The Impact of Information and Communication Technologies on Employment, Wages, & Profits

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Abstract

As technology doubles at the rate of Moore's Law and businesses continue to increase investment in information and communication technologies (ICT), it is becoming increasingly important to study the effect of technology on the labor market. This study examines the impact of ICT investment on employment, median wages, and profits in the United States and Canada between 1990 and 2010. Information technologies tend to eliminate the need for many middle class jobs and create jobs for highly skilled workers. The result is an increased demand for highly skilled workers and an increased supply of lower skilled workers, potentially exacerbating wage inequalities and decreasing employment.

I. Introduction

Information technology has been evolving at an increasingly rapid rate. The common rule of thumb that expresses this rate of growth is known as Moore's Law. Moore's law states that the number of transistors in a dense integrated circuit doubles approximately every two years. More simply put, the processing power of computers is doubling almost every two years. What is even more interesting is that computing power may not even be the most rapidly advancing component of information technologies. Martin Grotschel recently analyzed the speed with which a computer optimization problem could be solved by a computer between the years 1988-2003. He found that while processor speed improved by an impressive factor of 1,000, algorithms grew at a jaw dropping factor of 43,000 (Brynjolfsson & McAfee, 2012, p.23). Businesses have begun to realize the tremendous impact information technologies can have on their operations. The percentage of investment in Information and Communication Technologies (ICT) is increasing in NAICS industries in Canada and the United States (CSLS, 2014). As businesses increase investment in Information and Communication Technology it is becoming increasingly important to analyze the impact of ICT investment on the labor market.

In 1930 John Maynard Keyes said "We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which will hear a great deal in the years to come – namely, technological unemployment" (Brynjolfsson & McAfee, 2012, p.33). The argument for technological unemployment has resurfaced today. Traditional areas of ICT like television, radio, computers, and mobile devices have been a constant factor in the development of theories on technological unemployment in the 21st century. However, emerging fields of ICT like machine learning, artificial intelligence, natural language processing, and big data have begun to make people more wary about the potential effect of technology in the near future. Xerox recently developed an artificially intelligent customer service computer. The computer representative is effective at handling customer requests and cost approximately 1/50th of what a human laborer would cost to perform the job (Ballard, 2014). The rapid changes and developments in the ICT industry make this topic that much more important to study.

The study at hand uses data on the United States and Canada across eight industries to empirically test the relationship between investment in ICT and employment, median wages, and profits. There are numerous theories that have been developed on the relationship between the labor market and technology but far less empirical analysis. Three separate regressions were used on the three key variables of interest in this study; employment, median wages, and corporate profits by industry. The independent variables in each regression were held constant. The most important independent variables were investment in ICT as well as percentage of ICT investment in total investment. These variables were used as proxy variables for technology. A number of economic indicators were also used in the regression as explanatory variables to account for other key factors affecting the three key areas of study; employment, median wages, and corporate profits. The analysis reveals significant results and adds to the bank of empirical testing on this specific topic.

II. Literature Review

The literature reviewed for this study provides a comprehensive set of perspectives on the role of technological growth and the effect of technology on employment, median wages, and corporate profits. A point of emphasis is the pace at which technology is growing and how the effect of technology on the labor market is only going to increase. The effect of technology on employment is debated because it has historically provided economic growth, which creates jobs. An opposing theory has been brought forth by MIT economist Erik Brynjolfsson and Andrew McAfee which argues that as technology develops it is beginning to eliminate more jobs than it is creating. Additionally, as ICT capital becomes more productive the proportion of revenue distributed to capitalists is increasing while the amount distributed to laborers is remaining stagnant.

Rate of Technological Growth

Since the conception of the idea for Moore's Law, every two years computer processing power has doubled and continued to grow at an exponential rate. MIT professors Brynjolfsson and McAfee (2012) paint a picture of the magnitude of this growth by using the analogy of putting rice on a chessboard. If you put two pieces of rice on the first square, four on the next, eight on the next, and so on you would have a pile of rice as high as Mt. Everest by the 64^{th} square. The 32^{nd} square would be approximately equal to a football field of rice and it is estimated society hit the 32^{nd} square in our progression of technological growth in 2004 (Brynjolfsson & McAfee 2012). An example that helps depict this growth is automated cars. As recently as 2004 economists Frank Levy and Richard Murnane used the example of truck driving as a task that only humans could perform (Brynjolfsson & McAfee 2012). Their statements were disproved in 2010 when Google created a fleet of self-driving Priuses. If today technological power is only equivalent to a football field of rice and by 2070 it is going to be the size of Mt. Everest, it is more important than ever to not overlook the impact it is having on the economy, and more specifically the labor market.

