Forecasting the Potential Impact of the COVID-19 Pandemic on Employment Opportunities in the North Carolina Textile Industry using ARIMA Time Series Forecast Models

Sneha Rani[1], Lori Rothenberg[1], Helmut Hergeth[1]
Lisa Chapman[1]
[1]Department of Textile Technology Management, Wilson College of Textiles
NC State University, Raleigh, NC

Abstract
Employment opportunities in any industry are largely driven by several macroenvironmental factors. The global outbreak of COVID-19 slowed operations and transactions due to the extended lockdowns and changed consumer behaviors. The purpose of this study was to forecast the 2020 employment trends in the North Carolina textile industry from pre-pandemic data and to explore the potential impact of COVID-19 on employment in the industry. Data were obtained from the NC Department of Commerce Labor & Economic Analyses on employment, number of establishments, and wages for each of four textile businesses: textile mills, textile retail, textile wholesale, and textile services. Time series forecast models were built for data from 2014-2019 which were used to forecast data for 2020. In general, the number of establishments, employment and wages could be forecasted accurately for the first quarter of 2020. However, virtually none of the forecasts for the second quarter of 2020 were accurate. Interestingly, a few of the third and fourth quarter forecasts were accurate. Some of the inconsistencies could be unique to textiles because of its existing slow decline.

Key Words: ARIMA, Time Series, Employment, textile industry

1. Introduction

The textile industry in North Carolina has historically been one of the major industries providing huge employment opportunities for the eligible labor force. Over time, macro environmental factors such as changes in global and regional trade policies (Pickles et. al., 2015; Lu, 2013), technological advancements (Bessen, 2019), recession (Barker, 2011), and pandemics (Bodenhorn, 2020) affected employment (Kunz et al., 2016). The recent global outbreak of COVID-19 in 2020 slowed the operations and transactions across the entire textile industry global supply chain. Due to extended lockdowns and changed consumer behavior, several major businesses were severely adversely affected which led to closures of company divisions, furloughs, layoffs, wage reductions, and company shutdowns (Women's Wear Daily, 2020; Wall Street Journal 2020). However, at the same time, new employment opportunities requiring different skillsets emerged during this period. Several new business opportunities emerged. For instance, medical textiles demand increased because of increased healthcare operations and increased purchasing of masks and PPE through ecommerce websites (Wall Street Journal, 2020).

Most extant literature largely focuses on the impact of macro environmental factors on labor force opportunities related to historic events. As an extension of these previous studies, this study explored the possible impact of the recent pandemic, COVID-19, in 2020 on the textile industry. This study characterized labor growth opportunities for 2014-2019, when there was no pandemic. Using this as a benchmark, the 2020 scenario of labor growth employment opportunities in the textile industry was explored and compared, using the most recent validated employment data from the U.S. federal government. This study extended previously published studies that lacked analyses at a four-digit industry level particular to the textile industry (Rumberger et al, 1985; Duarte et al 2018; Acemoglu et al, 2016; Farooq & Kugler, 2015; Montgomery et al, 1998; Zhao et al, 2021). Though there have been studies which discuss the evolution and growth of the textile manufacturing sector or textile retail sector (Textile Heritage Museum, 2021; Acemoglu et al, 2016), all the four major business components (mills, retail, wholesale, and retailer) need exploration.

The purpose of this study was to forecast the 2020 employment trends in the North Carolina textiles industry from pre-pandemic data.

2. Data and Methodology

The North Carolina Department of Commerce, Labor and Economic Analysis Division (LEAD) and the U.S. Department of Labor's Bureau of Labor Statistics (BLS) have a federal-state cooperative program called The Quarterly Census of Employment and Wages (QECW) program. This program provides quarterly employment and wage data for the state of North Carolina and the United States. The QECW classifies business establishments using the North American Industry Classification System (NAICS) (www.nccommerce.com). We were interested in the data for the textile industry in North Carolina. We consulted the LEAD as to which NAICS codes would provide us with the most relevant and precise data. As suggested by LEAD, we used four-digit NAICS codes in the identification of companies. Data for the most recent years starting from the first quarter 2014 through the fourth quarter of 2020 came from https://d4.nccommerce.com/QCEWSelection.aspx.

This study divided textile companies based on the business types: Mills (all kinds of fiber, yarn, thread, fabric, apparel, and textile manufacturing, knitting, and finishing units), Retail (all kinds of apparel, textile, and home furnishing retail units), Services (dry cleaning and laundry services), and Wholesale (all kinds of apparel and textile related wholesalers) in North Carolina. Mills consisted of NAICS codes 3131, 3132, 3133, 3141, 3149, 3151, 3152, 3159. Retail consisted of NAICS codes 4422 and 4481. Services consisted of NAICS code 8123. Wholesale consisted of NAICS code 4243. For these four businesses, we chose three variables from the database: quarterly number of establishments (qtrly_estabs_count), quarterly employment (sum of month1_emplvl, month2_emplvl, and month3_emplvl), and quarterly wages (total_qtrly_wages). These are all quarterly measures over all the years studied. Data for the textile businesses encompass data for textile and apparel businesses, hereafter referred to as the textile industry.

