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P1_5 Lasting Effects of the Holocaust on the Global Jewish Population

Spence, D; Botterill, S; Comber, E; James, M.

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH.

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Abstract

The Holocaust of the Second World War had a dramatic effect on the number of Jewish members of the global society in so far as reducing the population size; this paper looks to examine how the global Jewish population has recovered in the last 65 years. We find that the period 1945-2010 is best-fit with a 3rd order polynomial, and that were the best-fit form to continue, the global Jewish population would reach its pre-WWII peak of ~17 million by the year 2041 - a setback of approx. 100 years.

Background

The Holocaust was one of the most horrific examples of genocide in recent history; however from an objective point of view it provides a fascinating data set regarding the global population of Jewish people – the main targets of Nazi Germany. Much like examining the behaviour of a fluid either side of a shock, this article will examine the population data available from 1882 to 2010 for the global Jewish population [1] [2].

Fig 1: Global Jewish Population 1882-2010

Analysis

Considering the influence that such a large-scale event has on the population dynamics, it would be unwise to try fitting a model to the data set as a whole, any relatively well-behaved function that tried to accommodate for the shock events during the period 1939-1945 would likely not represent the population growth accurately. With this in mind, we treat the data set as two distinct regimes – Pre- and Post-War.

Using MATLAB's[3] built in polynomial data fitting algorithm *polyfit.m* [3], which finds the least-squares regression line for a polynomial of pre-chosen order *n*

$$y = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0 \quad (1)$$

One's initial impression of the Pre-War data might be that it follows a broadly linear relationship with time (years), whilst the Post-War period is harder to judge, however the apparent presence of an inflexion point after the year 2000 suggests perhaps a cubic form, i.e. *n=3*. Also, we will examine the case that the previous linear form has resumed.

Fitting Results and Parameter Estimates

Having run the MATLAB code, we produce three graphs, extrapolated to future years in order to examine how the Jewish population (in millions) may have looked if the Holocaust had never taken place.

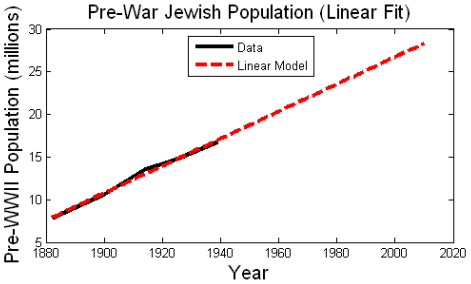

Fig 2: Pre-WWII Jewish population growth globally.

We find that the least-squares equation which best matches the Pre-War data takes the form

$$P_{pre} = 0.16\,y - 293 \quad (2)$$

where *P* is the global Jewish population, and y is the year (A.D.). The exact form of the fit line is less important as far as interest in the behaviour of population dynamics, more so the projected population in 2010 had the linear growth continued, and our analysis predicts a global population of 28.36 million. The second part of this analysis considers the post-WWII trend in population growth. We see a clear discrepancy between the pre-WWII growth behaviour and that afterwards. Our first model will assume that the previous linear behaviour has continued.

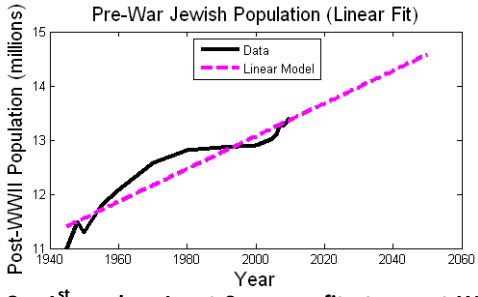

Fig 3: 1st order Least-Squares fit to post-WWII population growth.

MATLAB's *polyfit* finds the parameters of the best-fit line to be

$$P_{post(1)} = 0.03\,y - 47 \quad (3)$$

Inspection shows that a linear model is a poor fit for the measured data, as does the numerical measure of fit accuracy: the 'norm of residuals' [3], defined as,

$$NR = \sqrt{\sum_{i=1}^{N} d_i^2} \quad (4)$$

where *d* is the fit-data error for all points. This evaluates to $NR_1 = 0.8343$. This is relatively large and so we reject this model for the interval 1945-2010. It is sensible to assume, given the inflexion in data around 2000 A.D. that a cubic model may better suit the data presented, and so we alter the polynomial fit order to account for this.

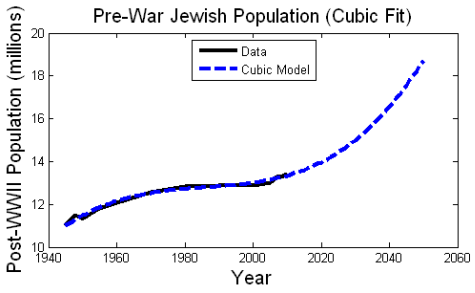

Fig 4: 3rd order polynomial Least-Squares fit to post-WWII population growth

Allowing for higher-order terms in the solver produces a much closer fit to the data, with the form

$$P_{post(3)} = 1.9 \times 10^{-5}\,y^3 - 0.12\,y^2 + 233y - 1.5 \times 10^5 \quad (5)$$

which has a norm of residuals value much lower than the previous model, at $NR_3 = 0.3753$, and so we are not able (over the range 1945-2010) to reject this model.

Discussion

It appears that the post-WWII growth follows a cubic relationship. However, the inflexion point that suggests a cubic nature may well be the onset of a new regime of linear growth similar to pre- WWII, following a transient delay period caused by a lost Jewish generation, who were unable to reproduce in the immediate post-war period. This is offered only as 'food for thought', as the true driving factors are likely more complicated.

Conclusion

We find that over the range considered, a 3rd order polynomial (as described) best fits the global Jewish population growth post-WWII, and that – were this model to continue – the global Jewish population would take until the year 2041 to reach its pre-WWII peak of ~17 million.

References

[1] Israeli Bureau of Statistics (2010)

[2] North American Jewish Databank (2010)

[3] The Mathworks, Inc. Natick, MA, USA. (2009)