Lane County, Oregon

Population Modeling and Housing Demand Forecasting

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25 October 2015

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1. Introduction

Urban planning is largely concerned with improving the built environment. One of the biggest factors with regards to how the built environment is used is the general population. The size of the population can influence housing, traffic, crime, schools, and available services among many other things. It also has economic influence, for example, how much federal aid and tax revenue is collected by a municipality. Therefore, preparing for population growth and distribution is of crucial importance for urban planners. Population modeling is an effective and valuable tool for forecasting these demographic changes.

This report will examine Lane County, Oregon in this context. Using historical population data and cohort demographic data, several population models will be explored in order to find an accurate approximation of the county's population in 2020. This data will then be used to forecast housing demand for the county in 2020. In order to gain a fuller context, this report will also examine this history and background of Lane County, as well as age and gender cohorts from specific census years.

2. Background

Lane County, Oregon was established in 1851 and is situated on the western coast of the state, roughly halfway between California and Washington states. On the west it is bordered by the Pacific Ocean, on the east, the Cascade Mountain Range. As of 2010, it was the fourth largest county in the state of Oregon in terms and population with 351,445 citizens. The county spans 4,620 square miles, 90% of which is forestland. Despite this vast amount of forest, 82.2% of households are located in urban areas. The county's largest metropolitan area is the combination of Eugene and Springfield, which account for 61% of the total county population. Its main industries are agriculture and timber, though several large recreational vehicle manufactures are located within the county. Lane County is also home the University of Oregon, which currently enrolls over 24,000 students ("Overview of Lane County" 1)

Figure 1. Map of Lane County, Oregon

Source: "Overview of Lane County"

Lane County's first appearance in the census was 1860 where it had a recorded population of 4,779. By 1940, the population had increased to 69,180 and it has continued to grow larger. It a large population growth between 1940 and 1950 when its population expanded by over 56,000 to 125,776. This was likely as a result of soldiers returning to the United States at the conclusion of World War II. Its largest population growth was between 1970 and 1980, when it expanded by 61,868 people to 275,226. This was likely caused by the baby boom. Since then, population growth has slowed, averaging just 2,500 people per year (1860-2010 Decennial Census)

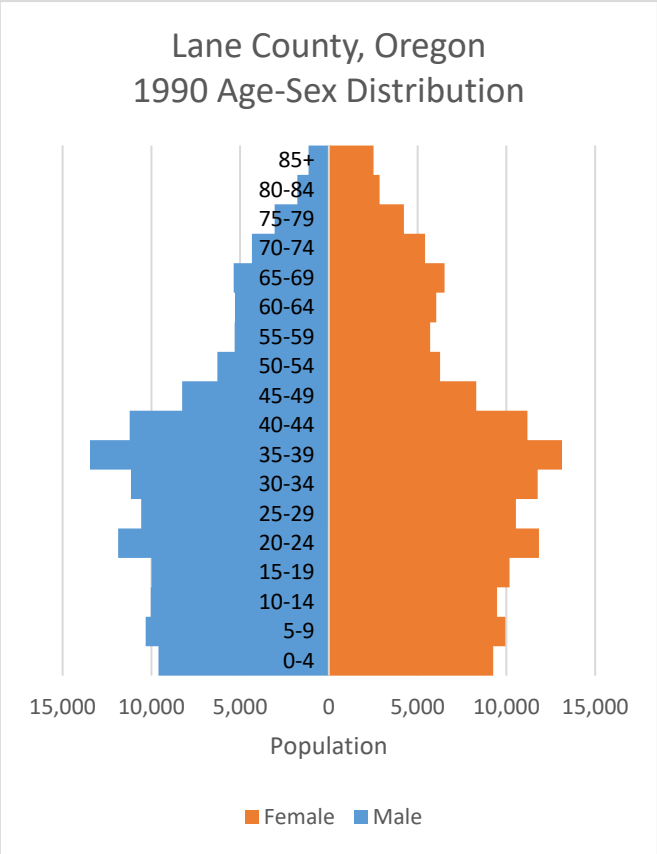
Racially, the county is primarily white. 88.4% of the population defined themselves as white in the 2010 census. 2.4% of the population is Asian with Native American and black following with 1.2% and 1.0% respectively. 2.8% of the population defined themselves as other while 4.1% of the population defined themselves as two or more races (2010 Decennial Census). The 2010 American Consumer Survey (5-Year Estimate) recorded Lane County as having a median income of $42,923 and a mean income of $56,541 (American Community Survey). The county has a very poor crime rate: approximately 2,359 violent crimes per 100,000 people in 2011 (Annual Part 1 and Part 2 Crimes).