As in previous analyses of the textile industry (Saki, 2020; Lu, 2015), this study used Autoregressive Integrated Moving Average (ARIMA) time series models to predict establishment, employment, and wages for textile companies in North Carolina.

3. Analysis & Results

3.1. The North Carolina Textile Industry (Q1 2014 – Q4 2018

Data from Q1 2014 – Q4 2018 were analyzed to determine the suitability of using ARIMA models. ARIMA models fit satisfactorily. With very few exceptions, forecast and actual values for 2019 were not statistically different using 95% prediction intervals. This was true for all textile companies analyzed together as well as for the individual textile sectors/businesses.

3.2 The North Carolina textile industry (Q1 2014 – Q4 2019

This section consists of the analyses using data up to the end of 2019. Time series analysis with ARIMA models was used to explore the trends, followed by forecasting future values. ARIMA models were used to forecast the values for the first three quarters of 2020.

The predicted values for 2020 were calculated as follows. Based on ACF and PACF plots, parameters for AR (p) and MA (q) were chosen. To identify the differencing orders, d, and build a stationary series, the Augmented Dickey Fuller (ADF) test was used. Based on the suitable parameters p, d, q, ARIMA models were fit and compared to find the best model to predict the growth of establishments across the total number of textile companies in 2020 and later. AIC was used to compare models. The residuals for the model were assessed for normality. The Ljung-Box Q values were used to assess the models for autocorrelation. In section 3.2.1, the trends and best fitting forecast models for all textile companies combined without regard to industry sector/business are presented. This is done for establishment, employment, and wages across all the industry sectors (or business types). Section 3.2.2 covers the trends examined across all four sector/business types followed by the details on best fit forecast models for each of them.

3.2.1 All textile companies

3.2.1.1 All textile companies: Establishments. Figure 3.1 shows a time series plot of the actual number of establishments over time

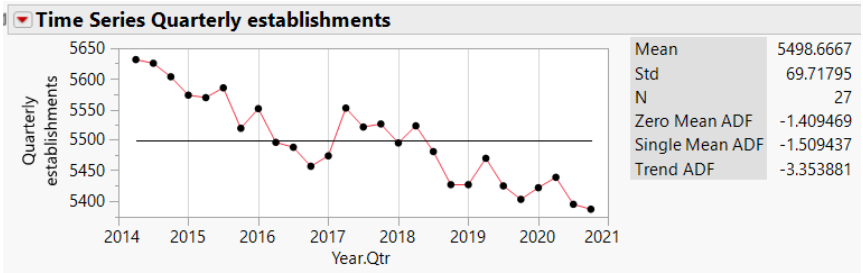


Figure 3.1. Time Series graph for establishments in the textile industry (Q1 2014 – Q3 2020)

ARI (1,1) had the lowest AIC 230.17 when compared with other models. Figure 3.2 shows the parameter estimates and below it a graph with, the 95% prediction interval for the forecasts. The interval was less wide for this variable compared to employment and wages.

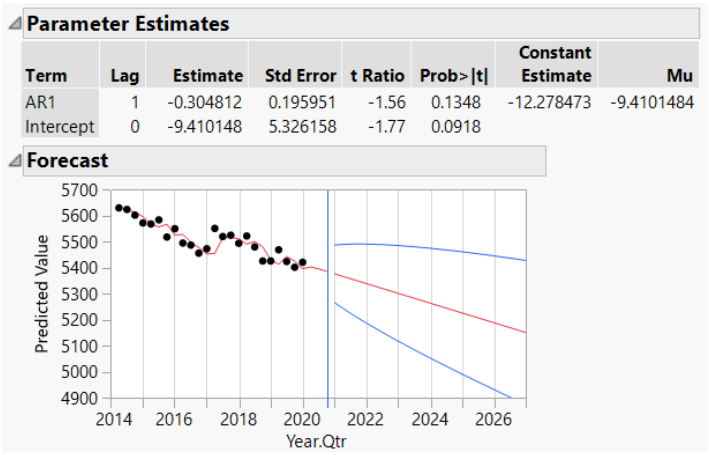


Figure 3.2*:* Parameter Estimates & Forecast plot for establishments in the textile industry based on the data from Q1 2014 to Q4 2019

3.2.1.2. All textile companies: Employment. Figure 3.3 shows a time series plot of actual employment numbers over time. The seasonal ARIMA (1,0,0) (1,0,0) 4 fit the best with the lowest AIC of 463.465. As shown in Figure 3.4, the 95% prediction intervals are wide for this variable, compared to establishments and wages.

