Natality Models

DATA 621: Business Analytics and Data Mining

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1 Abstract

2 Keywords

Natality, Births

3 Literature Review

Daniel Dittenhafer has done prior work analyzing births and unemployment rate in the United States, finding a negative relationship between births and unemployment during the time period studied (Dittenhafer, 2014). Dittenhafer's single predictor linear model using unemployment rate alone yielded an adjusted R^2 of 0.296 with a p-value approaching 0.

4 Methodology

4.1 Data Preparation

Data sets from the Census Bureau, Centers for Disease Control, and Bureau of Labor Statistics were joined together in order to provide a unified data set for analysis and modeling.

4.1.1 Natality Data

The natality data including birth counts per month were acquired from the Centers for Disease Control and Prevention in two data sets. The first data set contained data for the years 2003 - 2006 (Centers for Disease Control and Prevention, 2009). The second data set contained data for the years 2007 - 2014 (Centers for Disease Control and Prevention, 2016). The data sets were merged together and augmented with additional census, earning and unemployment data as described in the following sections.

4.1.2 Census Data

For the period of May 2010 - Decemeber 2015, the Census Bureau's census data was available as monthly population estimates broken down by age and gender (Census Bureau, 2015). The age data was in whole year granulatity and we created 10 year buckets for the female population by age: 15-24, 25-34, and 35-44.

For the period of 2000 - April 2010, monthly population estimates were only available for the total population (Census Bureau, 2010). We used annual age and gender estimates from the Census Bureau 2000 - 2010 time period, converted to ratio's, to divide the monthly total population into age and gender bins as shown in the following expressions:

Gender Bins

$$G_{year} = \frac{F_{year}}{P_{year}}$$

$$F_{month} = P_{month} * G_{year}$$

$$M_{month} = P_{month} - F_{month}$$

Where:

- G Gender Ratio
- F Total females, TOT_FEMALE
- M Total males, TOT_MALE
- P Total population, TOT_POP

Age Bins

$$F_{year\_x\_y} = \sum_{i=x}^{y-1} F_{year\_i}$$

$$A_{year\_x\_y} = \frac{F_{year\_x\_y}}{F_{year}}$$

$$F_{month\_x\_y} = F_{month} * A_{year\_x\_y}$$

Where:

- x Lower age bound of bin
- y Upper age bound of bin
- A Age bin's ratio

4.1.3 Earnings Data

The earnings data was acquired from the Bureau of Labor Statistics and specifically covers women's weekly earnings from 2003 - 2015 (Bureau of Labor Statistics, 2015). The acquired data was at a quarter year granularity and was transformed to a monthly granularity for use in this study where a given quarter's weekly earnings were assigned to each of the 3 months in the 12 month annual period.

4.1.4 Unemployment Data

Unemployment data (U3) was acquired from the Bureau of Labor Statistics. The data was at a monthly granularity with no transformations applied before use in the study (Bureau of Labor Statistics, 2015).

4.2 Data Exploration

We conducted exploratory data analysis to better understand the relationships in the data including correlations (Table 1), feature distributions and basic summary statistics. The data was separated into a training set (80%), used to fit the models, and a validation set (20%), used to test how well our candidate models generalize to unseen data.

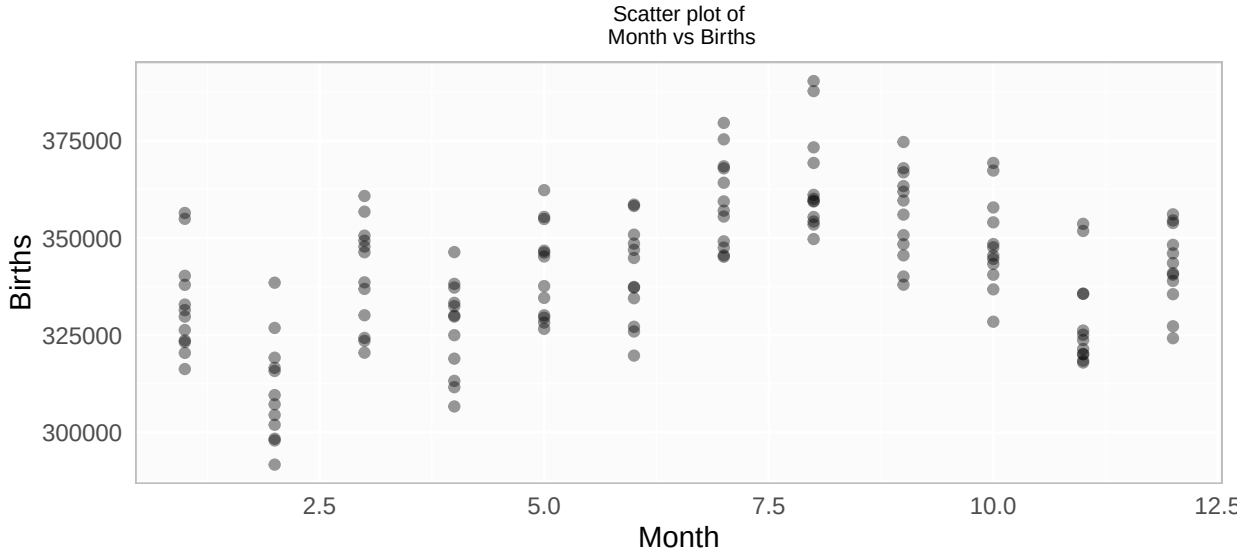
Table 1: Pearson's r Correlation Coefficients