3. Demographics

a. Distributions

The population of Lane County has continued to grow at a relatively uniform rate, however the distribution of that population has not changed so uniformly. Figure 2, below, depicts the age and gender distributions of Lane in 1990. In 1990, there were 138,989 males and 145,123 females; males

Figure 2. 1990 Population Pyramid



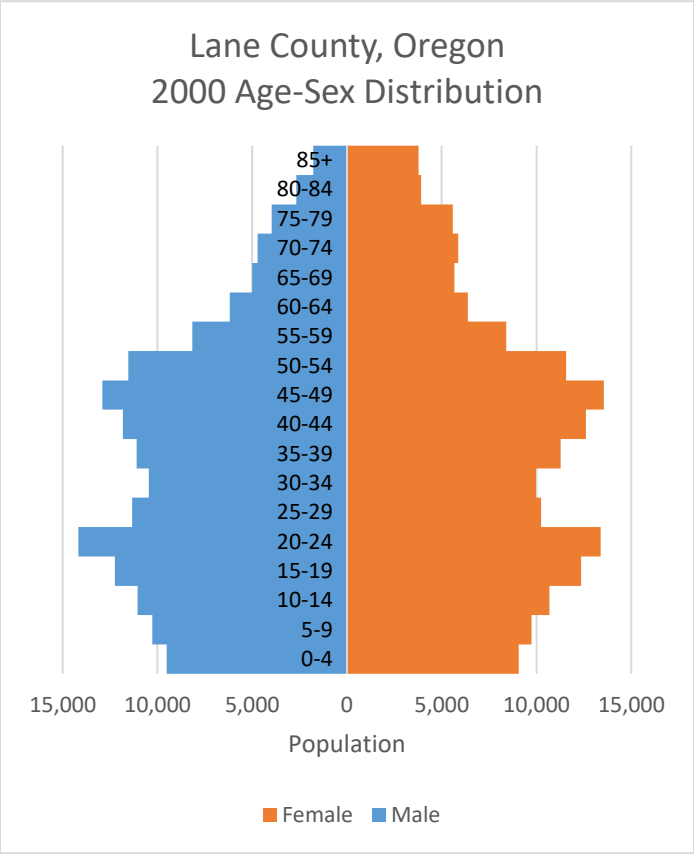
Source: 1990 Decennial Census

had an average age of 34.67 while females had an average age of 36.82. For both males and females, the 35 to 39 year cohort commands the largest percentage of the population, accounting for 9.7% and 9.1% of their respective populations. On a larger scale, the graph is mostly symmetrical and there is a population bump between 15 and 44 years; the graph rapidly tapers after this point. While the younger cohorts are slightly smaller than the large bump between 15 and 44 years, the overall shape of this pyramid indicates moderate growth in the population.

Between 1990 and 2000, the population in Lane grew from 284,112 to 322,959 – roughly 13.7%. The number of males increased to 158,941 and the number of females increased to 164,018. Additionally, the average age for each gender rose for each gender. In 2000, the average male was 36.38 and the average female was 38.64 years old.

