workers in a given industry is above the mean percentage of knowledge workers, then the rate of computer adoption in that given industry would be expected to be above the mean rate of computer adoption. To clarify, I will provide an example of 'Services' in 1984 in Table 1. The percentage of knowledge workers in 'Services' in 1984 is 60.0%, which is above the mean percentage of knowledge workers of 51.4% in 1984, thus I predict that the rate of computer adoption in 'Services' in 1984 will be above the average rate of computer adoption in 1984.

The expectation for hypothesis 1a was that Agriculture would have a lower rate of computer adoption than the average rate of computer adoption for each year because Agriculture has a lower percentage of knowledge workers than the overall percentage of knowledge workers in the private sector for each year in Table 1. Examining Table 25 or Figure 2, Hypothesis 1a was supported in every case, since 'Agriculture' had fewer computer users per 1,000 agricultural workers than the overall rate of computer users per 1,000 workers in the private sector of the economy for each year. Agriculture focuses on cultivating and extracting natural resources from the environment. Natural plants are grown, cultivated, and later harvested for their natural plant resources. As a result, use of the personal computer would be limited to mainly desk jobs, which are indoors, separated from much of agricultural work, which is outdoors. Or computers would be used in those

jobs requiring some type of monitoring of specific agricultural activities, such as how much food certain cows receive, or temperature and lighting control in a modern chicken coop.

In relation to hypothesis 1b, 'Transportation, Communications and Public Utilities' was expected to be below the average rate of computer adoption because it had a lower percentage of knowledge workers than the overall percentage of knowledge workers in each year in Table 1. However, upon examination of Table 25 or Figure 2, hypothesis 1b should be rejected, since 'Transportation, Communications, and Public Utilities' had an above average rate of computer users per 1,000 workers in each year. However, from more detailed examination of the rate of computer usage within 'Transportation, Communications, and Public Utilities' in Table 26, the rate of computer usage is higher than expected because of above average computer usage in both the industries of Communications and Public Utilities. There is also a good reason for a lower percentage of knowledge workers in 'Transportation, Communications, and Public Utilities.' In Table 9, 'Transportation' had a much higher number of workers than 'Communications' and 'Public Utilities;' in Table 27, 'Transportation' had a much lower percentage of knowledge workers than the other two industries of 'Communications' and 'Public Utilities.' Thus, 'Transportation' carries a much larger weight in the major industry category of 'Transportation, Communications, and Public Utilities,' and subsequently produces a lower percentage of knowledge workers for

Table 26. Rates of Computer Usage within All Major Industries, 1984-2001

	1984	1989	1993	1997	2001
Agriculture	38	79	128	163	259
Mining	287	298	446	455	448
Construction	60	109	145	194	249
Manufacturing, Durable Goods	278	369	433	484	513
Manufacturing, Non-Durable Goods	202	306	391	447	507
Transportation	202	293	367	411	423
Communications	556	684	782	815	812
Utilities and Sanitary Services	329	474	607	634	631
Wholesale Trade	269	390	491	543	586
Retail Trade	144	229	312	372	404
Finance, Insurance, and Real Estate	538	677	753	815	812
Private Household Service	5	9	15	38	96
Business and Repair Services	240	368	434	539	597
Personal, Except Private Household Services	81	117	205	284	360
Entertainment and Recreation	128	227	301	400	494
Hospitals	329	522	608	694	716
Medical, except hospitals	134	278	366	473	553
Educational	274	410	503	627	700
Social Services	74	183	236	301	424
Other Professional Services	328	547	670	769	814
Forestry and Fisheries	98	110	109	208	265
All Industries	224	330	410	477	520

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Table 27. Knowledge Workers in All Major Industries of the Private Sector, 1984-2001
% within Major Industry

		1984	1989	1993	1997	2001
Agriculture	Count	131	203	183	210	240
	%	5.6	9.5	9.8	12.4	12.4
	Total	(2,348)	(2,143)	(1,876)	(1,699)	(1,934)
Mining	Count	280	175	157	130	134
	%	39.5	35.8	36.2	34.6	33.0
	Total	(709)	(489)	(434)	(376)	(406)
Construction	Count	821	960	806	857	1,041
	%	19.8	22.2	21.0	24.5	21.6
	Total	(4,139)	(4,319)	(3,834)	(3,498)	(4,819)
Manufacturing,	Count	2,828	2,836	2,313	2,100	2,299
Durable Goods	%	36.6	40.0	38.2	39.6	41.2
	Total	(7,732)	(7,097)	(6,055)	(5,305)	(5,583)
Manufacturing,	Count	1,857	1,833	1,753	1,519	1,550
Non-Durable Goods	%	36.3	36.6	39.1	41.9	44.8
	Total	(5,109)	(5,007)	(4,485)	(3,621)	(3,460)
Transportation	Count	760	780	897	775	919
	%	33.9	34.4	38.6	36.6	36.0
	Total	(2,244)	(2,270)	(2,325)	(2,119)	(2,556)
Communications	Count	652	633	647	623	765
	%	69.7	74.2	76.1	78.0	76.0
	Total	(936)	(853)	(850)	(799)	(1,006)
Utilities and	Count	342	306	329	256	306
Sanitary Services	%	50.8	50.0	54.2	51.5	56.4
	Total	(673)	(612)	(607)	(497)	(543)
Wholesale Trade	Count	1,931	2,038	1,774	1,575	1,751
	%	72.0	72.8	71.5	69.7	71.0
	Total	(2,682)	(2,801)	(2,480)	(2,261)	(2,466)
Retail Trade	Count	6,575	6,565	6,347	5,579	6,676
	%	61.3	62.7	61.4	62.1	62.2
	Total	(10,722)	(10,473)	(10,334)	(8,979)	(10,729)
Finance, Insurance,	Count	3,856	4,184	3,920	3,403	4,088
and Real Estate	%	93.7	93.7	93.5	94.3	93.7
	Total	(4,114)	(4,467)	(4,192)	(3,609)	(4,363)