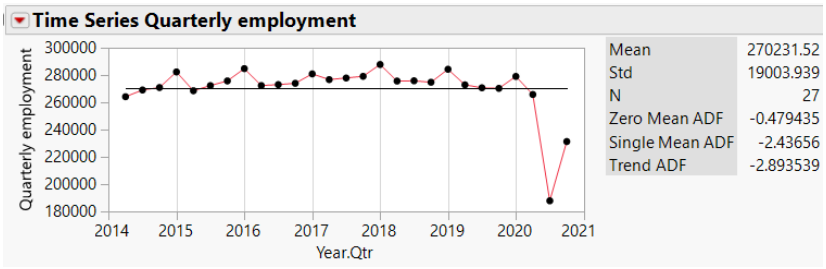


Figure 3.3*:* Time Series graph for employment in the textile industry (Q1 2014 – Q3 2020)

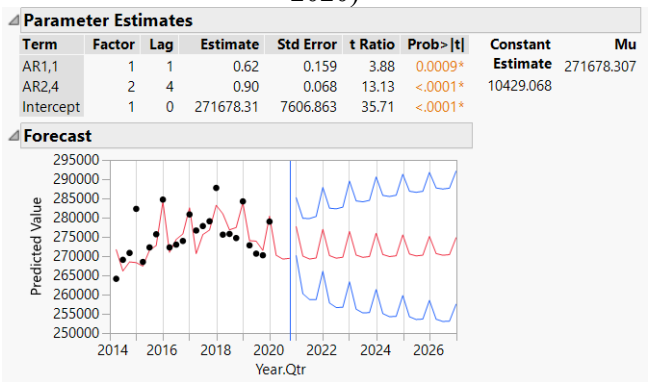


Figure 3.4*:* Parameter Estimates & Forecast plot for employment in the textile industry based on the data from Q1 2014 to Q4 2019

3.2.1.3. All textile companies: Wages. Figure 3.5 shows a time series plot of actual wages over time. The seasonal ARIMA (1,0,0) (1,0,0) 4 fit the best with an AIC 890.453. Other models did not have adequate model fit indicated by the significant Q statistic. As shown in Figure 3.6, the 95% prediction interval is wide for this variable.

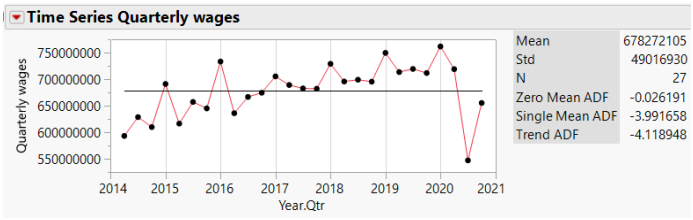


Figure 3.5: Time Series graph for wages in the textile industry (Q1 2014 – Q3 2020)

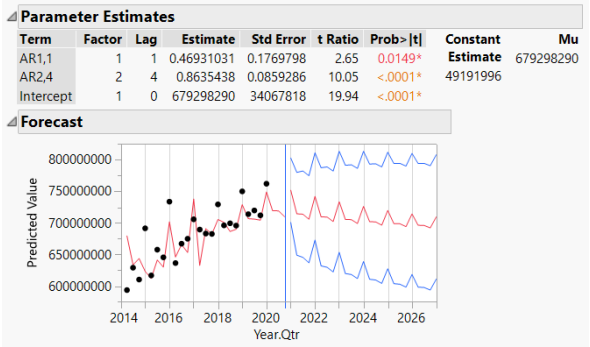
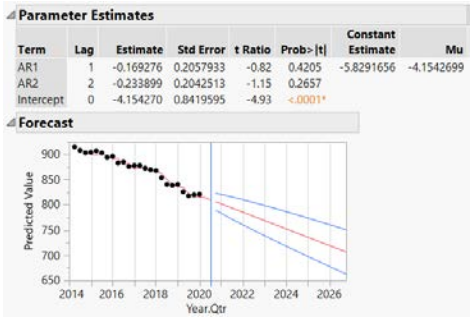
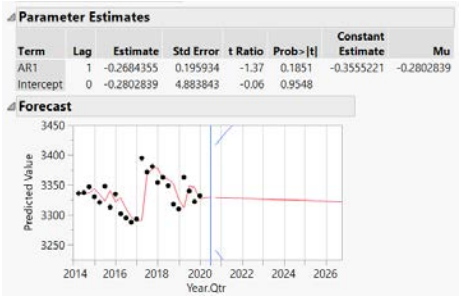


Figure 3.6: Parameter Estimates & Forecast plot for wages in the textile industry based on the data from Q1 2014 to Q4 2019

3.2.2 Trends across textile industry sectors in North Carolina (Q1 2014 – Q4 2019)

3.2.2.1. Establishment time series models. The best fitting models' forecast graphs based on the lowest AIC are shown in table 3.1. Mills and services had narrower 95% prediction intervals as compared to those of retail and wholesale. In addition, mills and retail showed a downward trend for establishments whereas wholesale showed an upward trend for establishments.