Figure 3, below, shows the population pyramid for Lane County in 2000. Like in 2000, the graph is mostly symmetrical, however it is also bimodal. The largest bump for both genders is in the 20 to 24 year cohort; for males it accounts for 8.9% of the population and for females it accounts for 8.2% of the population. This bump can be attributed to the presence of the University of Oregon within Lane County. The other bump is in the 45 to 49 year cohort for both genders; this is the largest cohort from 1990, ten years removed. There is a steep drop-off in population after the 50 to 54 cohort, and the older cohorts are female dominant; there are approximately 6,000 more females over the age of 65 in Lane. Similarly to 1990, the shape describes a moderate growth population.

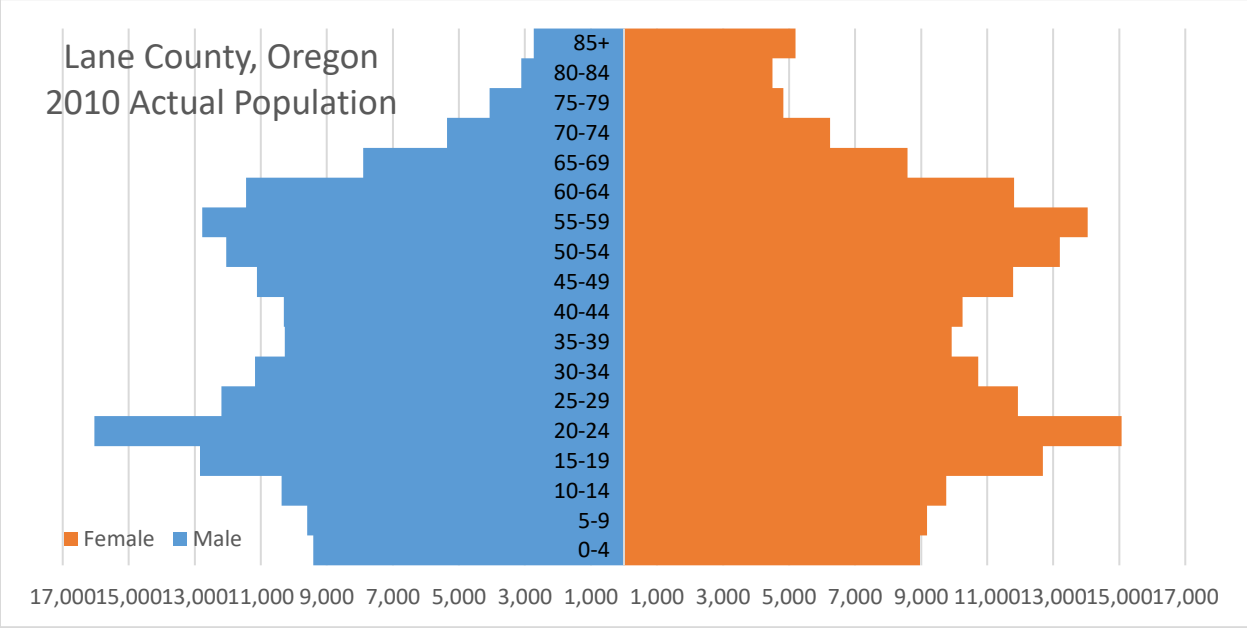
Figure 3. 2000 Population Pyramid



Source: 2000 Decennial Census

In 2010, Lane County's population had risen to 351,445, an increase of 8.8% from 1990. Males account for 172,447 people, while females account for the remaining 178,671 people. The average age for males in 2010 was 38.64 years old and the average age for females was 40.79. Again, the distribution is mostly symmetrical and bimodal, see Figure 4, below. For both genders, the population is largest in the 20 to 24 year cohort; the influence of the University of Oregon remains the driving factor behind this mode. The other mode is in the 55 to 59 year cohort. This is the same bump that has been moving through the pyramid since 1990. There is a steep drop-off in population after the 60 to 64 year cohort. If it were not for the influence of the university, this pyramid would most certainly depict a constricting population.