Table 27. Knowledge Workers in All Major Industries of the Private Sector, 1984-2001 (Continued)
% within Major Industry

Private Household	Count	15	11	17	9	13
Service	%	2.1	2.2	3.0	2.3	3.5
	Total	(724)	(509)	(572)	(395)	(371)
Business and	Count	1,763	2,379	1,979	2,220	2,892
Repair Services	%	53.2	58.7	54.9	59.5	60.8
	Total	(3,314)	(4,055)	(3,604)	(3,730)	(4,758)
Personal,	Count	577	602	579	568	720
Except Private	%	27.9	29.5	32.1	34.5	35.4
Household Services	Total	(2,070)	(2,043)	(1,803)	(1,648)	(2,032)
Entertainment and	Count	442	477	531	548	659
Recreation	%	61.4	67.6	66.6	65.8	61.7
	Total	(720)	(706)	(797)	(833)	(1,068)
Hospitals	Count	1,529	1,750	1,918	1,622	2,002
	%	75.4	78.8	81.5	81.1	82.7
	Total	(2,027)	(2,220)	(2,352)	(2,001)	(2,421)
Medical,	Count	1,258	1,611	1,816	1,878	2,286
except hospitals	%	60.7	66.0	65.5	67.4	68.3
	Total	(2,071)	(2,442)	(2,774)	(2,787)	(3,348)
Educational	Count	964	1,038	1,062	1,137	1,432
	%	83.7	83.8	85.2	86.7	87.9
	Total	(1,152)	(1,238)	(1,247)	(1,311)	(1,630)
Social Services	Count	405	560	601	697	859
	%	58.1	56.1	48.2	52.3	54.7
	Total	(697)	(999)	(1,247)	(1,332)	(1,570)
Other	Count	2,055	2,429	2,834	2,650	3,164
Professional Services	%	91.7	92.5	93.9	94.8	94.6
	Total	(2,242)	(2,627)	(3,018)	(2,795)	(3,343)
Forestry and Fisheries	Count	5	7	5	8	11
	%	8.3	10.0	8.1	17.4	15.7
	Total	(60)	(70)	(62)	(46)	(70)
All Industries	Count	29,046	31,377	30,468	28,364	33,807
	%	51.4	54.6	55.4	57.1	57.8
	Total	(56,485)	(57,440)	(54,948)	(49,641)	(58,476)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

'Transportation, Communications, and Public Utilities.' The result is a lower prediction of computer usage than is actually the case.

Despite having a lower percentage of knowledge workers, 'Transportation, Communications, and Public Utilities' was particularly prone to computer usage as the bivariate analysis also showed. Since communication is associated with information, it should not be too surprising that computer usage is higher than expected. In the Communications industry in 1992, Triplett (1999) noted that the communications industry was one of several industries that had significant computer investment. Also certain positions, such as radio and television broadcasting, telephone services, and miscellaneous communication services would be expected to use computers. For example, Barkume (1992/93) claimed that communications used computers in signal transmission. In Utilities and sanitary services, computers would be expected to be used in certain positions in electric lighting, gas systems, steam supply systems, and some positions in sanitary services. The result of course is above average computer usage despite a lower percentage of knowledge workers in 'Transportation, Communications, and Public Utilities.'

In relation to hypothesis 1c, 'Wholesale and Retail Trade' are expected to have a higher rate of computer adoption than the average rate of adoption of computers because 'Wholesale and Retail Trade' have a higher percentage of knowledge workers than the overall percentage of knowledge workers in the private sector. The percentage of knowledge workers is approximately 70% of workers in Wholesale Trade and between 61 to 62% of workers in Retail Trade; thus both industries have clearly an above average

percentage of knowledge workers. However, in examination of Table 25 or Figure 2, hypothesis 1c should be rejected in every year, since the rate of computer users per 1,000 workers in 'Wholesale and Retail Trade' is below the overall rate of computer users per 1,000 workers in each year. However, from examination of Table 26, the rate of computer users per 1,000 workers is only below the average rate of computer usage in each year for 'Retail Trade' only. This would make sense in 'Retail Trade' because most workers work in positions that deal directly with the public and thus would be expected to be less likely to utilize computers. Therefore, hypothesis 1c is partially rejected because only 'Retail Trade' has a below average rate of computer usage.