Table 3.1: Parameter Estimates & Forecast plots for establishments in all four businesses in the textile industry based on the data from Q1 2014 to Q4 2019

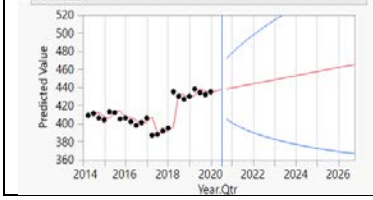
Mills. ARI (2,1) fits the best with AIC 150.206.	**Retail.** ARI (1,1) fits the best with AIC 224.187.
	

Wholesale. ARI (1,1) fits the best with AIC 175.245.

Parameter Estimates

Term	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1	1	-0.088812	0.203401	-0.44	0.6668	1.22017884	1.1206513
Intercept	0	1.120651	1.924548	0.58	0.5666		

Forecast

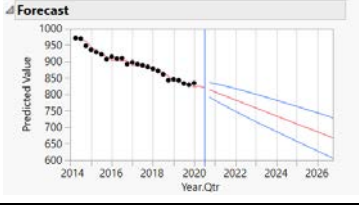


Service. ARI (2,1) fits the best with AIC 162.260.

Parameter Estimates

Term	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1	1	-0.252196	0.216611	-1.16	0.2580	-7.8883179	-6.086885
AR2	2	-0.043757	0.236134	-0.19	0.8549		
Intercept	0	-6.086885	1.178175	-5.17	<.0001*		

Forecast



3.2.2.2. Employment time series models. The best fitting models' forecast graphs based on the lowest AIC are shown in Table 3.2. Services and retail had wide 95% prediction intervals. Wholesale had an expanding upward trending 95% prediction interval and mill had an expanding downward trending 95% prediction interval for employment.

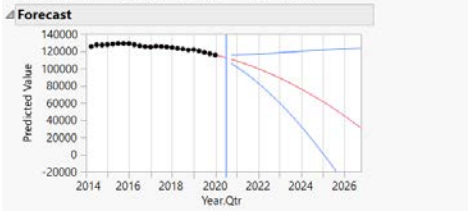
Table 3.2: Parameter Estimates & Forecast plots for employment in all four businesses in the textile industry based on the data from Q1 2014 to Q4 2019

Mills. ARI (2,2) fits the best with AIC 363.701.

Parameter Estimates

Term	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1	1	-0.4162	0.2295	-1.81	0.0856	-191.26071	-120.47342
AR2	2	-0.1714	0.2282	-0.75	0.4619		
Intercept	0	-120.4734	112.4509	-1.07	0.2974		

Forecast

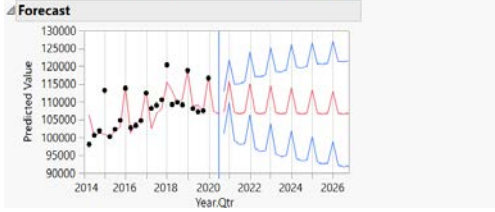


Retail. Seasonal ARIMA (1,0,0) (1,0,0) 4 fits the best with AIC 454.706.

Parameter Estimates

Term	Factor	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1,1	1	1	0.60	0.150	4.02	0.0006*	106238.312	
AR2,4	2	4	0.93	0.048	19.34	<.0001*	2878.54314	
Intercept	1	0	106238.31	7323.588	14.51	<.0001*		

Forecast

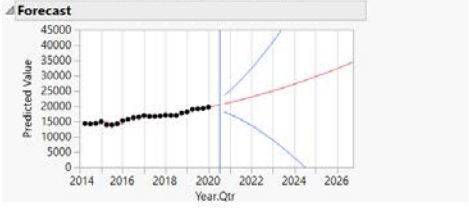


Wholesale. ARI (2,2) fits the best with AIC 341.128.

Parameter Estimates

Term	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1	1	-0.47365	0.20606	-2.30	0.0330*	24.5524866	14.0790615
AR2	2	-0.27025	0.20085	-1.35	0.1943		
Intercept	0	14.07906	61.36658	0.23	0.8210		

Forecast

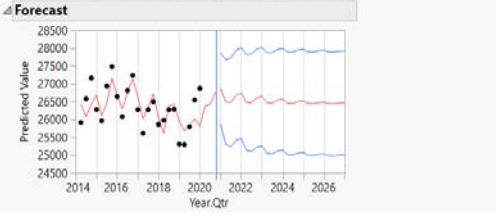


Service. Seasonal ARIMA (1,0,0) (1,0,0) 4 fits the best with AIC 362.853.

