Occupation Change and Technological Unemployment in North Carolina

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Abstract

Occupational change and turnover are constantly occurring, but many analysts predict the trends will accelerate in future decades as technological advances continue and become more capable of performing human tasks. This study examines recent occupational change in North Carolina as well as the potential impacts of technologically-induced unemployment on future employment forecasts. Between 2002 and 2015, both occupations adding employment as well as occupations decreasing employment changed in numbers at an annual average rate of near 3.5%. However, during the years of the Great Recession, annual employment change almost tripled to near 10% for both expanding and contracting occupations. Interestingly, the recessionary period was the only time span where the average wage of expanding occupations exceeded the average wage of contracting occupations. Using a detailed forecast of occupational downsizing resulting from future technology, employment forecasts are found to be significantly lower than forecasts from traditional sources. Hence, if enhanced technological unemployment does occur, future labor markets will be more dependent on job creation in new fields. Also, major changes will be required in higher education institutions and state-run unemployment compensation systems.

1 Introduction

Occupational change is an on-going process in the economy. In the last century, two great transitions of occupations have occurred. First was the decline of employment in farm occupations coupled with the rise of manufacturing occupations in the early to mid-20th century. Workers left the farm and migrated to factories in cities. Second was the shift out of manufacturing occupations in the last quarter of the 20th century to new work in service occupations (Wyatt and Hecker, 2006).

These occupational transitions have been facilitated by technological developments. The replacement of human and animal power on the farm with tractors, combines, and other agricultural equipment dramatically increased farm efficiency and labor productivity, thereby releasing unneeded labor for other uses. Likewise, the on-going mechanization and adoption of modern technology in the factory have lowered employment in manufacturing by 36% since the late 1970s (US Bureau of Labor Statistics, 2016a), even as manufacturing output has doubled (US Bureau of Economic Analysis, 2016). Fortunately in both cases, expansion in employment in other occupational areas (manufacturing in the case of farming; services in the case of manufacturing) was timely to prevent massive structural unemployment.[1]

Driving both occupational transitions was the development of technology for performing routine tasks. It has become useful to define occupations by the type of task performed. Acemoglu and Autor (2011) define three broad occupational task categories. *Abstract analytical and managerial tasks* (here termed "analytical tasks") involve problem-solving skills needing creativity and hypothesis testing and which require the highest levels of education. *Routine cognitive and manual tasks* (referred to as "routine tasks") use logical, repetitive processes requiring little variation or thought. Assembly-line occupations in manufacturing are a good

[1]The construction boom of the mid-1990s to the mid-2000s also cushioned the loss of manufacturing employment during that time period (Charles et al., 2013).

example using these tasks. Third are *non-routine manual tasks* that require flexibility and adaptation to specific situations, such as security guards and health care aides. Lesser levels of education and training are needed for the latter two types of tasks.

Technological replacement of human labor has occurred most pervasively in jobs with routine tasks, but more recently technology is being used to substitute for human performance of non-routine manual tasks. Security cameras replacing security guards is an example. However, with advanced development of robotics, artificial intelligence, and virtualization, some futurists forecast technology's performance of human tasks will increasingly enlarge to also include analytical tasks. The replacement of case research done by paralegals with computer programs is an example (Legal Skills Prof, 2013). Indeed, there are worries these developments could lead to Keynes' prediction of an economy with much less human labor required (Keynes, 1963). While Keynes viewed this outcome positively, others are concerned it could create a massive, permanent underclass (Standing, 2011). Whatever the outcome, it is thought by some that the rapid advancement of technology will cause the pace of occupational change to accelerate in future decades (Manyika et al., 2015).

This paper examines recent occupational change in North Carolina. As one of the nation's fastest growing states with an economy that has been restructured in recent decades (Walden, 2008), North Carolina offers an excellent environment for addressing several questions related to occupational change. What has been the rate of occupational change, and how has the upsizing and downsizing of occupations been influenced by phases of the business cycle? How do the wage rates of occupations adding employment and occupations reducing employment compare, and does the comparison vary with components of the business cycle? Is there evidence suggesting recent occupational change in North Carolina has been related to advances in technology? If it is found technological advances are related to occupational change, how might this linkage affect employment forecasts? Last, if increased occupational change and unemployment from technological advances are likely, what changes in both public and private policies are recommended to address the implications?