Births	1.0000000
FEMALE_35_44	0.3880661
Month	0.3646307

GenderRatio	0.2862173
FEMALE_15_24	-0.2307949
TOT_MALE	-0.3214851
TOT_POP	-0.3219328
TOT_FEMALE	-0.3223760
Year	-0.3593053
Earnings	-0.3697992
UnemploymentRate	-0.3862666
FEMALE_25_34	-0.3879287

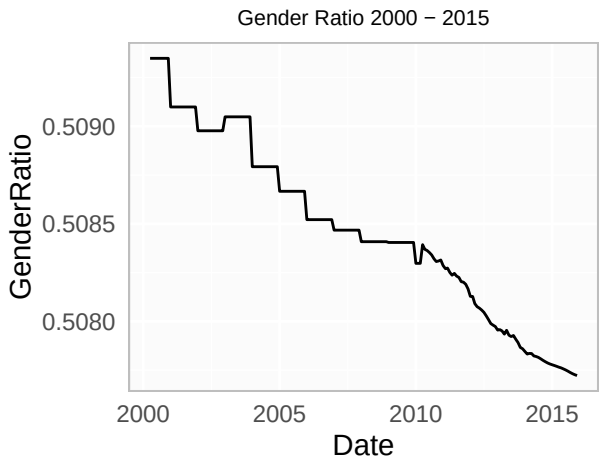
4.2.1 Seasonality

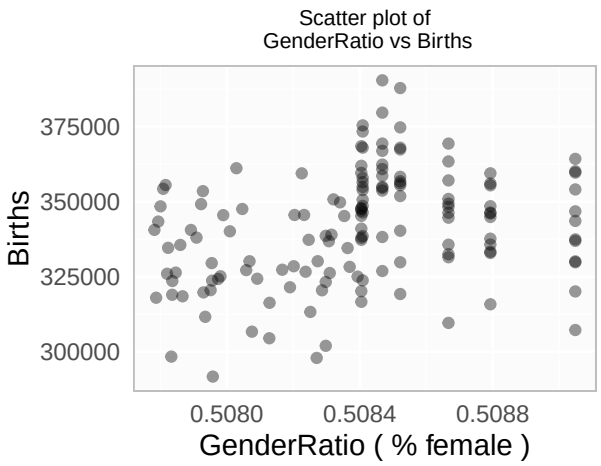
As one might expect, we saw seasonality in the birth data. As shown in the scatter plot, below, August is a very popular month for births. July and September are close behind. This suggests that many conceptions are occurs during the United States holiday season between Thanksgiving and New Years.



4.2.2 Gender Ratio

The computed gender ratio which was used to enable the gender buckets for the period of 2003 - 2010 can be seen in the scatterplot below. For these years, the gender ratio is constant for all months while the birth counts fluctuate. Interestingly, the proportion of females has been dropping steadily, though only slightly during the time period being studied.





5 Results

6 Summary

7 Appendix: Supplemental Tables & Figures

8 Appendix: Raw Code

9 References

Bureau of Labor Statistics. Labor Force Statistics from the Current Population Survey 2003-2015 - LNS14000000. Accessed: April 24, 2016. 2015. URL: http://data.bls.gov/timeseries/LNS14000000.

— Median wkly earnings, Emp FT, Wage & sal wrkrs, Women - LEU0252882700. Accessed: March 10, 2016. 2015. URL: http://data.bls.gov/cgi-bin/surveymost?le.

Census Bureau. Monthly Postcensal Resident Population, by single year of age, sex, race, and Hispanic origin. Accessed: April 24, 2016. 2015. URL: http://www.census.gov/popest/data/national/asrh/2014/2014-nat-res.html.

— National Intercensal Estimates (2000-2010). Accessed: April 24, 2016. 2010. URL: http://www.census.gov/popest/data/intercens

Centers for Disease Control and Prevention. Natality public-use data on CDC WONDER Online Database for years 2003-2006 available March 2009. Accessed: March 1, 2016. 2009. URL: http://wonder.cdc.gov/natality-v2006.html.

— Natality public-use data on CDC WONDER Online Database for years 2007-2014 available February 2016. Accessed: March 1, 2016. 2016. URL: http://wonder.cdc.gov/natality-current.html.

Dittenhafer, D. U.S. Births & Unemployment Rate 2007 - 2012. 2014. URL: https://github.com/dwdii/DataAcqMgmt/raw/master/
Dittenhafer-USBirthsAnalysis.pdf.