Parameter Estimates

Term	Factor	Lag	Estimate	Std Error	t Ratio	Prob>|t|	Constant Estimate	Mu
AR1,1	1	1	0.596	0.1885	3.16	0.0047*	26433.6028	
AR2,4	2	4	0.663	0.1482	4.47	0.0002*	3600.01967	
Intercept	1	0	26433.603	443.7983	59.56	<.0001*		

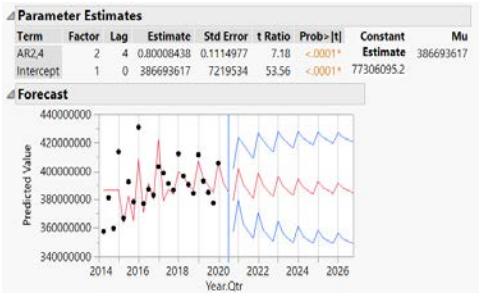
Forecast



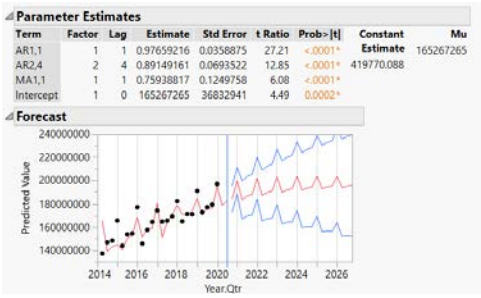
3.2.2.3. Wage time series models. The best fitting modes' forecast graphs based on the lowest AIC are shown in table 3.3. All four businesses had wide 95% prediction intervals.

Table 3.3: Parameter Estimates & Forecast plots for wages in all four businesses in the textile industry based on the data from Q1 2014 to Q4 2019

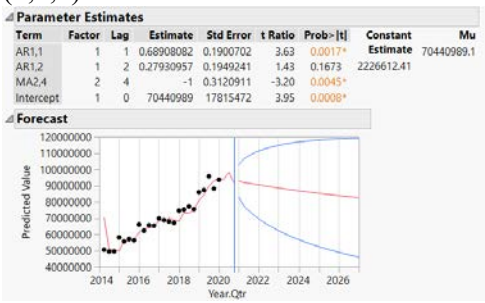
Mills. Seasonal ARIMA (0,0,0) (1,0,0) 4 fits the best with AIC 853.079.



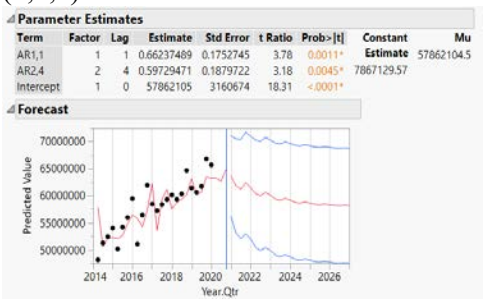
Retail. Seasonal ARIMA (1,0,1) (1,0,0) 4 fits the best with AIC 826.913.



Wholesale. Seasonal ARIMA (2,0,0) (0,0,1) 4 fits the best with AIC 802.046.



Services. Seasonal ARIMA (1,0,0) (1,0,0) 4 fits the best with AIC 787.697.



3.3 Forecasts for Q1 – Q4 2020

3.3.1 The North Carolina textile industry: All textile companies

Table 3.4 shows the actual quarterly values, predicted quarterly values, upper 95% confidence limit, and lower 95% confidence limit based on Q1 2014 – Q4 2019 data for employment, establishments, and wages for all the textile companies. The difference column shows the difference between the actual and predicted values. This difference indicates whether the time series models built on pre-pandemic data (Q1 2014- Q4 2019) were able to predict pandemic conditions.