Employment

As the role of technology in business grows, economists have begun to argue that technology is causing unemployment. In "How Technology is Destroying Jobs," David Rotman discusses a graph that shows the historical trend of productivity and employment in the United States. The pattern showed that productivity and employment had a strong positive relationship until 2000 when productivity continued to increase and employment remained stagnant. An interesting trend leading up to this change was that investment in information processing equipment and software investment was rising rapidly, with the largest jump occurring between 1990 and 2000 (Autor 2014). Erik Brynjolfsson and Andrew McAfee called this the "great decoupling" in their book *Race Against the Machine* (2012) and argue that the culprit of the "great decoupling" is technology. Brynjolfsson and McAfee provide additional empirical evidence that there is a new trend in our economy not being accounted for by looking at GDP growth, corporate profits, investment in capital, and employment. Empirical evidence shows that after the recession in 2009 GDP growth resumed its near normal trend of upward growth, corporate profits reached record levels, investment in capital recovered to normal levels, but there was no simultaneous growth in employment (Brynjolfsson & McAfee, 2012, p.8).

The idea that technology might actually hurt society instead of improve it goes against the long held economic assumption that new technologies improve social welfare by increasing productivity and providing access to new markets. A recent study showed that 88% of economists did not believe technology was hurting employment as a whole (Autor, 2014). One positive benefit from technology is that productivity growth from technology has allowed companies to allocate their human capital to new innovative projects. Economists Susanto Basu and John Fernald stated that "the availability of cheap information and communication technology capital allows firms to deploy their other inputs in radically different and productivity-enhancing ways" (Brynjolfsson & McAfee, 2012, p.26). Rotman said that although rising productivity may reduce the amount of employees a business needs to manufacture a product, it can also increase production and provide access to new markets (Rotman, 2013). He provides the company Kiva as an example of a company creating jobs in a new market as a result of technological growth. Kiva is hiring large amounts of employees to write algorithms for their manufacturing warehouse robots.

Different theories have been provided for what has caused recent trends of unemployment especially after the economic recession of 2007-2009. During the period following the recession America began to see job creation, but there were an insufficient number of new jobs created to keep up with population growth (Brynjolfsson & McAfee, 2012, p.6). There are three popular explanations that have been offered for the lagging recovery in employment: cyclicality, stagnation, and the end of work (Brynjolfsson & McAfee, 2012, p.8). Paul Krugman advocates for cyclicality. Krugman states there is simply not enough economic growth and the drop in demand is just another phase of the business cycle (Brynjolfsson & McAfee, 2012, p.8). Tyler Cowen supports an argument for stagnation and a long term decline in innovation and productivity. Cowen points to a declining growth in median incomes as the number one piece of evidence (Brynjolfsson & McAfee, 2012, p.9). Daren Acemoglu's findings that there was no indication of post-2000 productivity growth from information technologies supports Cowen's theory (Acemoglu 2014). However, Acemoglu's findings are refuted by the United State Congressional Budget Office in a report on United States productivity since 1995. The CBO stated that "Analysts have concluded that the productivity acceleration likely stemmed from developments in the information technology (IT) sector, including rapid technological change in the industries that produce IT goods" (CBO, 2007). The third explanation is the end of work theory. It is based on the idea that technology is taking the jobs that were previously given to human workers. Daniel Rifkin states that computers caused an important shift which has resulted in the creation of increasing technological unemployment that will ultimately create a near-workerless world (Brynjolfsson & McAfee, 2012, p.12).

A number of economists believe the impact of technological unemployment is most heavily felt my middle and lower skilled workers. Brynjolffson and McAfee (2012) argue that the result of technological unemployment targeted at the middle class is entirely restructuring our economy. The reason for the large impact on middle class workers is because the tasks they perform are the easiest to program into a computer. Computers can most readily replace the routine tasks like clerical work because is repetitive and follows a strict set of rules. Tasks that are repetitive and follow a strict set of rules are the easiest to computerize (Autor, 2014).

However, computers are no longer being limited to performing simple clerical tasks. New developments in fields like machine learning and artificial intelligence have allowed automation technologies to expand their skill set. Previously, physical tasks like stocking, packing, and shipping in a warehouse proved to be a formidable task for robots to complete. Now, new companies like Kiva have developed a fleet of robots that can perform these tasks in a warehouse (Autor, 2014). David Autor provides evidence stating that "In 1979, the four middle skill occupations [sales, office and administrative workers, production workers, and operatives] accounted for 60% of employment. In 2007, this number was 49%, and in 2012, it was 46%" (Autor, 2014, p.5)." On the other hand the most vexing tasks to automate are the ones that require flexibility, judgment, and common sense (Autor, 2014). High skilled jobs tend to be protected from technological unemployment because they require abstract thinking that requires a high level of flexibility, judgment, and common sense.

