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Forecasting Labor Force Participation at the Regional Level in the United States: The Case of Maine

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FORECASTING LABOR FORCE PARTICIPATION AT THE REGIONAL LEVEL IN THE UNITED STATES: THE CASE OF MAINE

by

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ABSTRACT

This project attempts to investigate the future of labor force participation in Maine using an econometric forecasting approach. Forecasting has become an increasingly popular form of statistical analysis which uses historical distributions to help estimate future distributions of econometric models. There exists extensive literature on forecasting employment, however the literature on forecasting labor force participation is relatively small. I adapt existing econometric models and make use of time series information on sociodemographic factors such as age and net migration in order to determine how Maine's changing demographic structure is affecting its labor force and how these effects will carry on into the future.

This study incorporates two separate disciplines—economics and statistics. The knowledge from this study has implications for the state of Maine and to policy makers, as it investigates which demographic factors have the greatest effect on labor force participation in Maine, and which policy areas can be improved in order to retain labor force participation, and consequently encourage economic growth, in the long run.

ACKNOWLEDGEMENTS

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INTRODUCTION

Background

Over the years, Maine residents have become accustomed to seeing the quick turnover of businesses around them. Whether in the industrial sector with the closing of Verso, Lincoln, and Old Town paper mills, or in the retail sector with the closing of retail giants such as Filene's and Macy's in the Bangor Mall, Maine is not known for its ability to attract and retain businesses. In parallel, Maine's labor force participation rate has been on a downward sloping trend since the early 2000s, with quarter four of 2017 closing at 627,000 people in the labor force as opposed to over 666,333 in quarter one of 2007. This pattern of declining labor force participation is not unique to Maine, it is also a national trend. The massive exodus of U.S. manufacturing jobs, which have been replaced by high-technology industries requiring high levels of human capital, has negatively affected low-skilled workers who were previously employed in these industries across the nation.

The issue of declining labor force participation in Maine is coupled with the state's aging population. Maine is the oldest state in The U.S. by median age. Maine's median age in 2014 was 44.2 years, 6.5 years above The U.S. median. (Breece, Mills, Gabe 2015). There are many sociodemographic reasons which can attribute to this age structure, one being the lack of diversity in the state. 95% of Maine residents identify as white, the racial group with the lowest fertility rate. Another issue is the aging of the baby-boomer generation which has been raising the share of the population in older age groups, for which labor force participation rates are lower. Out migration of high school and college graduates, due to a lack of employment opportunities and amenities within the state, is another determinant of labor force participation. Deller, Tsai, Marcouiller, and English found that amenities, particularly climate, urban facilities, land facilities such as hunting/fishing preserves and mountains, water variables, and winter variables such as cross-country ski areas and annual snowfall appear to play a significant role in regional economic growth. Of these amenities, they found that climate has the strongest influence on the growth of a population. This brings up the potential of Maine's harsh climate acting as a dis-amenity which could attribute to the issue of outmigration (Deller et. al 2001).

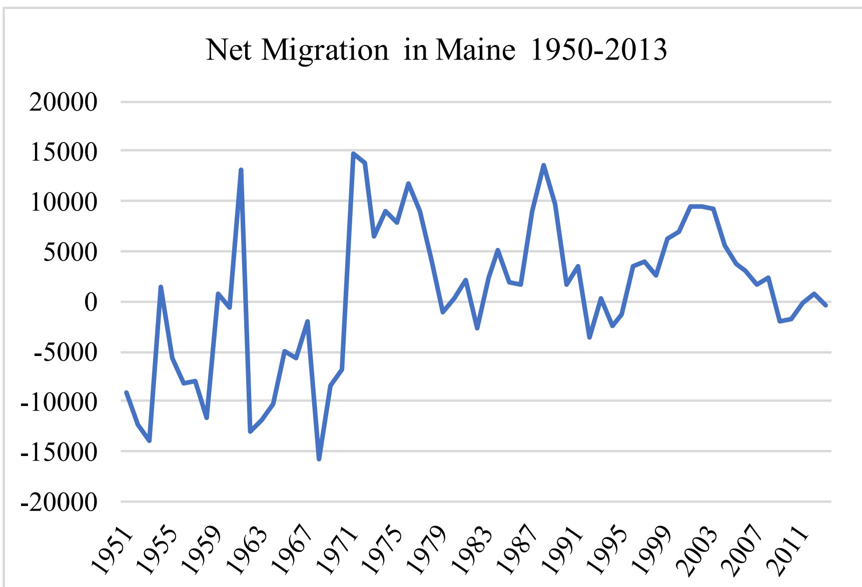

Figure 1: Net Migration in and out of Maine from 1950 to 2013

Net migration, the difference between people moving in and out of the state, and natural change, the difference between the number of deaths and number of births in the state, are two metrics which drive population. Figure 1 depicts the trend of net migration in the Maine from the year 1950 until 2013. After a few cyclical peaks and valleys through the 1900s and into the early 2000s, we see a downward trend in net migration after about 2003. Figure 2 is a graph comparing the number of deaths and the number of live births in the state over the past 70 years. As we can see, deaths began to surpass live births in 2012. In order to understand the combined effects of births and deaths in the state, the trend of natural change is depicted in Figure 3.