Table 3.4: Comparison of the predicted data of 2020 with the actual data of 2020 for the textile industry

Variable	Year	Qtr	Actual Quarterly values	Predicted Quarterly values	Upper CL (0.95)	Lower CL (0.95)	Difference	%difference
Employment	2020	1	265732	270227	276214	264240	(4,495)	-1.66%
Employment	2020	2	187767	269221	276260	262183	(81,454)	-30.26%
Employment	2020	3	231229	269424	276825	262024	(38,195)	-14.18%
Employment	2020	4	244710	277660	285194	270127	(32,950)	-11.87%

Establishments	2020	1	5439	5404	5472	5336	35	0.65%
Establishments	2020	2	5395	5397	5480	5315	(2)	-0.04%
Establishments	2020	3	5387	5387	5485	5289	0	0.00%
Establishments	2020	4	5385	5378	5489	5267	7	0.13%
Wages	2020	1	$719,219,695	$719,198,147	$764,361,305	$674,034,988	21,548	0.00%
Wages	2020	2	$547,288,601	$718,881,774	$768,771,268	$668,992,280	(171,593,173)	-23.87%
Wages	2020	3	$655,527,548	$709,667,282	$760,538,788	$658,795,777	(54,139,734)	-7.63%
Wages	2020	4	$774,976,115	$751,708,953	$802,794,212	$700,623,694	23,267,162	3.10%

Red colored values with negative sign in the table show that the actual data of 2020 did not fit in the prediction interval with the value less than the lower confidence limit

3.3.2 The North Carolina textile industry: Textile industry sectors/businesses

Table 3.5 has the following columns: the actual quarterly values, predicted quarterly values, upper 95% confidence limit, and lower 95% confidence limit based on Q1 2014 – Q4 2019 data for employment, establishments, and wages for all the textile industry sectors. The difference column shows the difference between the actual and predicted values. This difference indicates whether the time series models built on pre-pandemic data (Q1 2014 - Q4 2019) were able to predict pandemic conditions. The largest decrease is in the second quarter of 2020. The third quarter numbers are better than the second quarter.

Table 3.6: Comparison of the predicted data of 2020 with the actual data of 2020 for the four textile businesses (mills, retail, wholesale, and service)

	Business	Year	Qtr	Actual Quarterly Values	Predicted Quarterly Values	Upper CL (0.95)	Lower CL (0.95)	Difference	% change
Establishment	Mills	2020	1	811	815	826	803	(4)	-0.43%
	Mills	2020	2	804	810	825	794	(6)	-0.69%
	Mills	2020	3	802	806	823	789	(4)	-0.51%
	Mills	2020	4	806	802	821	783	4	0.50%
	Retail	2020	1	3,326	3,329	3,388	3,270	(3)	-0.09%
	Retail	2020	2	3,302	3,329	3,403	3,256	(27)	-0.82%
	Retail	2020	3	3,303	3,329	3,417	3,241	(26)	-0.78%
	Retail	2020	4	3,294	3,329	3,428	3,229	(35)	-1.04%
	Services	2020	1	851	825	840	810	26	3.15%

	Services	2020	2	839	819	838	800	20	2.42%
	Services	2020	3	826	813	835	791	13	1.58%
	Services	2020	4	826	807	832	782	19	2.35%
	Wholesale	2020	1	451	436	456	415	15	3.45%
	Wholesale	2020	2	450	437	465	409	13	2.95%
	Wholesale	2020	3	456	438	472	405	18	4.06%
	Wholesale	2020	4	459	439	478	401	20	4.48%
Employment	Mills	2020	1	113,824	114,142	115,866	112,418	(318)	-0.28%
	Mills	2020	2	93,049	112,434	115,663	109,205	(19,385)	-17.24%
	Mills	2020	3	102,168	110,637	115,578	105,695	(8,469)	-7.65%
	Mills	2020	4	104,151	108,700	115,639	101,761	(4,549)	-4.19%
	Retail	2020	1	106,129	107,224	112,066	102,383	(1,095)	-1.02%
	Retail	2020	2	56,224	106,662	112,315	101,008	(50,438)	-47.29%
	Retail	2020	3	88,932	107,063	112,983	101,142	(18,131)	-16.93%
	Retail	2020	4	99,088	115,740	121,756	109,725	(16,652)	-14.39%
	Services	2020	1	26,805	26,389	27,197	25,581	416	1.58%
	Services	2020	2	21,892	26,433	27,373	25,493	(4,541)	-17.18%
	Services	2020	3	22,881	26,762	27,745	25,779	(3,881)	-14.50%
	Services	2020	4	22,721	26,877	27,875	25,879	(4,156)	-15.46%
	Wholesale	2020	1	18,974	20,068	21,098	19,038	(1,094)	-5.45%
	Wholesale	2020	2	16,602	20,419	22,298	18,540	(3,817)	-18.69%
	Wholesale	2020	3	17,248	20,829	23,622	18,037	(3,581)	-17.19%
	Wholesale	2020	4	18,750	21,237	25,132	17,342	(2,487)	-11.71%
Wages	Mills	2020	1	$383,428,300	$391,724,689	$413,613,384	$369,835,994	(8,296,389)	-2.12%
	Mills	2020	2	$290,914,209	$385,284,966	$407,173,661	$363,396,271	(94,370,757)	-24.49%
	Mills	2020	3	$334,901,823	$379,394,567	$401,283,263	$357,505,872	(44,492,744)	-11.73%
	Mills	2020	4	$406,365,674	$401,700,251	$423,588,946	$379,811,556	4,665,423	1.16%
	Retail	2020	1	$177,689,414	$178,683,638	$189,467,774	$167,899,501	(994,224)	-0.56%
	Retail	2020	2	$122,536,066	$182,407,725	$193,443,315	$171,372,135	(59,871,659)	-32.82%
	Retail	2020	3	$166,855,049	$184,217,930	$195,488,113	$172,947,747	(17,362,881)	-9.43%