Income / Wages

Another point of debate is the role technology might be having on the stagnation of wages. A key part of Bryjolfsson and McAfee's (2012) book is the paradoxical idea that faster technological progress can hurt wages and jobs for millions of people. While GDP per person in the United States has been rising in the 21st century, median income has actually shown a decline (Brynjolfsson & McAfee, 2012, p.37). In a recent poll it was found that 43% of economists are in support of the idea that technology is playing a central role in median income stagnation (Autor 2014). The reasoning for this is that technology has created an increase in demand for high skilled jobs, while eliminating middle class jobs. David Autor stated that "Technological advances that have secularly pushed outward the demand for skilled labor over many decades will continue to do so." (Autor, 2014, p.39) Currently the labor supply for high skilled workers is expanding but the wages for high skilled workers is still increasing. The increase in wages even as the labor supply is growing exemplifies how strong the demand is for high skilled workers (Brynjolfsson & Mcafee 2012). At the same time, many of the middle class workers that lost their jobs as a result of technological unemployment are forced to search for work in lower skilled markets. The result is an increased labor supply of low skilled workers and stagnant median wages in low skilled job markets.

While median incomes remain stagnant, there is an increasing share of income going to capital owners which can be seen by rising levels of corporate profits (Brynjolfsson & McAfee, 2012). Brynjolfsson and McAfee (2012) claim the reason for changes in income distribution is a result of bargaining theory. Bargaining theory states that the money generated by labor and capital is distributed based on the contribution from each input. As technology becomes more productive compared to human labor it will take a larger portion of the generated wealth. Finally, Brynjolfsson and McAfee (2012) discuss how technology is creating a generation of superstars that can make multi-million dollar products that profit from the automation of many middle class jobs. *The Race Against the Machine* uses an example of the impact of this effect with a conversation between Ford CEO Henry Ford and United Automobile Workers president Walter Reuther as they tour a modern auto plant. "Ford jokingly jabs at Reuther: "Walter, how are you going to get these robots to pay UAW due?" Not missing a beat, Reuther responds: "Henry, how are you going to get them to buy your cars?" (Brynjolfsson & McAfee, 2011)

III. Data

The data for this study comes from five sources; the Center for the Study of Living Standards (CSLS), Organization for Economic Cooperation and Development (OECD), the Bureau of Labor Statistics (BLS), Statistics Canada, and the Bureau of Economic Analysis

(BEA). The databases from these websites were able to provide us with data on both the United States and Canada across eight industries: Manufacturing (NAICS 31), Educational Services (NAICS 61), Information and Cultural (NAICS 51), Mining and Oil and Gas Extraction (NAICS 21), Retail Trade (NAICS 44-45), Wholesale Trade (41), Professional, Scientific, and Technical Services (54), and Arts, Entertainment, and Recreation (71). Data for the three dependent variables varied in availability between the United States and Canada. Employment by industry was available in both the United States and Canada from 1987 – 2013. Median income by industry was available from 2002 – 2013 in the United States and from 1987-2013 in Canada. Corporate profits by industry was available from 1998 – 2009 in the United States and from 1988 – 2013 in Canada. Data for all independent variables was available in both the United States and Canada from 1990 – 2011.

CSLS Data

The main dataset for this analysis was taken from the Center for the Study of Living Standards (CSLS). The CSLS is based out of Ottawa, Canada and works on a number of projects with federal, private, and charitable organizations. In the data section of their website they make available databases to the public. The specific database used for this analysis is called the "Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends: Canada vs United States". The database has collected data on a number of variables between the time periods 1980-2013 for both Canada and the United States. The main objective of this dataset is to show how investment in ICT has grown in both Canada and the United States.

Within the database tables are provided for Total ICT investment for both the United States and Canada by NAICS industry. Full data was not available for all industries especially industries with very low levels of ICT investment. The dataset provided three key variables used in this analysis. The first of the three variables is “ICT Investment, millions of current dollars”. The variable is measured in 2013 dollars and is a measure of annual investment in ICT. The second variable is the “Proportion of ICT Investment in Total Investment” which measures the percentage of total industry investment spent on ICT goods. The third variable is GDP by industry and is measured in millions of 2013 dollars. The database has full data from 1987 – 2013 for industries in the United States and data from 1987 – 2011 for industries in Canada.

OECD Data

The Organization for Economic Cooperation and Development (OECD) provided all data for national economic indicators. The OECD is based out of Paris, France and has been created to help national governments create better public policy. The OECD provides economic data on a country level. Data for Canada and the United States was pulled from the OECD for the following variables; national GDP, national unemployment, national productivity growth, and national PPI.