Technological change and its implications for the labor market will likely be one of the top issues of the 21st century. Typically changes in the labor market occur slowly, meaning they can be imperceptible to the average observer. This paper provides a look at how technology is impacting the labor market in one state, and specifically how it is affecting employment availability and wages in alternative occupations. The findings will help reveal the transformative nature of technological change on the labor market so that both private and public decision-makers avoid "sleepwalking" through the effects that will likely touch almost every industry and employment sector.

2 Occupational Change and the Business Cycle

The Occupational Employment Statistics program of the U.S Bureau of Labor Statistics (BLS) uses a semi-annual mail survey to collect information on occupations (US Bureau of Labor Statistics, 2016b). A sample of 1.2 million business establishments is used to develop information for almost 800 occupations. Self-employed workers are not included in the surveys. For each occupation there is information for total employment, the relative size of the occupations total employment, and the average (both mean and median) hourly wage paid.

Annual data for North Carolina from the BLS occupational series were assembled for four years 2002, 2007, 2010, and 2015. The data set was begun with 2002 because this is the earliest year for which the occupational categories are consistent with later years.[2] The Great Recession began at the end of 2007, so the occupational data for May (when the surveys are benchmarked) 2007 is the latest prior to the recession's onset. The bottom of the job market during the Great Recession occurred in 2010, and 2015 was the last available year for the occupational data at the time of the analysis.[3] Four sets of comparisons - 2000 to 2007, 2007 to 2010, 2010 to 2015, and 2000 to 2015 were investigated to answer the questions about occupational

[2]The BLS began using the North American Industry Classification System (NAICS) for occupations in 2002. However, even using the NAICS, there were some changes in classifications from year to year that precluded matching all occupations. Occupations which could not be matched where not included in the analysis. This is the reason there is some variation in the number of occupations in each year.

[3]The Great Recession officially ended in mid-2009, but the job market only began improving in early 2010.

change.

Table 1 shows how the speed and type of occupational change in North Carolina varied during the recent business cycle. There are several notable findings. First, examining the pace of occupational change (columns 2 and 5), the annualized rates of change for occupations gaining employment and those losing employment are similar in magnitude. However, employment change accelerated for both occupations gaining employment and occupations losing employment during the recessionary period of 2007-2010, with the acceleration greater for gaining occupations than for losing occupations. Also, the 2007-2010 recessionary period is the only one where the annualized rate of change for job gainers was greater than the annualized rate of loss for job losers. This suggests there are economic opportunities even in the disruptive period of a recession. During the economic recovery of 2010-2015, the pace of employment change dropped for both occupations gaining jobs and those losing jobs to levels close to the rates in the period prior to the recession (2002-2007).

Table 1: Measures of Occupational Change in North America

	Occupations Increasing Employment			Occupations Decreasing Employment		
Time Period	Annualized Rate (5%) of Jobs Gained	Number of Occupations Gaining Jobs	Weighted Average Wage of Occupations Gaining Jobs	Annualized Rate (%) of Job Losses	Number of Occupations Losing Jobs	Weighted Average Wage of Occupations Losing Jobs
2002-2007	6.72%	355	$17.93	-6.87%	247	$19.73
2007-2010	10.69%	291	$22.52	-9.45%	391	$18.22
2010-2015	5.97%	392	$20.20	-6.18%	309	$19.83
2002-2015	3.35%	322	$18.38	-3.73%	280	$20.34

[a] There were also 6 occupations in 2002-2007, 8 occupations in 2007-2010, 9 occupations in 2010-2015, and 6 occupations in 2002-2015 with no change in employment. The total number of occupations differ for each comparison period due to changing occupational descriptions which precluded matching. The wage is the median wage per hour in real 2015 dollars in the initial year of each time span.