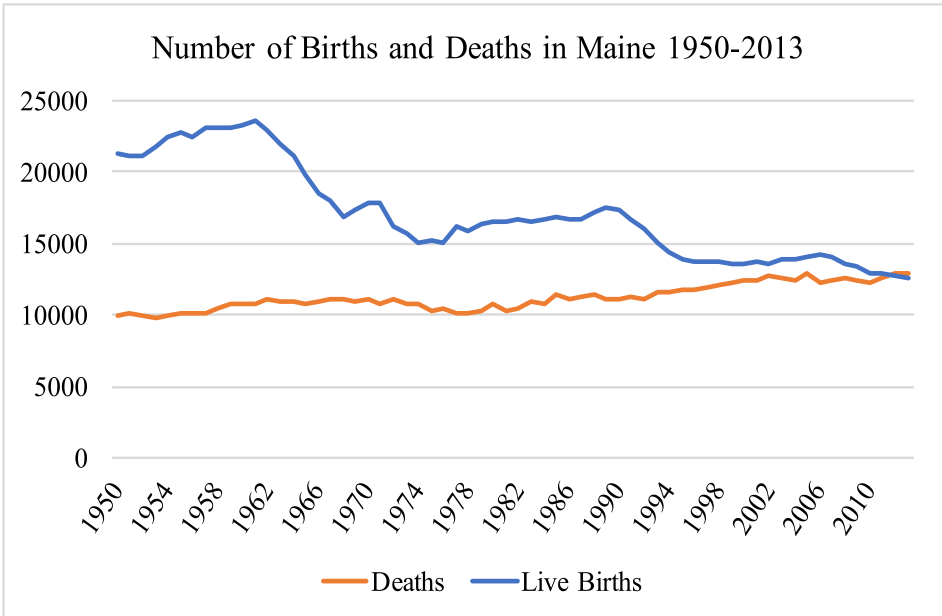

Figure 2: Live Births and Deaths in Maine from 1950 to 2013

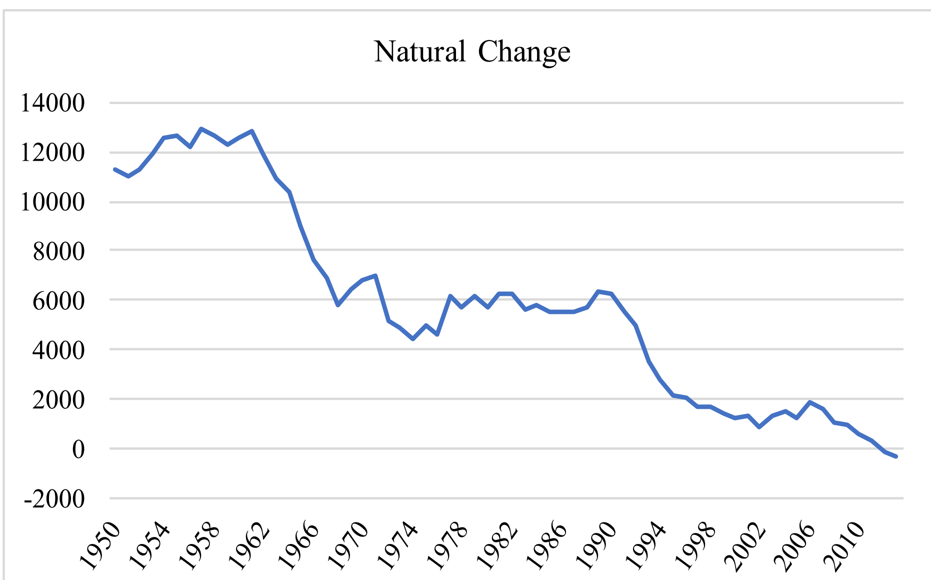

Figure 3: Natural Change of Population in Maine from 1947 to 2013

These graphs are quite concerning as they depict a trend of declining births and rising deaths, especially coupled with the unsteady cyclical trend of migration in and out of the state. Increasing deaths can be related to the increasing number of elderly residents in the state. If we look at the ratio provided by the Breece, Mills, and Gabe of working-age people to seniors in Maine, which is derived by dividing the population of people age 16 to 64 by that of those 65 and over, the ratio in every county in Maine is lower than the overall U.S. ratio. This is especially apparent in northern Maine where industries that were attractive in the early 1900s no longer exist, and in coastal Maine, where many retirees live (Breece, Mills, Gabe 2015). Figures 4 and 5 both allow visualization of the changing age structure in Maine. Figure 4 shows trend lines for the three age groups included in this study over the past 36 years. The age group defined as "under 18" appears to be experiencing little to no growth as it converges with the "over 65" group, which has seen a slight increase in the past few years. People aged "18 to 64" have grown historically but have begun to plateau in the past few years as well.