Figure 4. 2010 Population Pyramid



Source: 2010 Decennial Census

b. Projections

The population data for Lane County between 1940 and 2000 was used to create several population models. These models were used to predict the total population in 2010 and in 2020. There were eight models in total, each based off a different type of mathematical equation; they were: linear, exponential, logarithmic, second order polynomial, sixth order polynomial, power, moving average, and logarithm-transformed modified exponential. Each model was evaluated using the coefficient of determination (R^2) and the mean absolute percent error (MAPE). The coefficient of determination is a measure of prediction and accuracy; the coefficient describes what percentage of the population can be described by the year. The best possible coefficient of determination is one. The mean absolute percent error is a calculation of forecast error; it is the different between the projected population and actual population divided by the actual population. The best possible MAPE is zero. The summary of the projection models results can be viewed in Table 1, below.

Table 1. Summary of Population Projection Models

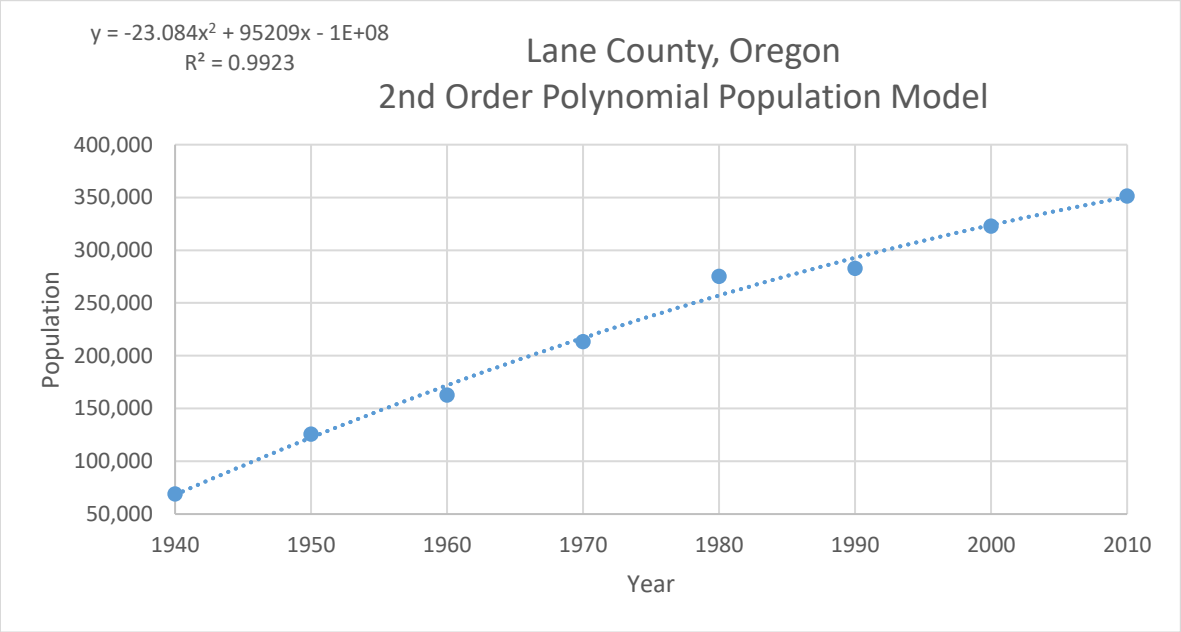
Model	Equation	R^2	MAPE	Actual 2010	Predicted 2010
Linear	$y=ax+b$	0.9795	4.29%	351,445	366,470
Exponential	$y=a*e^{bx}$	0.8938	13.08%	351,445	425,684
Logarithmic	$y=a+b*\ln(x)$	0.9806	4.20%	351,445	365,837
Polynomial (2nd order)	$y=ax^2+bx+c$	0.9923	2.59%	351,445	350,196
Polynomial (6th order)	$y=ax^6+bx^5+...+g$	0.9977	1.56%	351,445	351,224
Power	$y=a*x^b$	0.9940	3.41%	351,445	364,041
Moving average	$y_t=avg(y_{t-1},y_{t-2},y_{t-3},...)$	N/A	8.14%	351,445	337,202
Modified exponential	$y=c-a*(b\hat{}x)$	0.9688	6.82%	351,445	341,910