In relation to hypothesis 1d, 'Finance, Insurance, and Real Estate' are expected to have higher rates of adoption of computers, since they have a higher percentage of knowledge workers than the overall percentage of knowledge workers in each year in Table 1. In examination of Table 25 or Figure 2, hypothesis 1d is supported in each year because 'Finance, Insurance, and Real Estate' have a higher rate of computer users per 1,000 workers than the overall rate of computer users. This is not surprising, since Triplett (1999) and Stiroh (1999) noted that there was significant computer investment in the finance industry. Additionally, 'Finance, Insurance, and Real Estate' involve a high percentage of desk jobs that utilize information and knowledge so that there should be very high personal computer usage among workers in 'Finance, Insurance, and Real Estate.'

In relation to hypothesis 1e, the Service industry is expected to have a higher rate of computer adoption due to a higher percentage of knowledge workers relative to the overall percentage of knowledge workers in each year in Table 1. In examination of

Table 25 or Figure 2, hypothesis 1e is apparently supported for every year except 1984. However, computer adoption in the 'Service' industry varies significantly as can be seen in Table 15 and from examination of the rates of computer adoption in more detail in Table 26. More specifically, the rate of computer usage was above the average rate of computer usage per 1,000 workers from 1984 to 2001 for 'Business and Repair Services,' 'Hospitals,' 'Educational,' and 'Other Professional Services,' and thus hypothesis 1e was only supported in these industries. The rate of computer usage was below the average rate of computer usage per 1,000 workers from 1984 to 2001 in the industries of 'Private Household Service,' 'Personal, except Private Household Services,' 'Entertainment and Recreation,' and 'Social Services.' Only 'Medical, except Hospitals' crossed the average rate of computer usage as it was below the average rate of computer usage from 1984 to 1997.

For some reason computer adoption lagged in services early on, and has gained speed ever since, as services has the knowledge workers readily available to continue computer adoption. Barkume (1992/93) pointed to the diversity and size of the 'Service' industry as reasons for future growth in computer usage. In my analysis, this would explain the later growth in computer usage after 1989. The overall trend of above average computer usage in the 'Service' industry is likely due to those areas of the service industry, which are more likely to utilize computers due to the nature of the work they perform, such as business services, hospitals, educational, professional and related services, and other services.

In relation to hypothesis 1f, 'Mining, Construction, Manufacturing, Forestry, and Fisheries' are expected to be below the average rate of computer adoption for each time

period, since ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ have a lower percentage of knowledge workers than the average percentage of knowledge workers in the private sector for each year in Table 1. Upon examination of Table 25 or Figure 2, hypothesis 1f appeared to be supported for every year, since the rate of computer users per 1,000 workers in ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ were below the average rates for all workers in the private sector of the economy for each year. However, from examination of Table 26, ‘Manufacturing, Durable Goods’ from 1984 to 1997 and ‘Mining’ in 1984 and 1993 had an above average rate of computer usage; thus there was only partial support for hypothesis 1f. Lower computer usage is expected in ‘Forestry and Fisheries’ because these industries focus on extracting natural resources from the environment. However, forestry, like agriculture, involves an additional cultivation process. This differs from fisheries and mining, in which, natural resources are extracted from the environment and prior development of the natural product is not required for extraction. Construction and Manufacturing are taking natural resources and adding physical labor in the creation of new physical products; however, manufacturing occurs indoors, has been systematized, and readily uses computers. Since most of the jobs in these industries are labor intensive, focus on physical products rather than information, and are not office work, computer usage would be expected to be lower. Thus, the rate of adoption of computers is lower in ‘Mining, Construction, Manufacturing, Forestry, and Fisheries’ than most of the other industries.

Overall, there is only partial support for hypotheses 1, which predicts that the percentage of knowledge workers in a particular industry has a direct influence on the rate of computer usage in that industry. In particular, hypothesis 1 was supported in the

case of 'Agriculture,' and 'Finance, Insurance, and Real Estate.' 'Mining, Construction, Manufacturing, Forestry, and Fisheries,' 'Wholesale and Retail Trade,' 'Transportation, Communication, and Public Utilities,' and 'Services' were partially supported.

Hypotheses 2: Level of Diffusion by 2001

Hypothesis 2a predicted that computer usage in Agriculture would not reach the level of 50% diffusion in 2001 because of a below average level of knowledge workers from 1984 to 2001. Hypothesis 2a was supported, since Agriculture only had 27.0% of employees in the private sector using computers in 2001 as shown in Table 14. This result is lower in comparison to a random survey that examined computer ownership among farmers in the Great Plains in 1996 (Ascough, Jr., et al. 1999), in which, it was found that nearly 37% owned a IBM-compatible PC in the overall random sample in the study. However, Ascough, Jr., et al. (1999) found that daily computer use was below 10% despite a higher percentage of computers owned by farmers. Thus, computer usage in agriculture is not a necessary component of the daily routine of most farmers. The low level of computer usage in 'Agriculture' is likely due to the nature of agricultural work that deals with live physical commodities often in an outdoor environment where computers are not present. Thus, Agriculture has failed to adopt the new dominant mode of production toward worker use of new computing technology by 2001; thus they are not part of the New Economy by 2001.