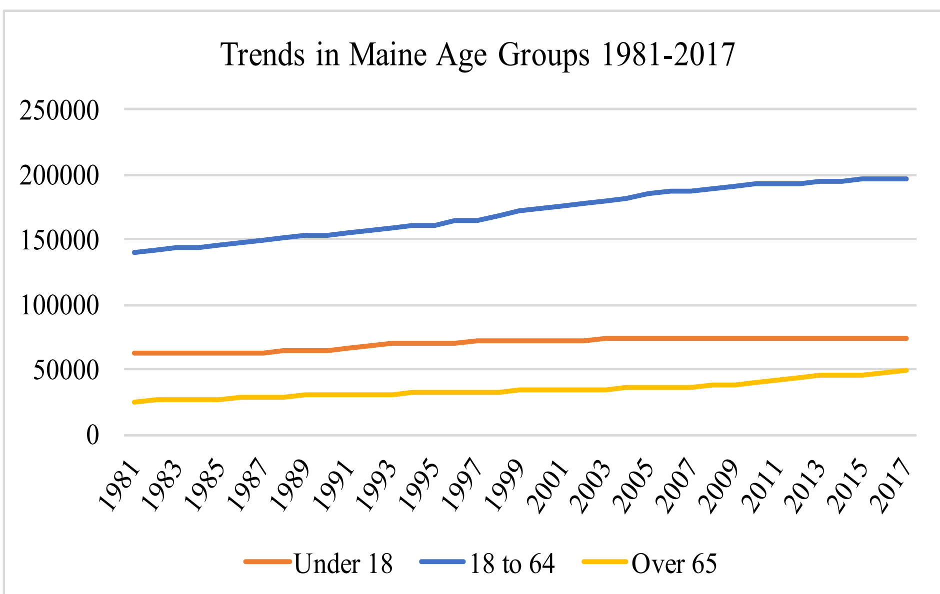

Figure 4: Change in Trends of Maine Age Groups 1981-2017

Figure 5 shows the share of the population in each age group and how these shares have changed from the year 1981 to the year 2017. The "under 18" group has remained stagnant while the "18 to 64" and "over 65" groups have seen growth. Since the "under 18" age group defines the next generation of potential employees in the state and the older end of the "18 to 64" group will be entering retirement in the next few years, we should expect a struggle to fill job vacancies in the future in Maine.

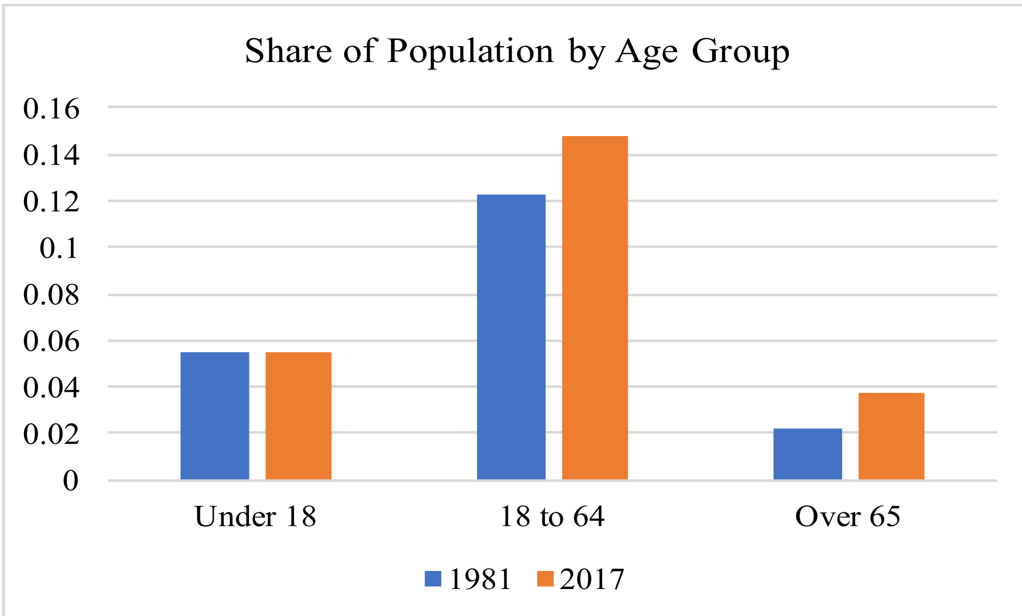

Figure 5: Change in the Share of Maine's Population by Age Group 1981- 2017

The following two figures depict trends in Maine's population over time. Figure 6 is a historical trend line of Maine's population since 1947 and Figure 7 is a closer look at the population in the 20th century. As we can see from Figure 7, a population dip after the recession in 2007 has led to a static population for almost a decade, before a slight rise.