Source: 1940-2010 Decennial Census' and Michael Borsellino

Using the R^2 and MAPE as the sole evaluators of accuracy, the sixth order polynomial is the most accurate model. Its R^2 value of 0.9977 is the highest of the eight models and nearly one; its MAPE of 1.56% is the lowest of the eight models and nearly zero. Only two models fared poorly: the exponential model had an R^2 value of 0.8938 and a MAPE of 13.08% and the moving average model had a MAPE of 8.14% (moving average models do not use regression to calculate values, therefore they do not have a coefficient of determination). In both cases, the results are only poor when compared to the other six models; alone, both would be considered adequate population models.

However, R^2 and MAPE cannot be solely relied on to evaluate a population model. While a model may align with the eight data points, it may deviate substantially from the trend before or after the known points. This is the case with the sixth order polynomial, which predicted a population of -452,056 in 1930 and 62,600 in 2020. In other cases, a model may fit poorly overall but in small sequences may be perfect. While none of these models fits poorly, the second order polynomial is a great example of a model that predicts several points well. In this case, the end of the trend where it's MAPE is 0.30% over the final two points and its absolute percent error (APE) for 2010 was 0.36%; it under predicted the 2010 population by 224 people with 350,196. As a result, the second order polynomial (see Figure 5, below) is the most accurate model, at least in its in ability to predict the population of Lane County in the near future.