Hypothesis 2b predicted that 'Transportation, Communications, and Public Utilities' would be below 50% computer usage by 2001 because they have fewer knowledge workers than the overall percentage of knowledge workers from 1984 to 2001

in Table 1. My hypothesis apparently was not supported because as shown in Table 14, 55.3% of employees in 'Transportation, Communications and Public Utilities' used the computer in 2001. As I also explained earlier in relation to hypothesis 1, many positions within the industry of 'Transportation, Communications, and Public Utilities' would benefit from using a computer. This likely contributes to stronger than expected computer usage in 'Transportation, Communications, and Public Utilities.' However, upon further examination of computer usage in the industries constituting 'Transportation, Communications, and Public Utilities' in Table 28, Transportation had below 50% computer usage in 2001. Thus, there is partial support for hypothesis 2b in relation to 'Transportation,' but the hypothesis is rejected for 'Communications' and 'Public Utilities,' since computer usage is 82.6% in 'Communications' in 2001 and 63.9% in 'Public Utilities' in 2001 as shown in Table 28, which are both above 50% computer usage by 2001. Therefore, 'Communications' and 'Public Utilities' have adopted the new dominant mode of production and can be considered to be part of the New Economy by 2001, but 'Transportation' cannot be, since it failed to reach 50% computer usage by 2001.

Table 28. Computer Usage within Transportation, Communications, and Public Utilities in the Private Sector, 1984-2001
% within Year

Industry		1984	1989	1993	1997	2001
Transportation	Count	444	633	852	865	1,093
	%	21.1	29.9	39.9	40.8	42.7
	Total	(2,109)	(2,115)	(2,137)	(2,119)	(2,557)
Communications	Count	494	583	659	656	831
	%	54.3	72.4	81.4	82.1	82.6
	Total	(909)	(805)	(810)	(799)	(1,006)
Utilities and	Count	230	286	366	318	347
Sanitary Services	%	35.9	48.7	62.9	64.0	63.9
	Total	(640)	(587)	(582)	(497)	(543)
Transportation,	Count	1,168	1,502	1,877	1,839	2,271
Communications	%	31.9	42.8	53.2	53.9	55.3
& Public Utilities	Total	(3,658)	(3,507)	(3,529)	(3,415)	(4,106)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

Hypothesis 2c predicted that 'Wholesale and Retail Trade' would reach a level of 50% computer usage by 2001 because of an above average percentage of knowledge workers from 1984 to 2001 (see Table 1). Hypothesis 2c apparently was not supported because only 45.3% of employees in 'Wholesale and Retail Trade' used the computer in 2001 as shown in Table 14. In other words, the level of 50% computer usage was not reached despite having an above average level of knowledge workers. However, in Table

29, computer usage is below 50% for those in 'Retail Trade,' but computer usage is above 50% in 'Wholesale Trade.' The nature of 'Retail Trade' requires less use of computers and more direct interaction with customers. Thus, hypothesis 2c is partially supported, since 'Wholesale Trade' has above 50% computer usage. As a result, 'Wholesale Trade' can be considered to be part of the New Economy by 2001 because Wholesale Trade has adopted the new dominant mode of production of computing technology in the New Economy. On the other hand, Retail Trade has not reached 50% computer usage by 2001 and thus cannot be considered to be part of the New Economy because they have not adopted the new dominant mode of production of computing technology by 2001.

Table 29. Computer Usage within the Trade Industry of the Private Sector, 1984-2001

% within Year

		Year				
Industry		1984	1989	1993	1997	2001
Wholesale Trade	Count	716	1,093	1,219	1,263	1,490
	%	28.0	41.2	52.0	55.9	60.4
	Total	(2,559)	(2,650)	(2,345)	(2,261)	(2,466)
Retail Trade	Count	1,467	2,414	3,215	3,406	4,489
	%	14.5	24.3	33.2	37.9	41.8
	Total	(10,092)	(9,928)	(9,682)	(8,979)	(10,729)
Wholesale & Retail Trade	Count	2,183	3,507	4,434	4,669	5,979
	%	17.3	27.9	36.9	41.5	45.3
	Total	(12,651)	(12,578)	(12,027)	(11,240)	(13,195)

Source: Current Population Survey, October 1984, 1989, 1993, 1997, and September 2001

As you might recall, there is no hypothesis 2d for 'Finance, Insurance, and Real Estate' because this industry reached 50% computer usage in 1984 (Table 14) due to a high percentage of knowledge workers in 'Finance, Insurance, and Real Estate' (Table 1). Thus, there is no way to falsify the hypothesis with increasing computer usage, since 'Finance, Insurance, and Real Estate' have already adopted a dominant mode of production of new computing technology by 1984, and thus were the first industries to be part of the New Economy. It would have been nice to examine computer usage within the three industries of 'Finance, Insurance, and Real Estate' in Table 17; however, they were not divided up as three distinct industries as 'Finance,' 'Insurance,' and 'Real Estate' in both the 21 major industry categories and the 51 detailed industry categories. 'Finance, Insurance, and Real Estate' is combined into one category in the 21 major industry categories. Even within detailed industry categories, 'Insurance' and 'Real Estate' are combined into one category.