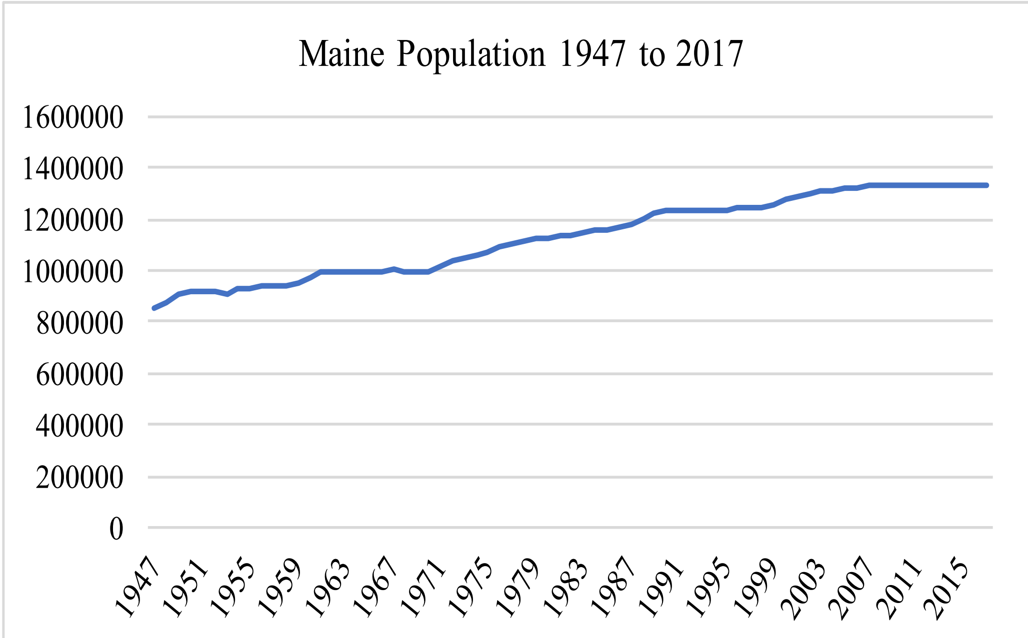

Figure 6: Maine Population 1947 to 2017

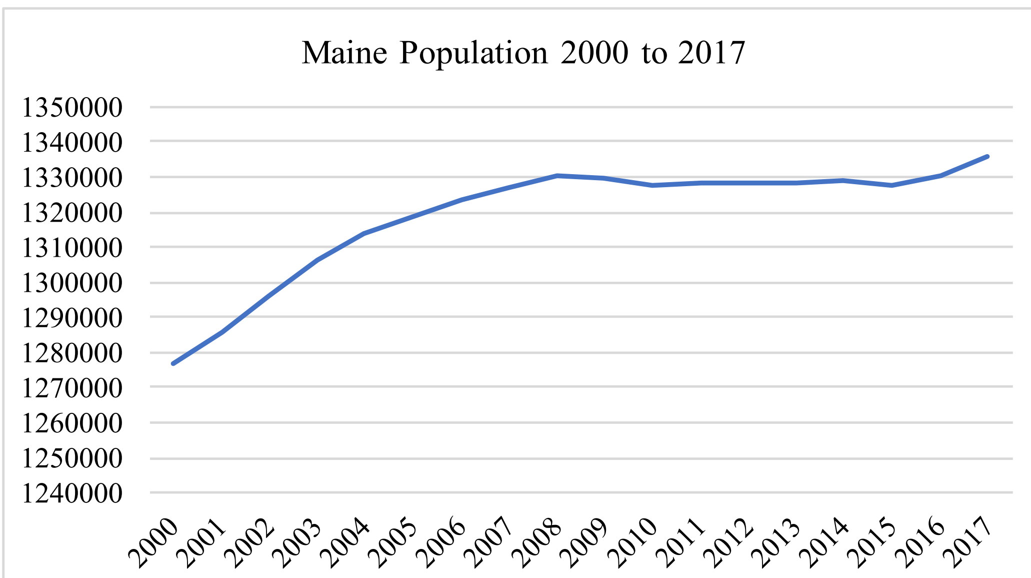

Figure 7: Maine Population 2000 to 2017

Objective

Historically, Maine's economic development has been dependent on its agricultural and industrial sectors, as textile and shoe companies, as well as fishing, lumber yards and paper mills prevailed throughout the state. In recent years, industries with large production and manufacturing needs have moved production overseas due to lower labor and material costs, while keeping research and development centers domestic. This increase in global competition for low cost labor has consequently affected employment, particularly low-skilled labor, and labor force participation across the nation. Between 1979 and 2010, The United States lost 7.9 million manufacturing jobs, about 42% of its 1979 manufacturing base. It lost 42.8% of these jobs prior to the Great Recession, and then lost another 29.7% during and after the recession (Wolman et. al, 2015).

My objective in this study is to understand which demographic effects are responsible for the changes in labor force participation rates that we see in Maine, and to forecast a short-term prediction which will allow us to see how participation will look in the future. The labor force participation rate is defined as the percentage of the non-institutional working-age population reporting themselves as either working or actively looking for work (S. Aaronson, B. Fallick et al). Therefore, its long-run trend is an important determinant of the supply of workers to The U.S. economy. It is important to understand the distinction between employment and labor force participation before we continue with this study. This study is concerned with the shrinking of Maine's labor force and the implications this has towards economic development of the state. Even though an increase in jobs may be introduced to a state, the labor force can still be decreasing. This is because, though some people are moving from unemployment to employment due to an increase in available jobs, people are also shifting straight from unemployed to "not in the labor force," mostly due to retirement or an abandoned search for employment. Since unemployment only takes into account those members of the population who have been actively searching for work in the past six weeks, it disregards many members of society who are able to and would like to work but who are jobless and have not been actively searching for work. Labor force participation can include both the employed and the unemployed, and for this reason, I believe it is a better indicator of a region's economic development.

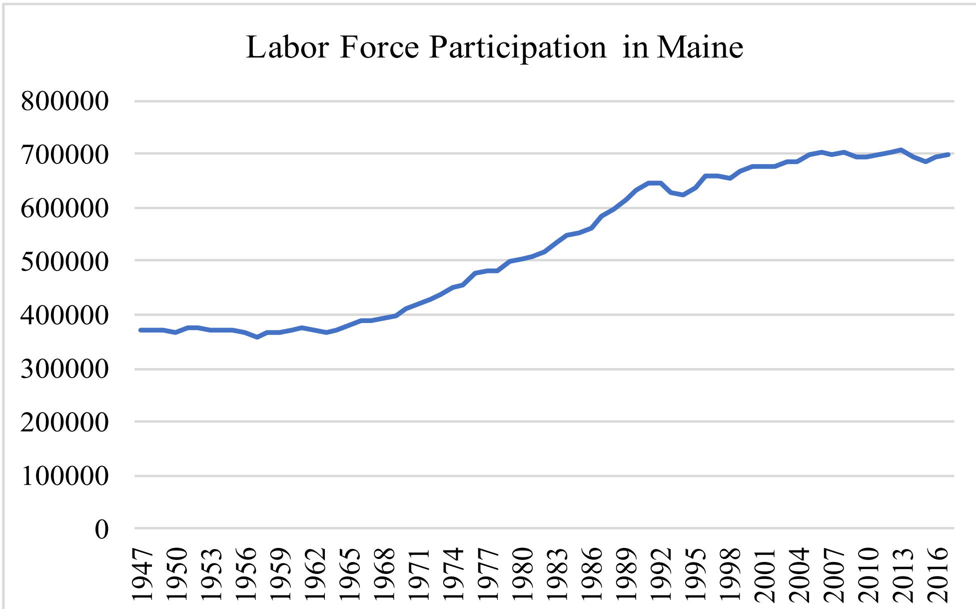

Figure 8: Labor Force Participation in Maine from 1947 to 2017

Figure 8 depicts the trend of labor force participation in Maine over the past 70 years, showing a period of static growth since the early 2000s that can be seen more clearly in Figure 9, a graph depicting labor force participation in the last decade.