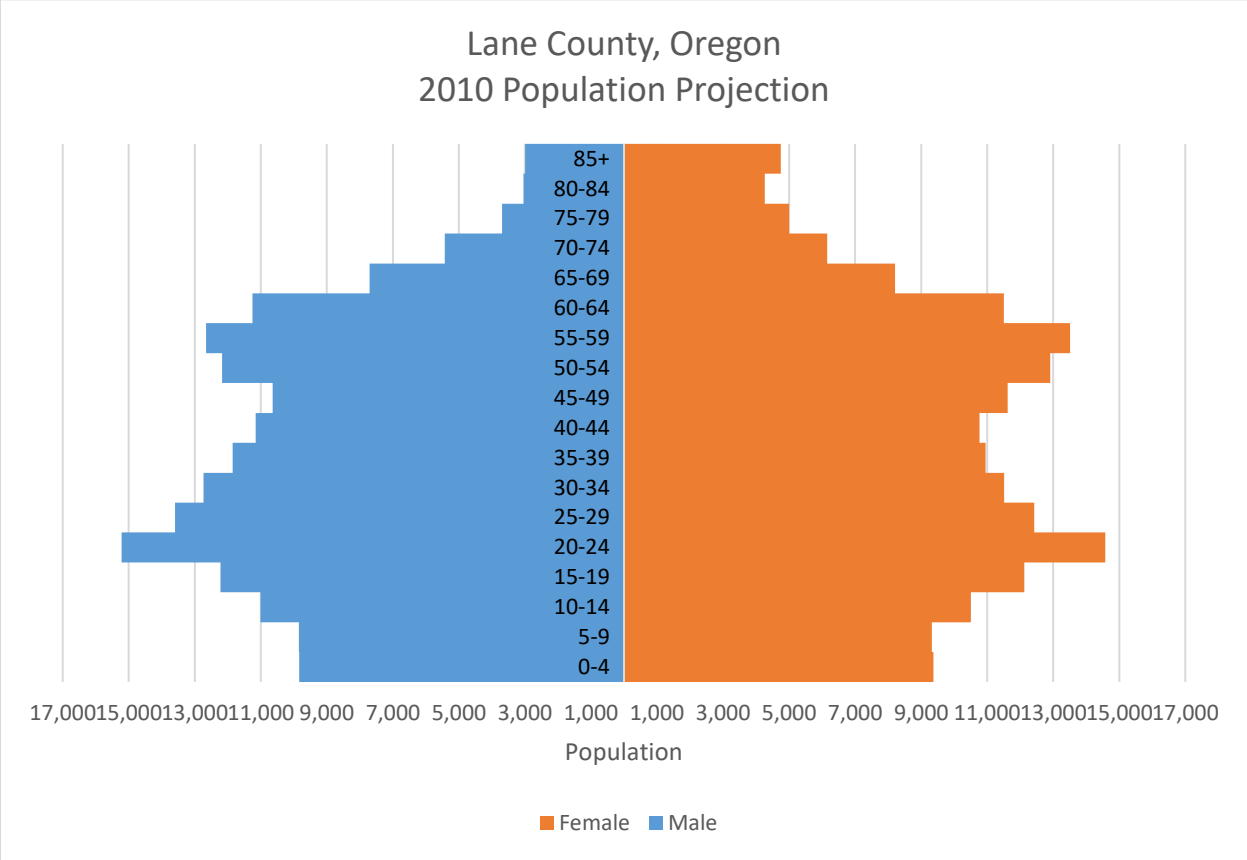
Figure 5. Second Order Polynomial Model



Source: 1940-2010 Decennial Census' and Michael Borsellino

There was one more model used to predict the 2010 population in Lane County. It is called a bottom-up projection, or cohort component model. It differs from the above models in that is uses factors such as crude death rate, fertility rate, and migration to calculate expected population. Theoretically, this model should be more accurate than the above models because it accounts for the factors that influence population, rather than using regression techniques to identify population trends. Specifically, this model required six data about six factors that could be responsible for influencing the population. It required the population in five-year age cohorts from 1990 and 2000. It required the crude death rates per 100,000 for each of these years. This data was readily available in ten year increments, therefore the number of deaths per year was divided by two and distributed into the appropriate cohorts; this should give an adequate approximation of crude death rate for each cohort. Lastly, the fertility rate for 1990 and 2000 was calculated. This data was aggregated from the available one-year cohorts. Using this information, survival rates, number of births, and migration for each cohort was calculated. The resultant population pyramid is below.

Figure 6. 2010 Population Pyramid Projection



Source: 1990-2000 Decennial Census', Compressed Mortality Data, and Live Births Data

This model proved to be highly accurate as its absolute percent error for 2010 was 1.5%. The true 2010 population in Lane County was 351,445 while this model predicted a population of 356,578, an error of 5,133. Most of the error came from the cohorts between 20 and 44 years, and the error tended to be larger for males than females. The APE for males was 2.5% as compared to 0.5% for females. This error was also visible in the calculated migration residual for 1990 through 2000; it could be a resulting from the influence of the University of Oregon on population models or it could be a result of the approximated crude death rates. Despite this error, the shape and magnitude of the projected population pyramid is nearly identical to that of the true population pyramid on the bottom of page 4.

4. Housing

As mentioned in the Introduction, population modeling has tremendous value in urban planning. In this case, its value is in predicting 2020 housing demand in Lane County. This is accomplished by using population and housing information from 2000 and 2010 in addition to construction and demolition permits issued by the county over that same time period.

In 2000, Lane County had 138,946 housing units, 93.9% of which were actively occupied. The average household size in 2000 was 2.42 people per unit. In 2010, the number of housing units increased to 156,112, 93.5% of which were actively occupied. The average household size in 2010 was 2.35 people per unit. The decrease in occupancy may be due to the housing crisis and recession, though Lane County appears to have not been affected greatly. 2010 occupancy rates in Oregon and the United States were 90.7% and 88.6%, respectively. For both geographies, these rates decreased by over 1% between 2000 and 2010.