There is a second set of significant results from looking at the number of occupations gaining and losing employment during the time periods (columns 3 and 6). In the two economic growth periods of 2002-2007 and 2010-2015, the number of occupations adding employment exceeded the number of occupations reducing employment; by a margin of 44% in the earlier period and by a 27% margin in the latter period. However as would be expected, during the recessionary period of 2007-2010 the roles were reversed, with the number of occupations having less employment exceeding the number of occupations boosting employment by 34%. During the entire period (2002-2015), the number of occupations adding employment exceeded the number reducing employment by 15%. Last, the differences in wage rates of gaining and losing occupations are noteworthy (columns 4 and 7). During the pre-recessionary growth period (2002-2007), occupations losing jobs paid higher wages than occupations gaining jobs by margin of $1.80 per hour. But during the recessionary period (2007-2010) the difference was reversed with occupations gaining jobs paying an hourly wage $4.30 per hour more than occupations losing jobs. In the expansionary period following the recession (2010-2015) the wage rate of gaining occupations continued to exceed the wage rate of losing occupations, but by a very small margin of $0.37 hourly. For the entire period (2002-2015), the wage rate of occupations losing jobs exceeded the wage rate of occupations gaining jobs by $1.96.

Table 2 shows the top 25 occupations gaining employment and the top 25 occupations losing employment in North Carolina between 2002 and 2015. A large number of the expanding occupations were in food services (food prep and serving, restaurant cooks, waiters and waitresses, and food preparation managers), health care (registered nurses, home health aides, medical assistants, pharmacy assistants), office services (administrative assistants, accountants and auditors, general office clerks, and receptionists), and retailing (retailing salespersons, manufacturing sales representatives). In contrast, the occupations leading in employment losses were in manufacturing (sewing machine operators, textile winding machine operators, textile knitting machine operators, production supervisors, and machine feeders, meat packers) and construction (general and operations managers, carpenters, and construction laborers). The manufacturing losses were related to structural changes in the industry, while the construction losses were likely from the cyclical decline

related to the Great Recession.

Table 2: Top 25 Job Gaining Occupations and Top 25 Job Losing Occupations in North Carolina (2002–2015)

Gaining Employment			Losing Employment		
Occupation	Average Annual Gain (jobs)	Hourly Wage ($)	Occupation	Average Annual Gain (jobs)	Hourly Wage ($)
food prep and serving	5935	8.77	executive secretaties	-1950	19.48
customer service reps	3136	16.26	general & operation mgrs.	-1093	38.33
retail salespersons	2790	11.03	sewing machine operator	-831	12.51
home health aides	1907	10.78	customer support spec.	-731	26.55
administrative assistants	1801	14.82	fast food cooks	-729	8.66
restaurant cooks	1405	11.42	textile winding mach. op	-722	1377
waiters & waitresses	1263	8.55	tech. product sales rep.	-643	28.78
software application devs.	127	44.92	textile knitting mach. op.	-623	14.41
child care workers	1037	10.14	shipping packers	-586	11.10
accountants & auditors	965	27.98	teacher assistnats	-539	n.a.
general office clersk	923	14.10	preschool teachers	-496	10.40
management analysts	876	36.96	shipping clerks	-493	14.41
security guards	805	12.12	production supervisors	-472	25.51
landscaping workers	804	12.25	machine feeders	-449	13.58
food preparation managers	793	15.56	computer programmers	-442	39.56
employment placement sp.	772	23.84	bookkeepers & account.	-437	16.74
computer systems analysts	764	38.46	institutional cooks	-436	10.87
firefighters	603	17.40	legal secretaries	-377	20.13
freight movers	596	12.20	order clerks	-371	15.73
medical assistants	540	14.96	meat packers	-365	11.58
pharmacy assistants	518	12.46	construction laborers	-350	13.15
receptionists	490	13.09	medical secretaries	-338	14.86
non-tech. product sales rep.	472	26.78	switchboard operators	-329	13.35
police patrol officers	470	20.53	chief executives	-323	80.74