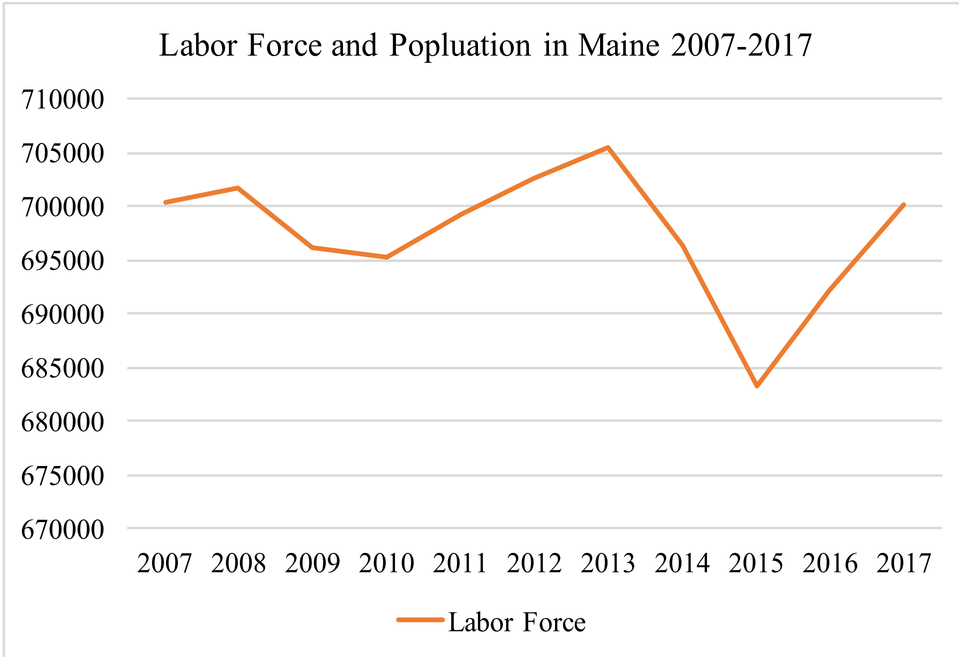

Figure 9. Labor Force Participation in Maine in the Last Decade

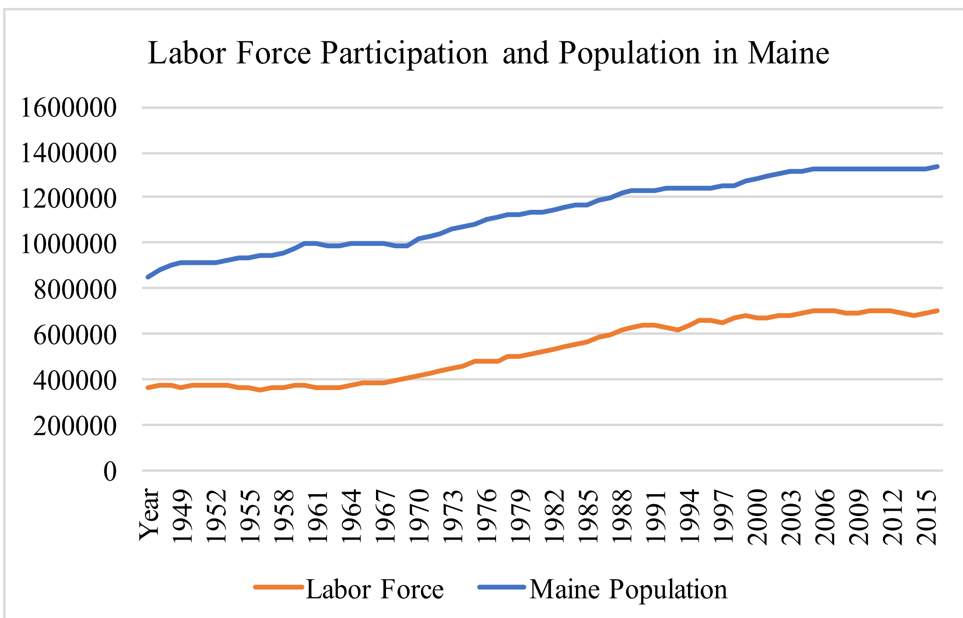

Figure 10. Historical Trends in Labor Force and Population in Maine

Figure 10 provides a comparison between the trends in labor force participation and population. This comparison is important because it shows how similarly correlated the two variables are. Therefore, population is a driver of labor force participation, which is the reason this study is focused on investigating variables which drive population, and which have significant effects on labor force participation. According to a study by Aaronson et. al (Aaronson, Fallick, Figura et. al, 2006) on declining participation rates, labor force participation for newer cohorts of adult women appear to have flattened out after more than three decades of steady rise, while new cohorts of men continue to be less inclined to participate in the labor market than their predecessors. In addition, teenagers and young adults are remaining in school longer and are reducing their labor force attachment whether in or out of school.