	Services	2020	1	$63,423,944	$63,293,922	$68,972,577	$57,615,267	130,022	0.21%
	Services	2020	2	$52,281,574	$62,664,810	$69,476,215	$55,853,405	(10,383,236)	-16.57%
	Services	2020	3	$59,848,428	$64,854,087	$72,106,852	$57,601,323	(5,005,659)	-7.72%
	Services	2020	4	$62,201,940	$63,634,739	$71,072,884	$56,196,593	(1,432,799)	-2.25%
	Wholesale	2020	1	$94,678,037	$93,969,857	$100,213,799	$87,725,915	708,180	0.75%
	Wholesale	2020	2	$81,556,752	$98,381,753	$105,964,564	$90,798,943	(16,825,001)	-17.10%
	Wholesale	2020	3	$93,922,248	$92,037,241	$100,963,157	$83,111,324	1,885,007	2.05%
	Wholesale	2020	4	$108,784,282	$92,956,312	$102,928,445	$82,984,180	15,827,970	17.03%

Red colored values with negative sign in the table show that the actual data of 2020 did not fit in the prediction interval with the value less than the lower confidence limit. Blue colored values in the table show the actual data from 2020 did not fit in the prediction interval with the value higher than the upper confidence limit

5. Discussion & Conclusion

The purpose of this study was to assess whether ARIMA models could be constructed to predict the 2020 employment trends in the North Carolina textile industry from pre-pandemic data. The findings were mixed.

Some of the ARIMA models from 2014-2019 data forecast employment trends in 2020, however some did not. When looking at all textile businesses combined, the forecasts for Q1 2020 were accurate for establishments, employment, and wages. When examining the businesses separately, the results were mixed. The forecasts for the number of establishments were accurate for mills, retail, and wholesale for the entire 2020. For services, the forecast was accurate for only Q3 & Q4. The forecasts for employment were accurate for mills, retail, and services in Q1, but not for wholesale. No other employment forecasts were accurate besides those of mills & wholesale in Q4. The models forecast wages accurately for mills, retail, services, and wholesale in Q1 & Q4. In addition, the forecasts were accurate for services and wholesale in Q3.

It is perhaps not surprising that the forecasts were the best for Q1 2020. The pandemic was just beginning. The economy would not feel the effects immediately. The fact that the number of establishments were accurately predicted for the entire 2020 may be because the businesses adjusted to stay in business.

The actual and predicted values from the 2020 data were compared to get a snapshot of the textile industry in North Carolina. The data showed a downward trend in the number of establishments from 5650 in 2014 to 5400 by the third quarter of 2020. Forecasts based on pre-pandemic data through 2019 showed a downward and narrow prediction interval, as compared to prediction intervals for other variables, for 2020. Establishments for mills and services were already decreasing before 2020. Retail establishment numbers were fluctuating before 2020. The number of wholesale establishments, however, increased in 2018 and 2019. When comparing actual and predicted values for 2020, there was a very small impact on the total establishments. The actual number of retail establishments was smaller than the projected values by approximately 0.8% in Q2 and Q3, followed by textile mills with an overestimate in establishments by approximately 0.5-0.7% by the projected values. However, the number of textile service and wholesale establishments were overestimated by approximately 2-4% in 2020.

All textile companies together in North Carolina employed 0.27 million people on average with a seasonal rise in the fourth quarter every year. As expected, the employment numbers dropped down to approximately 0.19 million people in Q2 2020. Since the employment trend was uniform by the end of 2019, the prediction intervals were moving along the mean with wide intervals for 2020 and later years. The ARIMA model overestimated employment in the textile retail companies by approximately 47% in the second quarter of 2020. However, in the third quarter, there was an increase with 32,000 people employed which showed potential recovery in the textile retail industry. Employment by mills was overestimated by approximately 17% in Q2 2020. Similarly, employment by wholesale companies was overestimated by approximately 19% in Q2 2020. The overestimate improved by just 1% from the projected values in the third quarter of 2020. Laundry and dry-cleaning services were overestimated by approximately 17% by the projections in Q2 2020, which recovered in Q3 2020 adding approximately 1000 jobs in this quarter. This is still 14.5% less than the projected jobs. There had been a gradual increase every year until the end of 2019 in the wages earned by the population employed by all the textile companies. In addition to the gradual increase in wages, there was a higher rise in the fourth quarter every year because of a seasonality factor. However, similar to the employment case, wages also had a huge downward spike by the end of Q2 2020. Forecasts show wide prediction intervals for the wages of the textile companies. Mills had a uniform trend along the mean line for wages mixed with year-end seasonality. Retail, wholesale, and services had a gradual increase through the period from 2014 to 2019. However, by the end of Q2 2020, wages were down across all the four business types. For mills, the actual reduction was as large as 24.5% from the projected wages, which improved in the third quarter. For retail, wages were overestimated by 33% from the projected values. Wages did improve in the third quarter. Similarly, for both wholesale and services the wages were overestimated by 16-17% from the projected values, and the situation for both improved in the third quarter of 2020.