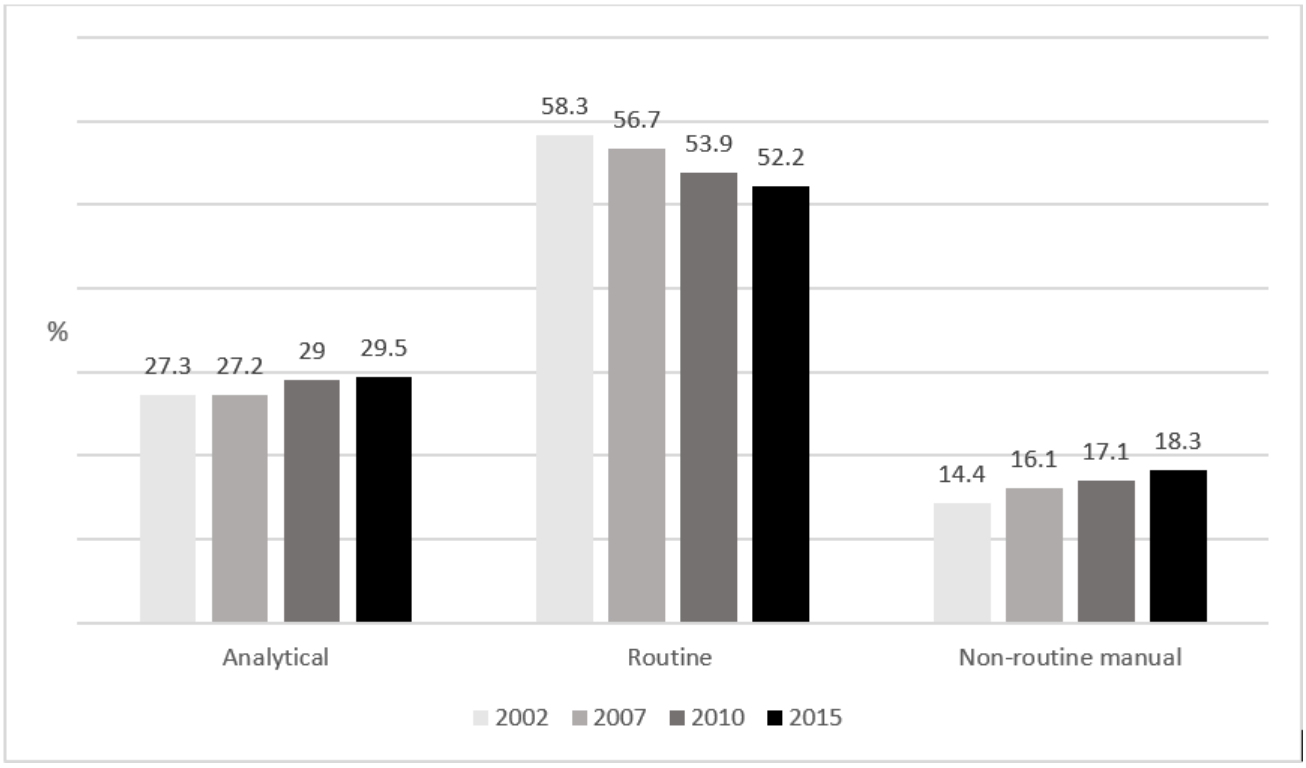
n.a. = not available; dollars are real 2015 values in the initial year (2002); hourly wage is the median; median wage was $16.18 for all occupations in 2002.

Yet despite individual occupational changes, there was a clear continuation of trends in occupations classified by the Acemoglu and Autor (2011) task framework. Figure 1 shows upward trends in the percentage of jobs performing analytical tasks and non-routine manual tasks and a commensurate downward trend in occupations doing routine tasks.[4] Since analytical, routine, and non-routine manual task occupations generally correspond to high, medium, and low wage jobs, the trends demonstrate a continuing polarization of the job market with growth in the shares of both high-paying and low-paying jobs and decline in the share of middle-paying jobs (Autor, 2010).

There are four major conclusions from these findings. First, occupational change has been widespread in North Carolina, during both growth and recessionary periods. Over the entire time period, more occupations gained jobs than lost jobs. Second, occupational change accelerated during the period of the Great Recession, with a significant jump in the number of occupations losing jobs. Also, the rate of employment change increased in both gaining and losing occupations. Significant is the finding that the rate of employment growth for those occupations adding jobs during the macroeconomic downturn exceeded the rate of employment decline for those occupations losing jobs. This finding adds support to the notion that economic opportunities and entrepreneurial activity may actually increase during recessions (Field, 2011). Third, while the average wage rate of occupations gaining jobs was lower than the average wage rate of occupations losing jobs during the entire time period (2002-2015), during the recessionary period (2007-2010) the wage rate of occupations adding jobs was substantially higher than the wage rate of occupations losing jobs, and

[4]Following Acemouglu/Autor, analytical tasks are defined to include managerial, professional, technical and public administration occupations; routine tasks include clerical, administrative, sales, transportation, production, and operative occupations; and non-routine manual tasks are performed in personal and business service occupations.