Hypothesis 2e predicted that the level of diffusion of computer usage will reach 50% in the Service industry by 2001, since the Service industry has an above average level of knowledge workers in Table 1. Overall, hypothesis 2e is apparently supported because the Service Industry has 59.8% computer usage in 2001 as shown in Table 14. However, the degree of support for hypothesis 2e varies when computer usage is examined within the industries that make up the service industry shown in Table 15. In the specific service industries of 'Business and Repair Services,' 'Hospitals,' 'Medical, Except Hospitals,' 'Educational,' and 'Other Professional Services' (mainly consists of non-profit, public, and professional business services, see methods section for details),

computer usage reached above 50% by 2001 as shown in Table 15. In particular, 'Business and Repair Services' reached 50% computer usage by 1997 and almost reached 60% by 2001. Both 'Hospitals' and 'Other Professional Services' reached the level of 50% computer usage very early in 1989. 'Hospitals' had reached over 70% by 2001 and 'Other Professional Services' had reached over 80% by 2001. 'Educational Services' reached 50% by 1993 and had reached over 70% by 2001. 'Medical, Except Hospital Services' reached 50% by 2001 in Table 15. Thus, these results indicate that these specific industries within the service industry have adopted the new mode of production by 2001 and therefore are part of the New Economy by 2001.

The industries constituting the service sector that had failed to reach 50% by 2001 in Table 15 were: 'Private Household Services' at 9.2%; 'Personal, Except Private Household Services' at just over 35.6%; 'Entertainment and Recreation' at 48.4%; and 'Social Services' at almost 44%. Thus, a new mode of production is still being adopted in these industries of the service sector and thus the New Economy does not exist in these industries of the service sector. Therefore, while overall adoption of computers in the service industry suggest that a new mode of production has become dominant, and as a result there is a New Economy by 2001, this is only the case for certain industries within the service sector. In particular, 'Business and Repair Services,' 'Hospitals,' 'Medical, Except Hospitals,' 'Educational,' and 'Other Professional Services' have reached a new dominant mode of production of technology usage by 2001, and thus are part of the New Economy by 2001. Thus, hypothesis 2e is only partially supported.

Hypothesis 2f predicted that 'Mining, Construction, Manufacturing, Forestry, and Fisheries' would have reached a level of diffusion of 50% computer usage by 2001 in

Table 14 because they have a lower percentage of knowledge workers than the overall percentage of knowledge workers for all years in Table 1. Hypothesis 2f is apparently supported because 42.9% of private employees in 'Mining, Construction, Manufacturing, Forestry, and Fisheries' use the computer in 2001 as shown in Table 14. However, overall support for hypothesis 2f changes when I examine computer usage in more detail in the industries of 'Mining, Construction, Manufacturing, Forestry, and Fisheries' in Table 16. In particular, 'Manufacturing, Durable Goods' and 'Manufacturing, Non-Durable Goods' reached 50% computer usage by 2001 in Table 16, which contradicts the overall conclusion for hypothesis 2f. This strongly suggests that 'Manufacturing, Durable Goods' and 'Manufacturing, Non-Durable Goods' had adopted a new mode of production of computing technology by 2001, and therefore are part of the New Economy by 2001. Thus, hypothesis 2f is only partially supported in 'Mining, Construction, Manufacturing, Forestry, and Fisheries.'

Overall, I found partial support for my second set of hypotheses because 'Transportation, Communications, and Public Utilities' unexpectedly reached 50% computer usage by 2001 and 'Wholesale and Retail Trade' failed to reach 50% computer usage by 2001. This also occurred with the first set of hypotheses because the percentage of knowledge workers in these two industries did not always predict actual computer usage. For example, 'Transportation, Communications, and Public Utilities' has certain sectors and occupations where computer usage is more likely, such as, communications, which deals directly with information. Additionally, 'Wholesale and Retail Trade' has an above average level of knowledge workers that led to 'Wholesale Trade' reaching 50% computer usage by 2001. The problem associated with knowledge work predicting actual

computer usage in these two industries suggests that other factors may play a role in predicting overall computer usage. However, the fact that the industries of 'Communications,' 'Public Utilities,' 'Finance, Insurance, and Real Estate,' 'Services,' 'Manufacturing,' and 'Wholesale Trade' reached 50% computer usage by 2001 strongly suggests that these industries have adopted a new mode of production of computing technology, and therefore are part of the New Economy. However, only certain industries that make up the 'Service' industry reached 50% computer usage by 2001, such as 'Business and Repair Services,' 'Hospitals,' 'Medical, Except Hospitals,' 'Educational,' and 'Other Professional Services.' On the other hand, 'Agriculture,' 'Transportation,' 'Retail Trade,' and 'Mining, Construction, Forestry, and Fisheries,' and the following areas of the 'Service' economy: 'Private Household Services,' 'Personal Except Private Household Services,' 'Entertainment and Recreation,' and 'Social Services' have failed to reach 50% computer usage, which strongly suggests that these industries have not yet reached a dominant mode of production in the use of computers to perform work and thus are not part of the New Economy. These industries failed to reach 50% computer usage by 2001 due to a lower percentage of knowledge workers in these industries except for 'Retail Trade.' The lower percentage of knowledge workers is related to the type of work being performed in these industries and subsequently the lack of applicability of computers to work tasks. However, sometime in the future these industries may reach beyond the level of 50% computer usage and become part of the New Economy.