All variable data was pulled directly from the OECD’s website for Canada and the United States. The national GDP data was available from 1980 – 2015. National GDP is made internationally comparable by following the System of National Accounts. The OECD measures GDP in USD per capita and in million USD at current prices and PPPs. The unemployment rate was available for the United States and Canada from 1980 – 2015. The OECD measures the unemployment rate as the amount of people 15 and older who are without work, actively seeking work, and available to work. The labor productivity measure taken from OECD measures GDP per hour worked in constant prices. Data for labor productivity was available from 1970 – 2013. The producer price indices (PPI) data measures the average prices of prices received by the producers of various commodities. The OECD provides data on the producer price indices from 1970 – 2013.

BLS Data

Both industry employment and industry median income data for the United States was obtained through the website for the Bureau of Labor Statistics (BLS). The BLS gathers their data from the Current Employment Statistics Survey which is a national survey. The BLS has made NAICS industry specific employment data available for the United States from 1939 – 2015. The employment data used in this study is the Not Seasonally Adjusted annual averages from 1990 – 2011. The data specifically measures the raw number of individuals with employment in different industries throughout the United States. The data for median wages was gathered from the BLS Occupational Employment statistics. The data for median income by industry is available from 2002 – 2013.

BEA

The Bureau of Economic Analysis is an agency in the Department of Commerce. The BEA was organized to gather information and provide relevant insight on the United States economy. The data for corporate profits by industry was obtained from a database made public by the Bureau of Economic Analysis (BEA). The specific database where the data was withdrawn is called the National Income and Product Account Tables. The profits are calculated as before tax profits and measured in millions of dollars. The data is available from 1998 – 2009.

Statistics Canada

Statistics Canada is a member of the Canadian Industry Portfolio and produces statistics to help the Canadian people understand their population, resources, economy, and society. Statistics Canada provides databases through their website that are free and available to the public. Median wages for Canada were obtained from Statistics Canada's Earnings of Individuals, by selected characteristics and North American Industry Classification System (NAICS), 2011 constant dollars database. The median wages are measured in 2011 constant dollars and data is available from 1987 – 2013. Corporate profits by industry were obtained from Statistics Canada's Quarterly balance sheet and income statement, by North American Industry Classification System (NAICS) database. Data was available from 1988 – 2013 and is measured in millions of dollars.

IV. Methodology

The following model was estimated separately for employment, median wages, and corporate profits. The model was also estimated separately for the United States and for Canada. The model was estimated using Ordinary least squares (OLS), fixed effects, and random effects estimation methods in STATA 13.1. The fixed and random effects models were then tested for effectiveness using the Hausman test. Finally, the models were tested for heteroskedasticity and autocorrelation. The following model is the form for the regressions:

$Y_i = \beta o + \beta 1\text{Total Investment in ICT by Industry}_i + \beta 2\text{Industry Specific GDP}_i + \beta 3\text{National GDP}_i + \beta 4\text{National Productivity}_i + \beta 5\text{National Unemployment}_i + \beta 6\text{National PPI}_i + \beta 7\text{Proportion of ICT Investment in Total Investment}_i + \varepsilon_i$

All variables were converted into percentages to create consistency in the magnitudes of all variables. Y_i stands in the equation as the dependent variable. There were three different dependent variables used and each one was estimated separately. The United States and Canada were prime options for this analysis because they both have large economies and large amounts of available data.

The reason ICT investment by Industry was chosen as an independent variable is because it measures total investment in software and computers which provides a relative measure of overall technology usage in an industry. Based on the literature reviewed there is mixed sentiment amongst economists as to whether or not technological unemployment occurs as a result of increasing ICT investment. However, as the amount of total investment in ICT increases the literature reviewed for this study provides a strong argument that it will eliminate more jobs than it creates. The relationship ICT investment by industry has with median wages and corporate profits is another controversial topic of debate. Classical economists would argue that technological growth through ICT will improve both median wages and corporate profits. However, the literature reviewed for this study uses bargaining theory to argue that more productive ICT technology is keeping median wages stagnant while increasing corporate profits. The variable ICT as a percentage of total investment is another variable of interest when it comes to measuring the effect of technology on the labor market. Rather than looking at raw investment numbers, this measure allows us to see whether the proportion of ICT capital that is being used is increasing in comparison to other forms of capital investment.

Industry specific GDP growth rate is a variable that helps explain the overall health of an industry. The value for the beta coefficient of industry specific GDP Growth Rate is expected to be positive. It is expected that as production in the industry increases employment, wages, and profits will increase as well. The national productivity growth rate is another measure but its impact on employment, wages, and corporate profits is not as easy to predict. National productivity growth measures increased output in an industry which impacts employment, wages, and profits in different ways. Increases in productivity make workers more productive which results in businesses not needing as many employees. However, these gains in productivity often also increase output which creates new jobs. Therefore, it is difficult to precisely say whether productivity will have a positive or negative relationship with employment. As workers become more productive they produce more goods, therefore deserving a higher wage. The expected relationship between median wages and productivity is positive. When businesses don't need as many employees to produce the same output they obtain more profits. Therefore the expected relationship between productivity and profits is positive. The unemployment rate was added as a variable in our analysis to measure the percentage of workers in a country who are actively looking for a job but cannot obtain one. The national unemployment rate is expected to have a negative relationship with employment, median wages, and corporate profits. When the unemployment rate increases it is a direct measure of employment decreasing. Also when unemployment is high it is because businesses can't afford to hire employees. Therefore it is a sign of lower profits and inability to pay workers more wages. The national PPI Growth Rate was chosen as a measure of increasing costs for producers. It is expected that the beta coefficient will be negative with all three dependent variable. The reasoning is that as costs increase businesses will be able to produce less goods which results in lower wages, less employees, and lower profits.