Figure 1: Changing Share of North Carolina Occupations Classified by Task Type



Source: data – U.S. Census Bureau; calculations by the author.

the margin was the highest of any during the individual time periods. This result implies firms add more high-valued employees during recessions, perhaps as they consolidate jobs into a smaller number requiring greater skills and training. Or, during dire times, firms may prefer more talented and experienced workers, and with a weak labor market, they find the supply of such workers more available. Last, the polarization of the North Carolina job market continued unabated throughout the recent business cycle.

3 Occupational Change and the Likelihood of Technological Unemployment

Economists Carl Frey and Michael Osborne developed an index measuring the probability of an occupation experiencing technological unemployment due to workplace innovations substituting machinery and technology for human labor (Frey and Osborne, 2013). Applied to the national job market, Frey and Osborne's analysis indicates almost half of current U.S. employment could be replaced by technology in upcoming decades. While alternative analyses predict much lower rates of technological unemployment (Arntz et al., 2016), the Frey/Osborne forecasts can be considered "upper bound" estimates of technology's potential impact on the labor market.[5] The Frey/Osborne measure, referred to here as the "probability of technological replacement" (PTR), is unique for each of 702 occupations and is based on an assessment by Frey and

[5]The difference between the Frey/Osborne (FO) analysis and the Arntz/Gregory/Zierahn (AGZ) analysis is the handling of occupations with multiple tasks. If technology can replace the major but not all tasks of an occupation, then FO considers the entire occupation to be replaced by technology. In contrast, AGZ eliminates tasks rather than occupations, and so assumes occupations with multiple tasks will be reorganized to permit those tasks continuing to be performed by humans to escape elimination. For example, if computer programs can perform the major task of paralegals case research then FO counts paralegals as an occupation replacing human performance with technology. But if one of the tasks of paralegals is to also customize the case research for a specific case something that may not be easily accomplished by a computer program - then AGZ does not eliminate that component of paralegals. Instead, AGZ assumes the paralegal profession will be reconstituted to continue to perform the customization of computer-generated case research.

Osborne in consultation with experts in science and technology. Values for PTR range from 0 to 1, where 0 is no likelihood of job replacement by technology and 1 is complete job replacement by technology.

Table 3 reports the results of regressing occupational change (measured by the average annual change in the occupation's number of jobs) on PTR and a measure of aggregate change in the North Carolina economy. Two alternative measures of aggregate economic change for the state are used - the annual percentage change in total state employment, and the annual percentage change in aggregate state production of goods and services (gross state product, or GSP). In order to test variation in the aggregate economic change measures, the 2002-2015 time period is divided into the three sub-periods of pre-recession growth (2002-2007), recession (2007-2010), and post-recession growth (2010-2015).

Table 3: Est. Statistical Links between Occ. Change and the Likelihood of Tech. Unemp.

Variable	Using Annual Changes in NC Jobs		Using Annual Changes in NC GSP	
Technology Unemployment Index (PTR)	-3.401	***	-3.45	***
Aggregate Growth Control	0.715	***	1.03	***
Adjusted R^2	0.02		0.03	

N= 1834, Statistical level of significance: ***:0.01; **0.05; *: 0.10.