As we do not have data for 2020, the models in the above sections will be used to derive the information needed to project housing demand. The second order polynomial model, which was selected as the most accurate, predicted that Lane County's population would increase to 372,017 by 2020. A linear trend was used to calculate population in group quarters, leaving household population at 363,174, up from 342,915 in 2010. A linear trend that utilized the ratio of population change to housing unit change between 1940 and 2010 provided an estimate for total housing units in 2020: 170,495. A linear model was used to predict average household size in 2020, which decreased to 2.28. Using this data, the number of households in 2020 was calculated to be 159,287, an increase of 13,366 over 2010. Lastly, the occupancy rate was left unchanged at 93.5% due to the likely impact of the 2008 economic recession and uncertainty about future economic conditions; this suggests an increase of 936 vacant homes between 2010 and 2020.

Table 2. 2020 Housing Demand

Housing Demand	
Change in the Number of of Households 2010-2020	13,366
Change in the Number of Vacant Units 2010-2020	936
Units that Must be Replaced 2010-2020	4,850
Units Lost to Disaster 2010-2020	3,500
Units Lost to Conversion 2010-2020	675
Units Lost to Demolition 2010-2020	675
Total Number of Units Needed 2010-2020	19,152
Projected Housing Completions 2010-2020	8,000
Unmet Housing Demand 2011-2020	**11,152**

At this point, there is a clearer picture of what Lane County's housing needs will be in 2020. However, this does not account for changes in the current supply of housing. Lane County is prone to both earthquakes and wildfires, therefore an estimated 3,500 housing units, or 1%, will be lost between 2010 and 2020 ("Overview of Lane County" 1). Based on summaries of permit data between 2000 and 2010, it is expected that roughly 1,350 units will be converted or demolished. Based on the same summaries of permit data, it is expected that there will be 8,000 new homes built between 2010 and 2020. As a result, this projection estimates that Lane County will be short 11,152 housing units in 2020. However, if average household size and occupancy rates returned to their 2000 levels, 2.42 people per unit and 93.9% occupancy, the housing shortage would be a much more manageable 1,200 units. This goes to illustrates how small changes in social behavior (for example, living with roommates) could have large effects on available housing.

Regardless of the numbers used, the projection above demonstrates the likely scenario of a housing shortage in Lane County. The most obvious effect of this shortage would be an increase in home

cost and rent. This could be especially troubling if interest rates rise by 2020, as expected, resulting in a higher cost of borrowing for new home buyers. A housing shortage also had other economic effects: lost tax revenue, reduced work force, and decreased entrepreneurial activity are some examples. Most worrisome is that the housing shortage may have already begun in Lane County. A recent article in the Register Guard, a periodical based out of Eugene, Oregon, noted that home sales have increased by over 20% since 2014 while home prices are up 4% over the same period (Aleshire 1). This may be the first sign of an impending housing shortage in Lane County.

5. Conclusion

This report explored the demographic history of Lane County, Oregon. The demographic history was critically important for evaluating trends and providing context for further analysis. Following, this report examined several different models in an effort to forecast future population; this was then used to forecast future housing demand. Future housing demand is just one of many critical approximations that population models are used to inform. These forecasts will prove to be invaluable as government officials craft public policy and urban planners prepare for the future of their municipalities in relationship to shifting population totals and distributions.

With regards to this report, nearly every model was incredibly accurate in forecasting 2010 population. While "predicting" the past does not prove future success, it does lend credibility to the models. As a result, the magnitude of Lane County's 2020 housing shortage, predicted in part by the second order polynomial population model, may not be accurate; however, its existence should be cause for concern moving forward. This information should allow Lane County officials to create a plan that ameliorates this shortage before it begins, yielding economic benefits for the county and state as a whole.

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