V. Results

To begin, looking at the descriptive statistics in Table 1 there are some interesting results that should be noted. Employment is growing more quickly in Canada but median wages are growing more quickly in the United States. Both countries have high levels of ICT growth by industry at about 9% for the United States and 10% for Canada. Finally, both the United States and Canada have similar GDP growth rates on a national and industry level at about 5%. The average growth rates presented in tables 2 and 3 also show interesting results. In the United States, Educational Services has the highest employment growth rate and relatively high levels of ICT investment. Professional, Scientific, and Technical Services has the highest growth rate of median wages and a relatively medium to high level of investment in ICT. Mining and Oil and Gas Extraction has the highest average growth rate of corporate profits and has relatively medium to high level of investment in ICT. In Canada we see a similar story. Arts has the highest growth in employment and a very high level of ICT investment. Mining has the highest growth in median wages and a very high growth rate of ICT investment. Professional, Scientific, and Technical services has the highest growth rate in corporate profits and a medium level of ICT investment. The average growth rate tables show us that investment in ICT seems to increase employment, median wages, and corporate profits.

The results of the initial regression results for employment are given in Table 4 for the United States and Table 5 for Canada. The results do not provide evidence for technological unemployment. There were 152 observations in each regression and the Hausman Test revealed that random effects was the more effective model in both countries. The Breusch Pagan Lagrange Multiplier Test confirmed that random effects is more effective over OLS estimation. Tests for autocorrelation and heteroskedasticity revealed that there was autocorrelation and heteroskedasticity in the regression. The significant variables in the United States results are industry ICT investment, Industry GDP, and Nationally Productivity. All three variables are significant at a 5% level. The relationship between employment and ICT investment is actually positive, contrary to the argument brought forth in the literature review for technological unemployment. If investment in ICT increases by 1% then employment increases by .068%. The overall R-Square value for the United States employment regression model was .46. Looking at the regression results for Canada we see similar results. One difference is that National Productivity is not significant but percentage of ICT investment in total investment is significant. The relationship between employment and ICT investment is also positive. However, there is some evidence here for technological unemployment. As percentage of ICT investment in total investment increases by 1%, which is a measure of ICT usage intensity in an industry, employment goes down by .072%. The overall R-Square value for the Canada employment regression model was .21.

The regression results for median wages can be seen in Tables 5 and 6. The results were not significant. The model here might need to be adjusted with new independent variables or there might simply not be enough observations. The employment regression has a 152 observations for both the United States and Canada but the median income regression only has 77 observations for the United States and 114 observations for Canada. In the future once more data is collected on median wages this model will be able to provide much more significant results.

The regression results for corporate profits can be found in Tables 7 and 8. Although the results are significant, they are contradictory. The United States model had 88 observations and the Canada model had 144 observations. In the United States regression the Hausman test revealed that the random effects model is more effective than the fixed effects model. However, the Breusch Pagan Lagrange Multiplier Test revealed that the OLS estimation method is more effective than random effects. The results from the OLS estimation for industry ICT investment, industry GDP, and percentage of ICT investment in total investment were significant at a 10%

level. The results here are somewhat contradictory because as ICT investment increases corporate profits go down but as the percentage of ICT Investment in total investment goes up, corporate profits increase. Testing revealed that there is heteroskedasticity and autocorrelation in this regression. The R-Sqaure value was .17. Turning to the Canada corporate profit regression the results were significant but did not reaffirm the results from the United States corporate profit regression. The Hausman Test showed random effects was more effective than fixed effects but the Breusch Pagan Lagrange Multiplier Test revealed that the OLS estimation method is more effective than random effects. The only statistically significant variable in the OLS regression is industry ICT investment. The variable shows a positive relationship between ICT investment and Corporate Profits. This relationship is the opposite of the relationship between ICT investment and corporate profits in the United States. The R-Square value of the Canada corporate profit regression is .08. Test for autocorrelation and heteroskedasticity showed there is autocorrelation but not heteroskedasticity in the Canada corporate profit regression model.