The results in Table 3 show that using either measure of aggregate economic change, PTR is negatively related to occupational job change. The estimates show that every 0.1 unit increase in the likelihood of an occupation's employment being downsized by technology results in a 0.3 percentage point decrease in the occupation's annual job growth rate. The results also show every 1 percentage point increase in the aggregate job growth rate is related to a 0.715 percentage point increase in the occupation's job growth rate, and every 1 percentage point increase in the state GDP growth rate is associated with a 1.03 percentage point increase in the occupation's job growth rate.[6]

4 Implications for Employment Forecasts

Like all economic forecasting, projecting long-run employment predictions is difficult, especially when viewed with the benefit of hindsight.[7] A major impediment is accounting for future technical innovations which, among other things, affect the optimal combinations of labor and capital. An argument can be made that, by their nature, such innovations are unpredictable - some would say, even whimsical (Kennedy, 2016; Weiner, 2016). The longer the forecasting period, the greater the likelihood of error due to the inability to incorporate changes in technology.

The U.S. Bureau of Labor Statistics periodically produces employment forecasts for industries and occupations. BLS' forecasts for 2014 to 2024 by occupation were applied to North Carolina's occupational structure and then grouped by the three task categories of analytical, routine, and non-routine manual, with the results shown in the second column of Table 4.[8] There is both overall growth as well as growth in each of the task categories. There is also the expected shift out of routine tasks mainly to analytical tasks, with a slight increase in non-routine manual tasks. Still, the outlook is reasonably optimistic, with the major

[6] A regression was also run for each of the three time periods, which precluded controlling for the aggregate growth rate variables. The results also showed a negative and statistically significant relationship between the occupations growth rate and PTR of magnitudes similar to those reported in Table 3.

[7] For a critical review of employment forecasts, see Reynolds (2005).

[8] One issue is whether the national growth rates implied in the BLS forecasts should be adjusted upward for North Carolina, since the state has grown more rapidly than the nation in the post-World War II era. However, the positive difference in the North Carolina growth rate in GDP and the national growth rate has been narrowing, from 28% in the 1980s decade, to 23% during the 1990s, and to 11% from 2000 to 2010 (US Bureau of Economic Analysis, 2016). This trend follows the theory of growth convergence between states and regions (Higgins et al., 2006). Therefore, the national growth rates for occupations are directly applied to North Carolina.

implication being that higher levels of education will be required for more workers to be qualified for the fast growing occupations with analytical components.

Table 4: Alternative North Carolina Employment Forecasts (2014-2024)

	BLS	Frey/Osborne
Total jobs, percentage change, 2014-2024	10%	-8%
Analytical rask share % point change	+2% points	+6% poiints
Routine task share % point change	-2% points	-4% points
Non-routine manual task share % point change	+0.2% point	-2% points
Change in analytical task jobs	+250,754	+69,225
Change in routine task jobs	+78,608	-270,063
Change in non-routine manual task jobs	+88,051	-110,574

Source: Hogan and Roberts (2015); Frey and Osborne (2013); calculations by the author.

The process was repeated, but now applying the Frey/Osborne probabilities of each occupation undergoing a shift in performance by human labor to performance by technology. The same general growth rate for the North Carolina economy was assumed as in the BLS forecasts, and the same task groupings were developed. The results are reported in the third column of Table 4 under Frey/Osborne.

There are striking differences between the BLS forecasts and the Frey/Osborne forecasts. The aggregate changes in employment for the two forecasts are virtually a mirror image of each other, with a 10% gain in jobs in the BLS projection contrasted with an 8% decline in jobs using the Frey/Osborne projection. Both forecasts show a shift of employment to occupations performing analytical tasks, and the share gain is actually greater with the Frey/Osborne projections. However, there is a share loss twice as large for routine task occupations using the Frey/Osborne methodology, and Frey/Osborne shows a sizable drop in non-routine manual task jobs versus a small gain using the BLS projections. The result is a net gain in jobs for the three task categories combined using the BLS projections, with the largest increase for analytical task occupations. But using the Osborne/Frey methodology, only the analytical task occupations gain employment, and only at slightly more than one-fourth the level of the BLS projections, while the other two task occupations lose employment.

Thus, these comparisons show that major technological advances which result in a shift from human inputs to capital inputs in the workplace can give employment projections significantly different than traditional employment forecasts. In particular, if the speed of technological change increases, resulting in even faster and more unpredictable technology for human substitutes, then the structure of tomorrow's job market will be dramatically altered.