There were some limitations. First, we did not conduct outlier analysis. There were clearly outliers and if those were taken into account when modeling, we would have achieved better models in some cases. Second, we utilized the public data available on the LEAD website which is limited to quarterly data. Using a greater number of data points from monthly, weekly, or daily data might help with better forecasts. Third, this study is limited to the textile industry located in North Carolina. Fourth, it is possible that there can be other possible reasons behind the changes in numbers, such as changing government regulations, subsidies, and technology disruption. Analyzing those reasons are out of the scope of the study and recommended for future research.

References

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H., & Price, B. (2016). Import competition

and the Great US Employment SAG of the 2000s. Journal of Labor Economics, 34(S1). doi:10.1086/682384

Barker, M. (2011, April). Manufacturing employment hard hit during the 2007-09 recession. Monthly Labor Review. [Washington, DC]: U.S. Dept. of Labor, Bureau of Labor Statistics. https://www.bls.gov/opub/mlr/2011/04/art5full.pdf

Bessen, J. (2019). Automation and jobs: When technology boosts employment*. Economic Policy, 34(100), 589-626. doi:10.1093/epolic/eiaa001

Bodenhorn, H. (2020.) Business in a time of Spanish Influenza. National Bureau of Economic Research. http://www.nber.org/papers/w27495

Duarte, A., Sanches, R., & Dedini, F. (2018, December). Assessment and technological forecasting in the textile industry: From first industrial revolution to the Industry 4.0. Strategic Design Research Journal. 11(3), 193-202. doi:10.4013/sdrj.2018.113.03

Farooq, A., & Kugler, A.D. (2015, February 28) What factors contributed to changes in employment during and after the Great Recession? .IZA Journal of Labor Policy 4, 3. https://doi.org/10.1186/s40173-014-0029-y

JMP 14 predictive and specialized modeling. (2018). Cary, NC: SAS Institute.

Kunz, G. I., Karpova, E., & Garner, M. B. (2016). Going global the textile and apparel industry. (3rd ed.). New York, NY: Fairchild Books, Bloomsbury Publishing.

Lu, J. (2015). Forecasting of U.S. total textiles and apparel export to the world in next 10 years (225-2025). Journal of Textile and Apparel, Technology and Management, 9(2), 1-8.

Lu, S. (2013). Impacts of quota elimination on world textile trade: a reality check from 2000 to 2010. The Journal of the Textile Institute, 104(3), 239-250. doi: 10.1080/00405000.2012.717753

Montgomery, A. L., Zarnowitz, V., Tsay, R. S., & Tiao, G. C. (1998). Forecasting the U.S. Unemployment Rate. Journal of the American Statistical Association, 93(442), 478-493. doi:10.1080/01621459.1998.10473696

Pickles, J., Plank, L., Staritz, C., & Glasmeier, A. (2015). Trade policy and regionalisms in global clothing production networks. Cambridge Journal of Regions, Economy and Society, 8 (3), 381-402.

Rumberger, R. W., & Levin, H. M. (1985, July). Forecasting the impact of new technologies on the future job market. Technological Forecasting and Social Change. 27(4). Retrieved from https://doi.org/10.1016/0040-1625(85)90020-4

Saki, Z. (2020). *An investigation of U.S. textile and apparel (TAP) industry competitiveness* (Publication No. 27949949) [Doctoral dissertation, North Carolina State University]. ProQuest Dissertations & Theses Global.

United States Congressional Oversight Panel. (2011, January 13) An Update on TARP Support for the Domestic Automotive Industry: Congressional Oversight Panel January Oversight Report. https://fraser.stlouisfed.org/title/5142

Zhao, L., & Kim, K. (2021). Responding to the COVID-19 Pandemic: Practices and strategies of the global clothing and Textile value chain. Clothing and Textiles Research Journal, 39(2), 157-172. doi:10.1177/0887302x21994207