VI. Conclusion

Erik Brynjolfsson and Andrew McAfee (2012) provided a convincing argument about how the benefits generated by technology may not be guaranteed to everyone in society. The argument is not new and dates all the way back to 1817 in David Ricardo's classical text On the Principles of Political Economy and Taxation. Ricardo stated that "My mistake arose from the supposition, that whenever the net income of a society increased, its gross income would also increase; I now however, see reason to be satisfied that the one fund, from which landlords and capitalists derive their revenue, may increase, while the other, that upon which the laboring class mainly depend, may diminish, and therefore it follows, if I am right, that the same cause which may increase net revenue of the country, may at the same time render the population redundant and deteriorate the condition of the laborer" (Ricardo, 1817, p.284). The empirical analysis presented in this paper has not provided evidence for a negative relationship between investment in ICT and employment, median wages, or corporate profits. In the employment regression, the positive coefficient estimate of ICT Investment in Canada and the United States shows that investment in technology is actually having a positive effect on employment. However, the potential for technology to replace jobs faster than it creates jobs and to increase income inequality certainly exists. Therefore, more research is needed to continue to explore the effect of technology on the labor market.

Works Cited

Acemoglu, D., (2014). Return of the Solow Paradox? IT, Productivity, and Employment in U.S. Manufacturing. Retrieved from http://www.nber.org/papers/w19837

Autor, D.H., (2014). Polanyi's Paradox and the Shape of Employment Growth. Retrieved from http://economics.mit.edu/files/9835

Ballard, Barclay. "Xerox's new AI Customer Care Agent Learns Just Like a Human." October 28th, 2014.Web. <http://www.itproportal.com/2014/10/28/xeroxs-new-ai-customer-care-agent-learns-just-human/>.

Brynjolfsson, E., & McAfee, A. (2011). Race Against the Machine. Lexington, Massachusetts: Digital Frontier Press.

Bureau of Labor Statistics (BLS). (2014). Database of Employment, Hours, and Earnings – National. Retrieved from http://www.bls.gov/data/#employment

Bureau of Labor Statistics (BLS). (2014). Occupational Employment Statistics. Retrieved from http://www.bls.gov/oes/tables.htm

Bureau of Economic Analysis (BEA). (2014). National Income and Product Account Tables, Corporate Profits Before Tax by Industry. Retrieved from http://www.bea.gov/iTable/iTable.cfm?ReqID=9&step=1#reqid=9&step=3&isuri=1&904=1998&903=243&906=q&905=2013&910=x&911=0

Center for the Study of Living Standards (CSLS). (2014). Database of Information and Communication Technology (ICT) Investment and Capital Stock Trends: Canada vs United States. Retrieved from http://www.csls.ca/data.asp

Congressional Budget Office (CBO). (2007). Labor Productivity: Developments Since 1995. Retrieved from https://www.cbo.gov/sites/default/files/03-26-labor.pdf

Organization for Economic Cooperation and Development (OECD). (2014). Database of Gross Domestic Product (GDP). Retrieved from https://data.oecd.org/gdp/gross-domestic-product-gdp.htm

Organization for Economic Cooperation and Development (OECD). (2014). Database of Growth in GDP per capita and labour productivity. Retrieved from http://stats.oecd.org/Index.aspx?DataSetCode=PDB_GR

Organization for Economic Cooperation and Development (OECD). (2014). Database of Producer Price Indices. Retrieved from https://data.oecd.org/price/producer-price-indices-ppi.htm

Organization for Economic Cooperation and Development (OECD). (2014). Database of Unemployment Rate. Retrieved from https://data.oecd.org/unemp/unemployment-rate.htm

Ricardo, D., (1817). On The Principle of Political Economy and Taxation. Kitchener, Ontario: Batoche Books.

Rotman, D., (2013). How Technology is Destroying Jobs. Retrieved from http://www.technologyreview.com/featuredstory/515926/how-technology-is-destroying-jobs/

Statistics Canada. (2014). Earnings of Individuals, by selected characteristics and North American Classification System (NAICS), 2011 constant dollars. Retrieved from http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=2020107

Statistics Canada. (2014). Quarterly balance sheet and income statement, by North American Industry Classification System (NAICS). Retrieved from http://www5.statcan.gc.ca/cansim/a26?lang=eng&id=1870001