Chapter 6 Conclusion and Discussion

In my dissertation, I argue that a new mode of production based on computing technology has been adopted over the past two decades. I test two hypotheses in relation to the adoption of the new mode of production in each industry. The first hypothesis uses the percentage of knowledge workers as a predictor of the rate of computer usage in each industry. The purpose of this hypothesis is to characterize how quickly the adoption of the new mode of production is occurring. The second hypothesis uses the percentage of knowledge workers in a given industry to predict the level of computer usage reached by 2001 in that given industry. The purpose of this hypothesis is to show whether a New Economy has developed in a given industry by 2001 by examining the level of computer usage adopted by 2001. Reaching 50% computer usage by workers in a particular industry is the determining factor of whether a new mode of production has become significant enough to be considered a New Economy.

The average percentage of knowledge workers is used for both hypotheses and is defined as the percentage of knowledge workers across all industries in a given year. In hypothesis 1, the above average percentage of knowledge workers in the following industries predicted that the rate of computer usage would be above the mean rate of computer usage: 'Wholesale and Retail Trade,' 'Finance, Insurance, and Real Estate,' and the 'Service' industry. The rate of computer usage was expected to be below the mean rate in the following industries due to a below average percentage of knowledge workers: 'Agriculture,' 'Transportation, Communications, and Public Utilities,' and 'Mining, Construction, Manufacturing, Forestry, and Fisheries.' I found that the percentage of knowledge workers correctly predicted the rate of computer usage for the industries of

'Agriculture,' 'Transportation,' 'Finance, Insurance, and Real Estate,' and 'Mining, Construction, Forestry, and Fisheries.' Additionally, the rate of computer usage was successfully predicted in some industries of 'Services' as follows: 'Business and Repair Services,' 'Hospitals,' 'Educational,' and 'Other Professional Services' from 1984 to 2001, and 'Medical, except Hospitals' in 2001. However, the percentage of knowledge workers did not predict the rate of computer usage in the industries of 'Communications and Public Utilities,' 'Wholesale and Retail Trade,' and 'Manufacturing.'

Hypothesis 2 suggests that the adoption of new technology has become dominant in the major industries of 'Finance, Insurance and Real Estate,' 'Services,' and 'Transportation, Communications, and Public Utilities.' Examination of computer usage within these major industries showed that the New Economy had formed in particular industries as follows because they reached 50% computer usage: 'Communications,' 'Public Utilities,' 'Finance, Insurance, and Real Estate,' 'Wholesale Trade,' 'Manufacturing,' 'Business and Repair Services,' 'Hospitals,' 'Medical, except Hospitals,' 'Educational,' and 'Other Professional Services.' A New Economy had not formed in the major industries of 'Retail Trade,' 'Mining, Construction, and Forestry,' and 'Agriculture.' In the first few decades of the twenty-first century, computer usage will likely reach dominant status in the industries of 'Retail Trade' and 'Mining,' since computer usage was above 40% in these industries by 2001.

My position on the New Economy is consistent with the positions of New Economy supporters. First, I believe that the New Economy exists, since computer usage had reached dominant status in most industries of the economy by 2001. Second, information technology is important to the New Economy. My conclusion is that

businesses in the private sector are using information technology to operate in a different manner than in the past. This has occurred not only in workers using new technology to perform work, but also in terms of organizational change. For example, businesses have used information technology for the purpose of increasing efficiency and reducing the size of the workforce in economic restructuring and globalization. Third, as mentioned in my literature review, the New Economy developed within the context of late capitalism. The New Economy was shaped by several economic phenomena of late capitalism that preceded the development of the New Economy. In Figure 1, technological developments in information technology, expansion of globalization, continued economic restructuring, increased competition, a continued concern with profit by capitalists, expansion of the service economy, and expansion of finance were influential in the direction of the New Economy. Fourth, the New Economy will continue to develop, as the development of information technology will find new applications in the workforce. The New Economy is a young economy and the New and Old economies will continue to integrate.

My research also addresses critics of the New Economy. First, some critics of the New Economy offered the view that the New Economy had faltered and did not meet expectations (Kotz and Wolfson 2004, Bauder 2000 and Pearlstein 2000). I argue instead that computer usage had continued to expand and had reached 50% usage by 2001 in most industries. Thus, the New Economy had formed in most sectors of the economy by 2001. Second, I am also reacting to Weimer (2000) and Stiroh (1999) who claimed that there was nothing "new" about the New Economy because technology has always been an important factor in increasing productivity. I respond that technology usage reached

50% computer usage in most industries and thus became significant enough to increase productivity as the new mode of production became dominant. My view of the New Economy is that a more fundamental change in the way work is performed occurred with the widespread use of new computing technology. Businesses operate differently than in the past because they use information technology in a new way. In other words, a new mode of production was adopted and became significant enough to be considered a New Economy in most industries of the economy. Therefore, the New Economy is a more permanent economic phenomenon than has been conceived by critics. The New Economy has continued to exist and will continue to expand in the future as the new mode of production continues to be adopted.