Although the Census Bureau estimates that The U.S. population will increase by 38 million people between 2015 and 20130, the bureau also estimates that the working-age-to-senior ratio for the entire U.S. will plummet from a current 4.2 in 2015 to 2.8 in 2030. This is a way more substantial issue in Maine since The Maine Office of Policy and Management (OPM) forecasts the total population in Maine will not change significantly by 2030, staying around the current 1.3 million, unlike the growing U.S. population. The OPM also expects a slight decline in population after 2030. While the rest of the world's population is booming, and many places are faced with the issues that go along with over-population, quite the opposite problem is present in Maine.

Forecasting

Another aim of this study is to create a forecast of labor force participation with the number of variables available. Forecasting models provide valuable information in many fields of study. Therefore, much literature exists in which methods of forecasting have been used not only by economists, but by political scientists and environmentalists as well. Edward Frees uses labor force participation forecasts to project the financial solvency of social security. He believes, that because everyone who is in the workforce is required to make social security contributions, labor force participation rates are critical to forecasts of the status of the Social Security System (Frees, 2006). Bechtel and Leuffen use forecasting methods in political science to predict how public support for the European Union develops "on the basis of theoretically motivated covariates such as economic development, trust in the EU's political institutions, knowledge about the EU or support for member state governments" (Bechtel and Leuffen, 2010).

Previous research has been done on combining different methods of forecasting including OLS, VAR, and ARDL, in order to see which provide the best forecasts predictions. Stock and Watson (Stock and Watson, 2004) show that combination forecasts of output growth often outperform forecasts generated by a single benchmark autoregressive model and that simple methods, typically outperform more complicated methods. They find that combination forecasts are a useful way of incorporating information from a large number of potentially relevant predictors, as is relevant to our study. According to Rapach and Strauss (Rapach and Strauss, 2006), this is also likely to be the case when forecasting regional economic variables, as a large number of both national and regional variables may contain information useful for forecasting. In Frees' study (Frees, 2006) of forecasting labor force participation, he finds that using the time series average forecasts poorly, and that one must use either differencing or autocorrelation to handle the time trend, with both of the latter techniques working equally well.

METHODOLOGY

Data

Data was collected on variables spanning a variety of socioeconomic topics, such as GDP and income, which are also relevant and can be used to forecast labor, the aim of this study is to focus on the changing demographics of Maine and how these issues are driving labor force participation. Therefore, the data chosen focuses on the following variables; age, divided into three groups ("under 18", "18 to 64", and "over 65"), number of live births, number of deaths, and net migration. A similar study by Edward Frees in 2006 (Frees, 2006) also forecasts labor force participation and looks at such demographic variables as gender, marital status, and age, in order to understand how these demographics metrics could affect labor force participation, and consequently the future of The Social Security System.

Data for this study comes from government organizations, namely The Census Bureau, The Federal Reserve, The Bureau of Economic Analysis, The Bureau of Labor Statistics, and The Maine Center for Workforce Research and Information. In order to increase the amount of historical observations that used yearly time series data. Most of the variables span back to the year 1947, giving us 71 observations with fertility and mortality data as well as data on migration spanning back to the year 1950. Unfortunately, there was difficulty in obtaining yearly age data by state back to the mid 1900s and so the age variables only span to 1981. This leaves 33 observations when modeling all of the variables together.

The labor force participation values were obtained from the Bureau of Labor Statistics, as was the data on employment. In order to present a clear explanation of the variables that are being dealt with along with number of observations, a table detailing the sources of data and how they were used in the models is included below, along with a table of summary statistics.

Table 1. Table of Variables

Source	Variable	Type of Variable
Bureau of Labor Statistics	Labor Force Participation	Dependent
	Population	Independent
Bureau of Economic Analysis	Employment	Independent
	Unemployment	Independent
	Income per capita	Independent
Maine Center for Workforce Research and Information	Net Migration	Independent
	Deaths	Independent
	Live Births	Independent
	Natural Change	Independent
U.S. Census Bureau	Age	Independent

Table 2. Table of Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Labor Force Participation	71	529234.3	134161	356400	705417
Population	71	1131094	152486	854000	1335907
Employment	71	498564.4	127933.2	335300	677141
Income per capita	71	15260.76	14217.21	1183	45072
Net Migration	63	778.9365	7446.83	-15781	14648
Deaths	64	11214.77	881.1504	9817	12866
Live Births	64	17074.88	3350.437	12566	23553
Natural Change	64	5860.109	4040.902	-300	12945
Under 18	37	69787.73	4465.53	62333	74579
18 to 64	37	170734.8	19184.52	139477	197260
Over 65	37	34433.62	6450.639	25231	49274

The data was cleaned, and the natural log of each variable was generated with the exception of net migration, which contained negative values. Including logs of all of the data allows testing of different models which will be discussed later on. A final clean data sheet containing only the variables that were used in the final model and spanning only the years 1981 to 2013, the years for which all of these variables were available without any missing values, was created for use in modeling the forecast.

Model

To run the preliminary regressions needed in order to calculate parameter estimates a standard linear model was used (OLS). This helped to see the effects of each individual independent variable on the dependent variable and whether they were significant, helping decide which variables would be used in the forecast to make the most meaningful predictions. After running various regression models, both logarithmically transformed and linear regressions, the log-log model presented the most robust results with the lowest standard errors and high R-squared value. A log-log model also makes the interpretation of my coefficients simpler since it presents them in elasticities, meaning a change of one percent change in labor force participation corresponds with the percent change of the coefficient estimate of each variable.