VII. Tables

	Table 1 - Descriptive Statistics							
	United States				Canada			
	Mean	St Dev.	Min	Max	Mean	St Dev.	Min	Max
Industry Employment GR	0.97	3.61	-11.63	10.23	1.87	4.36	-14.62	16.44
Industry Median Wage GR	2.16	3.28	-15.32	7.89	0.84	4.48	-15.1	18.65
Industry Corporate Profit GR	23.11	122.66	-229.58	949	24.57	278.44	-1314.4	2300
Industry ICT Investment GR	8.97	15.33	-39.77	61.55	10.1	31.49	-56.07	246.44
Industry GDP GR	5.69	7.06	-27.57	35.25	5.4	9.86	-42.17	76.7
National GDP GR	4.76	2.1	-2.04	6.67	4.6	2.3	-2.38	8.14
National Productivity GR	1.92	0.97	0.3	3.5	1.35	0.92	-0.1	2.9
National Unemployment GR	4	17.97	-11.88	60.38	0.76	11.98	-10.14	36
National PPI GR	2.05	2.69	-4.94	7.92	1.76	2.56	-3.5	7.45
% of ICT in Total Investment GR	2.73	9.51	-25.69	49.4	3.41	25.75	-46.91	205.8
Trend	10	5.5	1	19	10	5.5	1	19
N (employment)	152				152			
N (median wage)	49				95			
N (corporate profit)	88				133			

Table 2 - Average Industry Growth Rates

United States	Information and Cultural Industries [51]	Professional, Scientific and Technical Services [54]	Wholesale Trade [41]	Retail Trade [44-45]	Educational Services [61]	Arts, Entertainment and Recreation [71]	Manufacturing [31-33]	Mining and Oil and Gas Extraction [21]
Employment GR	0.3	2.73	0.34	0.52	3.25	2.84	-2.04	-0.14
Median Wage GR	2.87	4.17	-	0.865	3.1	0.27	2.23	1.64
Corporate Profit GR	49.34	41.92	6.75	5.49	14.29	7.92	11.33	47.89
Industry GDP	6.1	6.33	4.72	4	7.54	5.86	3.14	7.79
Industry ICT Investment GR	7.67	10.04	7.58	7.04	13.92	10.37	4.41	10.63
% of ICT Investment in Total Investment GR	2.36	1.78	3.49	3.34	3.48	3.36	0.32	2.74

Canada `	Information and Cultural Industries [51]	Professional, Scientific and Technical Services [54]	Wholesale Trade [41]	Retail Trade [44-45]	Educational Services [61]	Arts, Entertainment and Recreation [71]	Manufacturing [31-33]	Mining and Oil and Gas Extraction [21]
Employment GR	0.87	3.93	2.12	1.09	1.84	4.09	-0.65	1.68
Median Wage GR	-0.16	1.14	-	-	0.37	-	0.58	2.26
Corporate Profit GR	-52.79	158.6	31.17	7.98	-	-75	29.67	72.35
Industry GDP	5.03	8.1	4.54	3.91	4.78	5.18	2.5	9.2
Industry ICT Investment GR	3.87	7.23	8.8	9.2	7.97	18.58	4.77	20.39
% of ICT Investment in Total Investment GR	0.7	-3.38	0.81	2.52	1.55	10.01	4.51	10.58

Table 3 - Average Industry Growth Rates Level Terms

	Information and Cultural Industries [51]	Professional, Scientific and Technical Services [54]	Wholesale Trade [41]	Retail Trade [44-45]	Educational Services [61]	Arts, Entertainment and Recreation [71]	Manufacturing [31-33]	Mining and Oil and Gas Extraction [21]
United States								
Employment GR	3,058.26	6,203.94	5,620.22	4,025.29	2,405.56	1,671.55	15,775.84	578.37
Median Wage GR	44,143.58	47,877.36	-	21,113.75	37,935.00	22,052.78	32,614.72	39,530.25
Corporate Profit GR	38,805.75	32,953.83	75,937.33	92,775.50	3,810.00	4,421.00	167,725.40	26,917.50
Industry GDP	480,848.30	647,205.90	608,869.90	673,873.40	91,959.47	95,316.95	1,438,173.00	152,359.40
Industry ICT Investment GR	78,573.53	34,505.16	17,882.00	12,913.95	4,196.53	1,094.95	38,407.21	2,285.00
% of ICT Investment in Total Investment GR	45.31	45.87	33.65	19.41	18.89	5.12	13.08	4.28
Canada								
`	**Information and Cultural Industries [51]**	**Professional, Scientific and Technical Services [54]**	**Wholesale Trade [41]**	**Retail Trade [44-45]**	**Educational Services [61]**	**Arts, Entertainment and Recreation [71]**	**Manufacturing [31-33]**	**Mining and Oil and Gas Extraction [21]**
Employment GR	365.12	890.33	519.61	1,798.26	1,002.90	284.40	2,046.02	193.47
Median Wage GR	26,478.95	40,931.58	-	-	41,057.89	-	40,857.89	46,700.00
Corporate Profit GR	1,110.42	782.68	2,045.84	1,647.58	-	34.21	7,250.21	729.84
Industry GDP	34,713.11	44,406.68	53,268.00	54,926.95	52,553.42	8,896.00	155,386.40	62,410.79
Industry ICT Investment GR	6,735.49	1,888.45	1,529.58	1,211.78	891.77	274.83	2,239.45	267.00
% of ICT Investment in Total Investment GR	66.55	50.35	35.96	21.61	8.83	23.55	10.26	0.80