Third, some critics believe that the New Economy is less impressive than past technological revolutions. These critics believe that the New Economy exists, but is weak in comparison to past New Economies. I show that the New Economy is not weak because 50% computer usage in most industries had been reached by 2001. Computer usage is over 50% in most industries and thus there is sufficient data to conclude that there is a New Economy. Fourth, some critics will argue that the New Economy is not well developed. I respond to these critics by showing that the level of 50% computer usage has been reached in most of the economy which demonstrates that there is a New Economy.

My research is also important to the mode of production literature because it continues in the tradition of Marx and extends his conception of a new mode of production by applying it to the recent adoption of new computing technology in the economy. Thus, my research study is theoretically important in its extension of Marx's

conception of a mode of production to the adoption of computing technology in the late twentieth century and early twenty-first Century, and thus is important to sociology. Additionally, my research does not make the mistake of those in the articulation literature and confuse the mode of production with the consequences of the mode of production. This is a common mistake because the mode of production can influence other things, such as capitalist exploitation, the organization of labor, or the capitalist economy.

My research is also important to the neo-Marxists because it can be viewed as a reaction to critics who have recently viewed Marx as increasingly irrelevant. Some critics have argued recently that after the fall of Communism in Europe in the late 1980s and early 1990s, Marx was no longer relevant. For example, Luke (1989) argued that Marx is no longer as relevant to the economy today because the economy is no longer predominantly a manufacturing economy.

This position suffers from three problems. First, the concept of a mode of production is applicable beyond manufacturing to how work is performed using technology in other sectors of the economy. As my dissertation demonstrates, Marx can still be relevant to understanding the economy in terms of development and use of technology as a new mode of production. Second, this position often focuses on Marx's work as a political-economic system instead of focusing on Marx's solid understanding and critique of capitalism. Marx is useful for understanding that the capitalist workers are still exploited by the capitalist, and that workers are still required to sell their labor power to capitalists to survive in our social world. In relation to the first point, these workers are automatically part of the working class, even though they do not hold production jobs and are consequently unproductive workers. While unproductive

workers were not conceptualized by Marx as producing surplus-value, they still are at a disadvantage relative to capitalists and have recently experienced deteriorating working conditions by application of new management techniques, economic restructuring, reduction of real wages and health benefits, and relocation of some jobs with decent pay to other places in the world with great savings for the capitalist. Thus, Marx remains relevant as the fundamental nature of capitalism has not changed because the interests of the workers remain as a dependent relationship to capitalists. Third, Marx is a critic of capitalism and the capitalist mode of production, and thus will remain relevant as long as capitalism remains the dominant economic system.

In relation to the technology diffusion literature, this dissertation argues along the line of Grübler (1991) that a framework was important for the fairly quick adoption of the computer and Internet in comparison to past technological revolutions. This dissertation also highlights the importance of the adoption and subsequent diffusion of new technology to the development of the economy. Additionally, one distinct contribution of this study is the use of technology usage as a direct measure of technology diffusion rather than using an indirect measure of technology diffusion such as productivity. Thus, I am measuring technology more directly as it is used by workers in the economy. In other words, it views growth in technology from the perspective of workers actually using the technology in the performance of their jobs. My study is also important for the diffusion of technology literature because it does not assume that increasing diffusion in different industries equates with a higher rate of adoption at a particular point in time. Technology adoption can continue to expand, but at a slower rate due to a higher base of technology adoption. For example, the actual number of new computer users added

could be the same from one data point to the next, but the rate of adoption decreases due to a larger base.

Discussion: The Impact and the Future of the New Economy

The New Economy has had positive gains as a result of a new mode of production. Better quality information technology that is more efficient, less costly, with greater memory, and that is networked has spread throughout the economy leading to growth in productivity. Part of the increase in productivity comes from new software and more efficient hardware that makes tasks easier and quicker to perform on the computer. According to Smith and Thompson (1999), workplaces have been more integrated into global commodity chains by use of new technology, new communication, rational management techniques, and the influence of increasing trade. Communication between partners in global networks has increased and has been facilitated by the development of the Internet. For example, Alcaly (2003) gives an example of Dell's computer build-to-order system with various business partners that communicate through information technology. Computers are only ordered on demand and Dell can communicate with their business partners quickly electronically. It is also cheaper to communicate using the Internet than by telephone. These developments have facilitated transport as products are now ordered on demand and shipped to anywhere in the world. In his conclusion, Alcaly (2003) mentioned that a more flexible organization was facilitated by developments in information technology, such as a greater focus on customer needs that reduces inventories; closer relationships between suppliers, designers and distributors; and the

emergence of shorter product cycles, that enhance these business operations (Alcaly 2003).

In the New Economy, competition is intense. I believe that intense competition has produced the potential for companies that were otherwise doing well financially to have trouble competing. For example, companies can face problems due to market saturation of products. Market saturation will lead to decreasing demand, greater competition, and a reduction of the number of companies through mergers and bankruptcies (Nakamoto 2002). As a result, the economic environment is less certain and planning is more difficult by management. One response has been to plan quicker product cycles than in the past in an attempt to deal with a less certain environment. The one serious drawback to quicker product cycles is a reduction in basic R&D spending. This is unfortunate since basic R&D spending is important for future economic growth.