In order to obtain an in-sample forecast to see how accurate the original model was, a multivariate time series forecast was run with ordinary least squares, using the same regression that was used earlier to calculate coefficient estimates. This model generated a forecast trend for the in-sample data with which the actual historical values present in our data could be compared, determining how accurate the model's predictions were. As shown in Figure 12 in the next section of this paper, the model did well at forecasting the in-sample distribution.

For the out-of-sample forecast, a vector autoregressive model was introduced (VAR) with parameters specific to age-group, migration, fertility, and mortality. Generating a VAR forecast required the data to be made stationary. We establish a lag selection of 3 years which is recommended for the model and assessed the impulse response over 8 time periods, 2014-2021. Before estimating with a VAR, no serial correlation is established. The VAR model was chosen for the out-of-sample forecast as it appears to be widely used for forecasting over OLS. The VAR is a popular and straightforward method for the analysis of multivariate time series and is especially useful for describing the dynamic behavior of economic and financial time series (Inoue and Kilian, 2013). Within the forecasting literature, the accuracy of the VAR in studying forecasts has been mentioned repeatedly, as they have become increasingly popular. They have been used to study fiscal shocks (Canova and Pappa, 2007), technology shocks (Dedola and Neri, 2007), and shocks in labor markets (Fujita, 2011).

EMPIRICAL FINDINGS

The results of the original OLS regression are shown in Table 1, the table of coefficients. The model shows that the population “under 18” has the most significant and strongest effect on labor force participation. Since our model was logarithmically transformed this means that we can interpret our variable coefficients as percent changes. The coefficient of “under 18” means that a one percent change in people under the age of 18 corresponds to about a 2.2% change in the labor force participation. The other variable that stands out is the number of live births, which also has a significant positive correlation with labor force participation. The only variable which proves it is not significant to our model, with a p-value of 0.671, is the number of deaths. This is most likely due to the fact that a majority of natural deaths occur in the elderly or “over 65” age group, those who are already out of the labor force, and therefore do not affect it.

Table 3. Table of Coefficients

Variable	Label	Coefficient	Standard Error	T	P-value
Labor Force	LFP				
Deaths	deaths	0.0832094	0.1935183	0.43	0.671
Live Births	births	0.6184003	0.086564	7.14	0.000
Over 65	Over65	0.6618847	0.1043115	6.35	0.000
18 to 65	to65	-0.8450185	0.2156	-3.91	0.001
Under 18	under18	2.222431	0.2164967	10.27	0.000
Net migration	migration	3.60e-6	9.93e-7	3.63	0.001
_cons		-14.86921	2.412671	-6.16	0.000

The age group "18 to 64" was the only variable with a negative coefficient, meaning that as this age group increases, labor force participation in Maine decreases. The OLS model had an R-squared of 0.9775 and an adjusted R-squared of 0.9698. After using this model to generate an in-sample forecast, a graph of the historical trend predicted by the model versus the actual in-sample trend was generated and can be seen in Figure 11. From this figure, it is clear that the model was highly accurate in generating an in-sample forecast.

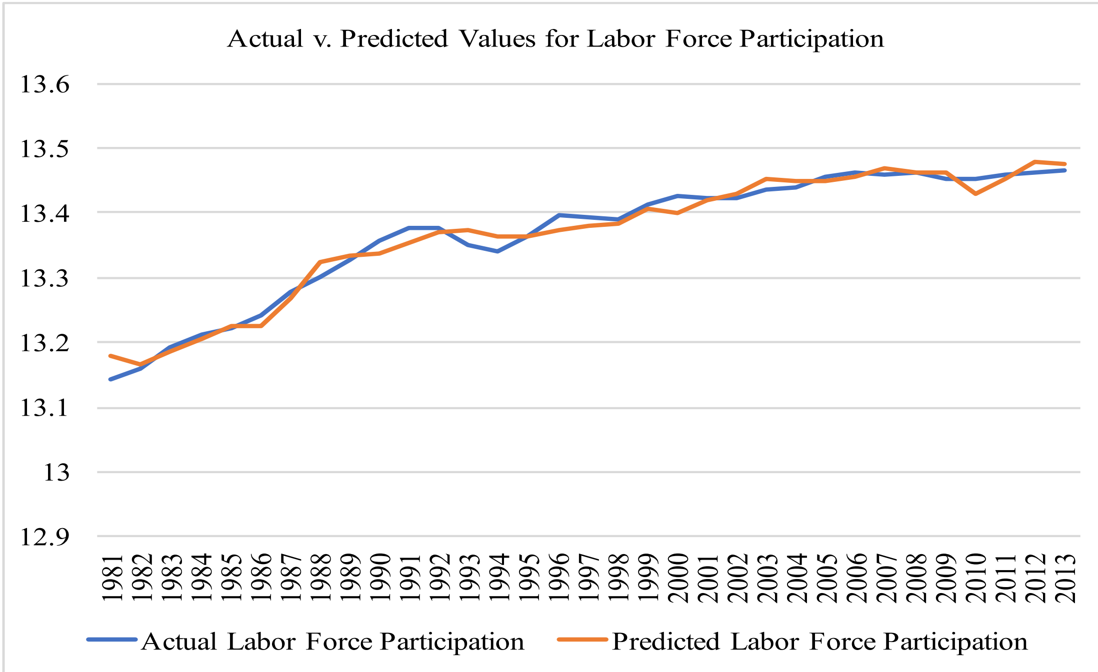

Figure 11. In-sample Forecast Actual v. Predicted from Model

The out-of-sample forecast results can be seen in Figure 12, which shows the actual numbers of labor force participation from 2007 to 2017, overlapped with the model generated forecast estimates from 2013 to 2021. The final numbers for the VAR forecast can be seen in Table 4.