	Table 4 - Regression Results: Employment					
	United States					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	0.068***	0.024	0.057***	0.021	0.059***	0.021
Industry GDP GR	0.207***	0.04	0.19***	0.035	0.193***	0.035
National GDP GR	0.096	0.636	0.2	0.442	0.195	0.452
National Productivity GR	-0.753	0.486	-0.813***	0.349	-0.813***	0.356
National Unemployment GR	-0.013	0.071	-0.01	0.053	-0.009	0.054
National PPI GR	-0.04	0.13	-0.058	0.089	0.058	0.091
% of ICT in Total Investment GR	-0.04	0.04	-0.043	0.031	-0.043	0.032
Trend	-0.014	0.06				
N	152		152		152	
R-Square	0.46		0.46		0.46	

	Table 5 - Regression Results: Employment					
	Canada					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	0.06***	0.022	0.046***	0.022	0.054***	0.022
Industry GDP GR	.083***	0.037	0.078***	0.037	0.083***	0.037
National GDP GR	0.078	0.401	0.087	0.389	0.076	0.393
National Productivity GR	0.07	0.433	-0.063	0.385	-0.06	0.389
National Unemployment GR	-0.066	0.082	-0.078	0.079	-0.076	0.079
National PPI GR	-0.083	0.183	-0.109	0.17	-0.118	0.172
% of ICT in Total Investment GR	-0.077***	0.026	-0.064***	0.026	-0.072***	0.026
Trend	0.05	0.068				
N	152		152		152	
R-Square	0.22		0.21		0.21	

	Table 6 - Regression Results: Median Income					
	United States					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	0.004	0.045	0.003	0.044	0.004	0.043
Industry GDP GR	-0.044	0.067	-0.07	0.071	-0.061	0.067
National GDP GR	-0.219	0.987	0.29	0.441	0.272	0.434
National Productivity GR	-0.732	0.484	-0.757	0.459	-0.754	0.452
National Unemployment GR	0.023	0.107	0.075	0.051	0.074	0.05
National PPI GR	0.019	0.117	0.104	0.111	0.101	0.109
% of ICT in Total Investment GR	-0.073	0.072	-0.088	0.07	-0.085	0.068
Trend	-0.154	0.29				
N	77		77		77	
R-Square	0.14		0.13		0.13	

	Table 7 - Regression Results: Median Income					
	Canada					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	0.007	0.038	0.001	0.039	0.005	0.038
Industry GDP GR	0.044	0.051	0.041	0.052	0.047	0.051
National GDP GR	-0.362	0.576	-0.511	0.534	-0.509	0.529
National Productivity GR	0.272	0.547	-0.263	0.551	-0.271	0.545
National Unemployment GR	-0.125	0.125	-0.162	0.116	-0.157	0.115
National PPI GR	0.484*	0.285	0.431	0.277	0.434	0.274
% of ICT in Total Investment GR	-0.02	0.08	-0.018	0.044	-0.02	0.043
Trend	0.052	0.08				
N	114		114		114	
R-Square	0.15		0.15		0.15	

	Table 8 - Regression Results: Corporate Profit					
	United States					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	- 2.65***	1.33	- 2.92***	1.4	- 2.79***	1.34
Industry GDP GR	6.85***	2.12	7.51***	2.45	6.92***	2.14
National GDP GR	66.83	52.19	41.64	51.54	40.96	49.83
National Productivity GR	4.67	33.69	-6.22	34.43	-5.7	33.29
National Unemployment GR	6.65	6.33	4.54	6.43	4.42	6.22
National PPI GR	-1.22	7.16	0.17	7.47	0.176	7.16
% of ICT in Total Investment GR	3.744*	2.21	4.18*	2.41	3.76*	2.23
Trend	-2.8	3.82				
N	88		88		88	
R-Square	0.17		0.15		0.15	

	Table 9 - Regression Results: Corporate Profit					
	Canada					
	OLS		Fixed Effect		Random Effect	
	β	SE	β	SE	β	SE
Industry ICT Investment GR	3.7***	1.45	3.64***	1.44	3.72***	1.43
Industry GDP GR	-2.44	2.49	-3.52	2.5	-2.91	2.47
National GDP GR	-6.8	26.78	0.345	25.34	-0.77	25.38
National Productivity GR	35.95	24.58	37.69	24.15	37.34	24.17
National Unemployment GR	-0.21	5.72	1.13	5.38	1.09	5.38
National PPI GR	2.97	12.74	6.09	12.23	5.47	12.23
% of ICT in Total Investment GR	-2.8***	1.7	-2.55	1.7	-2.81	1.69
Trend						
N	147		147		147	
R-Square	0.08		0.08		0.08	