However, economic competition may not be the sole reason for future economic problems. With deregulation and the lifting of legal economic controls, greater volatility in the United States and world economy may exist and thus possibly could lead to a greater likelihood of future economic downturns. Gadrey (2003) believes that deregulation of financial markets produces a focus on short-term gains, regular market instability, and greater economic risk, which facilitates debt and speculation. As a result, the future economy may face greater market volatility.

Significant government regulation of the Internet is also likely to happen at some point in the future. Brown (1999) believed that government regulation of the Internet will occur in the future just like with past media that faced government regulation. Litan (2001) pointed out that government regulation of the Internet is increasing with new

privacy laws in the European Union and censorship of the Internet by China and Singapore for example. O'Leary (2000) believed that regulation of the Internet needs to be the same internationally because governments cannot locate the things that need to be regulated such as the physical location of the server. Naim (2001:107) claimed that international trade organizations and national jurisdictions also need to be dealt with in relation to antitrust laws, regulators, differing regulatory standards toward information technology, and "consumer privacy, cross-border e-commerce, encryption, and tax harmonization." These issues will be worked out slowly in multi-lateral governmental organizations. How these rules are dealt with will influence how IT spreads globally (Naim 2001). Remember, regulation is part of the New Economy, not a constraint on the New Economy, meaning that future regulation is not necessarily a bad thing (Chorafas 2001).

Limitations and Future Research

Some may argue that my industry classifications are too broad and do not sufficiently capture computer usage within industry. I address this in my methods section as I contrast the relative advantages of simple data presentation versus detailed data presentation. I will now briefly summarize this argument. The advantage of large industry categories is clear presentation of computer usage by industry. The disadvantage is that the industry categories may be too broad and do not capture the actual nature of computer usage because there is great variation in computer usage within each major industry category. To counteract this problem, I do provide tables of computer usage within the industries of 'Service,' 'Mining, Construction, Manufacturing, Forestry, and

Fisheries,' 'Wholesale and Retail Trade,' and 'Transportation, Communications, and Public Utilities.' Additionally, I do qualify my conclusions about the hypotheses by discussing the results within the 21 major industry categories.

Thus far, this dissertation has shown that there is a new mode of production of computing technology that has recently developed, in which, many workers are using new computing technology to perform work tasks. I will now discuss possible future contributions to research. Future research should also examine other types of information technology usage that are part of the new mode of production. In relation to Internet usage, which was argued to be the other measure of the new mode of production, it would have been good to have more comparable data on Internet usage. I argue that what makes the new mode of production distinct is the ability to use both of these technologies in tandem with one another, thus the need to examine Internet usage too. The separate measures of email usage and Internet usage in 1993 and 1997 are combined into one measure in 2001. Thus, I only have comparable measures of Internet usage in 1993 and 1997. The universe for the 1998 and 2000 CPS data is different from the universe for the 1993 and 1997 data. In 1993 and 1997, the universe for Internet usage at work was computer usage at work. In 1998 and 2000, Internet usage was outside the home. The result was that Internet usage in 1998 and 2000 was higher than with the combined measurement of email and Internet usage in 2001, which is counter intuitive.

Other possible measures that might be examined are software usage, email usage, networks, and information and communication technologies (ICT) investment. Software usage is very much related to computer usage, but examination of software would tell to what extent certain industries and occupations are more likely to use certain types of

software to perform work. Thus, it would provide clarification of this new mode of production. Email usage is related to both computer and Internet usage and would be a good measure of use of the computer to communicate with other employees in this new mode of production. Measurement of the number of networks or ICT spending would be another measure that demonstrates the existence of a new mode of production.

The measure of computer usage I used only distinguishes users from non-users and does not specify how computers are being used, nor the purpose of computer usage. Future measurement could document the tasks behind computer usage in the new mode of production and the amount of time different types of workers spend on the computer. For example, it is likely that knowledge workers will spend more time on the computer than non-knowledge workers.

Additionally, I do not examine data of technology usage after 2001. It would be expected that technology usage among workers has continued to increase after 2001, but computer and Internet usage might have leveled off. Thus, more recent data must be examined to make the case that technology adoption of the computer and Internet have continued to increase after 2001. To understand the New Economy since 2001, measurements of the new mode of production after 2001 will have to be taken to characterize the further adoption and evolution of the new mode of production. Since the New Economy is young and not fully developed, the conception of the New Economy presented in this dissertation in relation to definitions, descriptions, characterizations, theories and conclusions about the New Economy are characteristic of the young New Economy. However, it is important to make early efforts to attempt to characterize the New Economy, which will provide a foundation for further characterization of a more

mature New Economy in the future. The future direction of the New Economy is not known at this point in time. However, certain descriptions, suggestions, and predictions about the future direction of the New Economy can be useful at this point in time. The New Economy will likely go through radical changes as adoption of new technology continues to take place, as new applications are found for information technology, and information technology becomes increasingly integrated into the business model.

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*Denotes use of popular literature

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