5 Policies for an Unpredictable Future

This paper has documented significant occupational changes occurring in North Carolina, changes that are likely to continue occurring possibly at accelerated rates as technological capabilities advance. The process will create issues and challenges for individual workers and for communities. To ease the transition to a new occupational structure, reforms of educational and labor market programs, processes, and policies should be considered.

The logical process is to first forecast what occupations will be downsized, what existing occupations will expand and new occupations developed, and then ensure that educational and training programs are in place to both retrain existing workers losing their employment and train new workers seeking employment for the occupations of the future. I term this process the *engineering model of workforce development*. In a predictable world, the engineering model is the process to follow.

The obvious problem is, the economic world is not predictable. As demonstrated in the previous section, occupational forecasts can be dramatically different under alternative assumptions of technological advancement and resulting technological unemployment. While the engineering model of workforce development

may work for an unchanging world or a world in which past trends continue, the model will give misleading forecasts under conditions of rapid and unknown technological change.

The initial step in a policy response to the rapidly evolving workplace is to systematically track occupational change. States should therefore establish a *EWSOC* - an Early Warning System of Occupational Change. EWSOC would include several components. First is examination of the annual BLS state occupational statistics to detect patterns and trends in occupational shifting, similar to the analysis performed in earlier sections of this paper. Second is use of traditional job postings as well as social media information about skill demands from sites such as LinkedIn to track market trends in hiring (State et al., 2014; Sussman and Korn, 2016). Third is regular direct surveys of firms in the state to access their hiring desires with respect to skills, training, and tasks to be performed.

Occupational churning - especially if it occurs at an accelerated pace - will have profound implications for states' higher educational institutions. Fields of study in community and technical colleges and four-year and higher colleges and universities may have to be rapidly altered and resources quickly reallocated to meet the rapidly changing needs of the workplace. It will become increasingly important for training in core competencies necessary for any occupation to be separate from training requirements directed at a specific occupation.

If occupational downsizing and change do proceed at a faster pace in future decades, then the composition of college students will likely change to include larger proportions of older, more mature students, with many having families to support. This may require two adjustments, one for support of unemployed workers, and the second for the delivery of higher education.

The current unemployment compensation system was designed for situations of temporary unemployment occurring with economic downturns. Workers were laid-off from their jobs during recessions, but were recalled to the same jobs once the economy recovered. For this cyclical type of unemployment, workers received compensation at some fraction of their full-time pay while they were temporarily unemployed. However, the unemployment resulting from technological change and occupational downsizing is structural in nature, as it results from permanent - not temporary - changes in the economy. To end a worker's structural unemployment means finding work in another occupation. For many workers facing such structural unemployment, this will require re-training for a new occupation. Therefore, the unemployment compensation system may need to be altered and augmented to provide upfront aid to be used by the worker for re-training costs, plus a monthly amount to help support the worker and any dependents of the worker during the retraining period.

At the same time, as more adult workers with dependents require public support during their training for a different occupation, it will be important for institutions delivering that retraining, such as community colleges and 4-year and beyond colleges and universities, to offer certificates and degrees in an efficient and timely manner that speeds the retraining process. To meet this goal may require modifications in how higher education institutions conduct courses and training and in the scope of educational requirements for a certificate or degree.

Private sector firms may also need to reconsider their worker training programs as technology disrupts the labor market. On-the-job retraining may become more important as technology rapidly alters the tasks performed by labor. The expectation of increased retraining at firms may cause a significant reformulation of the employer/employee contract. Costs incurred by firms in providing enhanced marketable skills to employees may necessitate temporary labor compensation deductions or limited non-compete contract clauses in the event an employee leaves the firms before a specified time period.

The prospect of massive skill retraining of the workforce in response to technological applications in the labor market implies the need for additional resources for these efforts. With public budgets facing increasing strains by expected future increases in health and retirement related programs, additional resources from the private sector will likely be considered. For example, at the post-secondary level (community and technical colleges, 4-year colleges and universities), this could occur with private sector firms being asked for more financial support in exchange for some level of private control over training and access to graduates. Alternatively, a tax on labor-modifying technological applications could be used to finance a labor retraining fund (Delaney, 2017). Bill Gates has offered this idea, but a possible downside is that the tax could stifle productivity-enhancing technological improvements.