Figure 12. Labor Force Participation Actual v. Forecast 2007-2021

Year	Actual	Forecast
2007	700,468	
2008	701,646	
2009	696,219	
2010	695,182	
2011	699,281	
2012	702,636	
2013	705,417	
2014	696,298	705,417
2015	683,369	705,417
2016	692,154	705,417
2017	700,099	705,417
2018		705,417
2019		705,417
2020		684,326
2021		681,234

Table 4. Forecast Values of Labor Force Participation 2014-2021

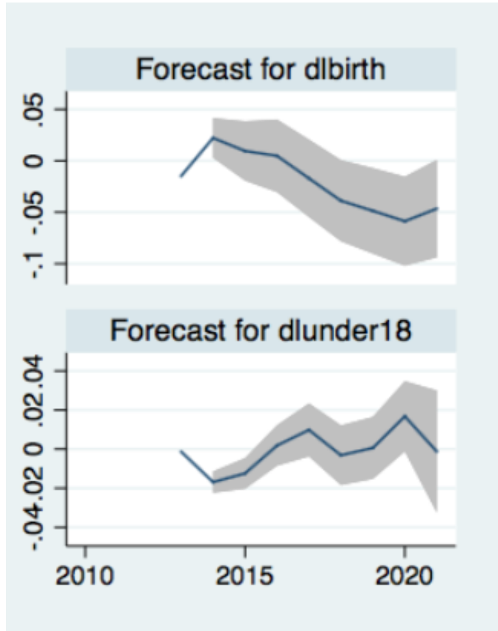

Figure 13. Forecasts of Live Births and Population Under 18 in Maine 2013-2021

Figure 13 focuses on the two most significant forecasts, the birth variable and the population under the age of 18. A sharp decline in births is forecasted, as well declines in the population under the age of 18.

DISCUSSION OF FINDINGS AND CONCLUSION

The choice of model specification is crucial to this study. The OLS model we used to in sample forecast prove that our variables are good indicators of labor force participation. The objective of this research was to investigate which areas of Maine's demographic structure played a part in the negative trend on labor force participation in the state. The birth variable as well as the age groups helped investigate this hypothesis, while the net migration variable depicted the future of migration in and out of Maine. Both of these variables are drivers of population and effect the demographic structure of the state. As seen in Figure 13, the most concerning forecast trend is that of births in Maine, which is shown to have a sharp negative slope. In turn, this negatively trending number of births effects the under 18 age group a few years later. As explained by our results, these two variables are also the ones that have the most substantial and positive effect on labor force participation. Therefore, the main issue responsible for declining labor force participation in Maine is the low fertility rates in the state leading to lack of children, or residents, under the age of 18.

Figure 12 shows that, though the forecast created by our model follows the trend of actual labor force participation well, the model tends to overestimate the decline in labor force participation in the year 2015. Therefore, we should keep in mind that the second dip in labor force participation which is forecasted is overestimated as well, although the negative trend should be consistent.

The structural changes due to advances in technology, loosening of international trade barriers, and an increase in human capital in The United States have completely revamped workforce characteristics in our country. According to projections from the Maine Center for Workforce Information and Research, there will be an increase in the number of jobs needed in 2024 by a total of 0.8%. Growth of employment in sectors such as Healthcare Practitioners and Technical Occupations (9.5%), Healthcare Support Occupations (9.4%), and Personal Care and Service Occupations (5.4%) will have huge growth. These sectors provide services which meet the demands of an aging population. Looking at the forecasts that we created for labor force participation, a growth rate of almost 10% by 2024 in healthcare sectors will mean a huge shortage of labor will be felt.

Our model shows the importance positive impact of the presence of people under the age of 18 and birth rates into the state. It is clear that in order to keep up with the imminent growth of employment, and in order to fill these positions, the state of Maine needs to focus on driving up the population of younger people in the state. This can be done by enticing higher rates of in migration, discouraging outmigration of high school and college graduates, and providing incentives to families for having children. Policies such as student loan repayment for potential healthcare workers can act as incentives to attract doctors, nurses, and other healthcare workers to the state. These policies are especially pertinent in rural areas in the state where we currently see a shortage of providers. Inhabitants in these areas must often travel to Bangor, Portland, or even in some cases Boston for proper medical services.

Sectors that are projected to have negative employment returns in 2024 are Production Occupations, with shocking projected percent change of -10.1% and Farming, Fishing, and Forestry Occupations with a decline of -3.5%. This just proves the trend of employment towards high technology, human capital-intensive work and away from manufacturing and production jobs which I mentioned in the background of this paper. A long-term goal of increasing focus on higher education in high technology sectors, which are defined as sectors that have higher average amount of research and development or percentages of scientific, engineering, and technical occupations (Malecki, 1984), while enacting programs which incentivize college graduates in these fields to stay in Maine, will increase human capital in the state. Malecki (Malecki, 1984) believes that there needs to be more focus on improvement of education and funding of universities since they can be and should be more fundamental in shaping competitive advantage in their regions. According to him, regions such as the Northeast, California, and Texas are the only areas where Universities regions are making a big difference because those tend to be the regions where there is more funding poured into universities, and where the universities place importance on research.

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