6 Discussion and Conclusions

The job market is continually being remixed and remolded. Some existing occupations die, other occupations are born, and some occupations are reconfigured. The remaking of the occupational structure is not new, but some analysts forecast rapid advances in technology will speed occupational overhaul and substantially reduce future labor demand.

Using North Carolina as a sample state, the research first found that major occupational churning has been occurring in the state. During the period 2002-2015, both occupations adding employment and occupations decreasing employment did so at an average annual rate of near 3.5%. However, this rate almost tripled during recessionary years for both occupational expanders and occupational contractors. Also in recessionary periods and likely contrary to popular conventional wisdom, the number of occupations adding employment was still three-quarters the number reducing employment, and the occupations adding jobs paid an hourly wage 24% higher than the occupations cutting jobs. Over the entire period, the leading expanding occupations were in food services, health care, office services, and retailing, while occupations in manufacturing and construction headed the list of downsizing occupations.

The prospect of massive technological unemployment could very well be the leading labor market issue of the next several decades. One measure of potential technological displacement of labor inputs developed by Frey and Osborne was found to have a statistically significant linkage to recent employment changes in the North Carolina labor market. Applying the Frey/Osborne index to the North Carolina labor market resulted in employment forecasts much lower than conventional forecasts from the U.S. Commerce Department. A worry is that the current challenging labor market for low-skilled workers, especially males, will spread to higher skill levels as technology broadens its capabilities to perform a wide variety of tasks (The Economist, 2011).

Of course, history could repeat itself and new industries and new occupations may be developed to absorb workers displaced by technology. Several possibilities have been offered. Employment opportunities in an expanding service economy for time-constrained households - termed the "concierge sector" – have been suggested (Fowler, 2015). The development and implementation of new technology and the management and analysis of increasing amounts and varieties of data are virtual cinches for more hiring (Manyika et al., 2016; Lohr, 2015; DuBravac, 2015). The next step in globalization may be the expansion of world tourism and with it jobs that cannot easily be performed by technology. Unless technology rapidly replaces human inputs in health care, the aging of the population should create expanded employment in health care.

Last and perhaps ironically, there may be a backlash against technology that could create jobs in traditional fields. One is a revival of artisans and artisanship as a rebellion against the low-cost, mass-made products that have come to dominate the 21st century consumer market. An increased demand for specialty, hand-crafted products could spark a boom for carpenters, masons, seamstresses, and jewelry makers (Bowles, 2014). Second are specialists in social interaction who work beyond the capabilities of machines and technology to help businesses understand the subtleties of human behavior (Colvin, 2015).

Still, the likelihood of a labor market that is transforming at a faster rate combined with the possibility of widespread and chronic unemployment from technological advances and applications supports an elevated policy response to these issues centered around three points. First is detailed monitoring of occupational change with a goal of identifying growing and shrinking occupations. Second is interaction of these findings with occupational training options at both the technical and four-year college levels. Crucial to this response is a goal of swiftly reallocating resources among programs and majors in line with the shifting occupational structure and speeding the retraining of adults displaced in their occupation. Third is reform of the unemployment compensation system to support more structural unemployment instead of cyclical unemployment.

Adapting to the labor market challenges created by technological adaptations in the economy may require more private and public resources. In exchange for greater funding of technical and 4-year colleges, private firms may require more control over curriculum and labor contracts that guarantee a sufficient return on their investment. Alternatively, augmented public funding could be derived from taxing the technology creating the labor market disruptions.

Change in both tasks and occupations is the norm rather than the exception in the labor market. In the

past, the labor market has been able to adapt to the introduction of labor-replacing technologies with new industries and new occupations that have re-employed job losers. But some say "this time is different," and that labor demand will be permanently lower as a result of the extraordinary abilities of modern innovations and machines to perform work tasks (Kotlikoff and Sachs, 2012; Brynjolfsson and McAfee, 2014). Whether accurate or not, the clear message is that we should be alert to the possibility and consider steps and plans now to avert - what could be - massive unemployment occurring when codes and controls replace brawn and brains. Preparing now for potential technology-induced job dislocation in the future is a daunting challenge, but one for which the benefits to workers - and society at large - are likely great.

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