Modeling Immigration: How Statistical Methodology Can Lend Support to Political Decisions

GENESEO

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1991: Spain introduces visa requirements to enter country.

1993: First 8.4 km, 3m tall fence in Ceuta is constructed. Spain begins immigrant rejections.

1995: Nearly 70,000 rejections at Ceuta border alone.

1998: 11km, 3m tall fence erected in Melilla. Plan Sur border control program initiated.

1999: Integrated System of Exterior Surveillance (SIVE) installed (9 mile radius of detection cameras).

2001: 9/11 attack on U.S. causes international scare. Attention drawn to the two cities.

2002: All time high in recorded illegal crossings.

2005: Spain invests €33 million to double height of fences in both cities.

2007: Spanish king visits Ceuta – causes diplomatic tension with Morocco.

2010-2011: Arab Spring causes spike in immigration into the EU.

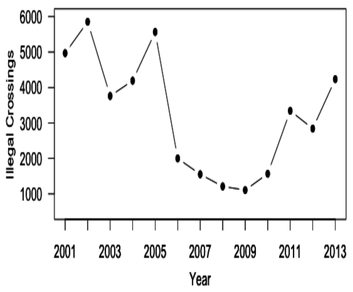
2013: 50%+ spike in illegal immigration compared to 2012.

2014: Projected illegal immigration rates to exceed that of 2002.

Background

Contrary to popular belief, the European Union (EU) actually extends into Africa. Located on the Mediterranean coast of Morocco are the two cities Ceuta and Melilla, which have been political entities of Spain since the 15th century. In 1991, the Spanish government introduced visa requirements for all non-EU citizens entering into Spanish territory. Since then, illegal immigration into the two cities from North Africa has become a serious issue. Being that Spain is a member of the European Union and Ceuta and Melilla are Spanish territories, if an immigrant successfully enters Spain they may travel within the EU sans papers. In recent years, global attention has been drawn to the two cities due to this reason. Difficulties in identifying immigrant nationality and negotiation of readmission agreements with origin countries further complicate the issue by making deportation unviable.

Illegal Crossings into Ceuta & Melilla



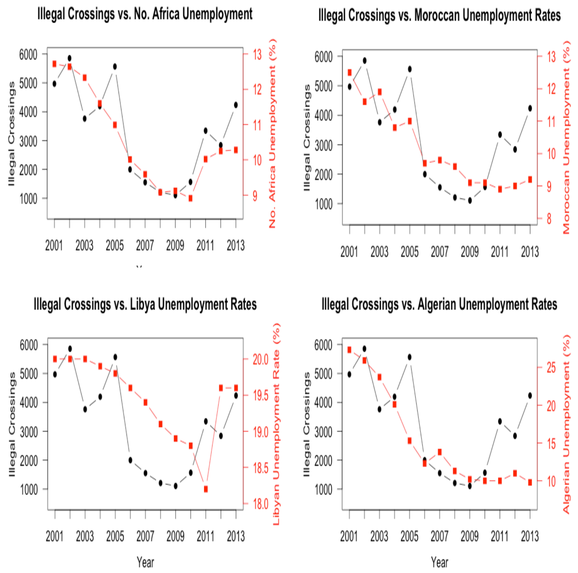
Objectives

The primary objective of this statistical study is to mathematically investigate the issue of illegal immigration into Ceuta and Melilla. Traditionally, qualitative studies on illegal immigration have concluded that economic conditions in an immigrant's origin country serve as a significant motivator for their decision to emigrate. In investigating the two cities, we would like to see if statistical tests and methodology can help Spanish legislators shape policy on immigration.

Methods

All statistical tests and graphs were produced using *R*. The study focuses on the calculation of correlation coefficients, running of ANOVA tests, and creation of visualizations to investigate immigration into the two cities. Variables were chosen based on exploratory data analysis. In the latter half of the study, the data set was partitioned into two intervals, 2001-2005 and 2006-2013. The data in each interval was then analyzed in a method similar to that employed on the original data set. The data set was split at 2005 because this was the year the height of the fences preventing would-be illegal immigrants from entering the cities was doubled. All data was collected from reputable historical archives of organizations such as the World Bank, Frontex, and the Spanish Interior Ministry. Multiple variables not presented in this study were also considered, but determined to be statistically non-significant. Conclusions were drawn based on the findings of this study and interventions made by Spain to deter the illegal immigrants from entering Ceuta and Melilla.

Results and Analysis



From the initial correlation coefficient calculations of *Illegals* ~ (variable), several points are worthy of note:

- The North African Unemployment Rate has a 0.85 correlation coefficient
- Moroccan, Algerian and Libyan unemployment rates (listed below) show correlations ranging from 0.61 to 0.68.
- The Spanish unemployment has a -0.12 correlation; EU unemployment 0.44.
- Real GDP correlations support the three above findings.
- Sub-Saharan Africa GDP growth is a non-significant indicator, thereby jointly suggesting with the above calculations that most immigrants originate from Northern Africa.

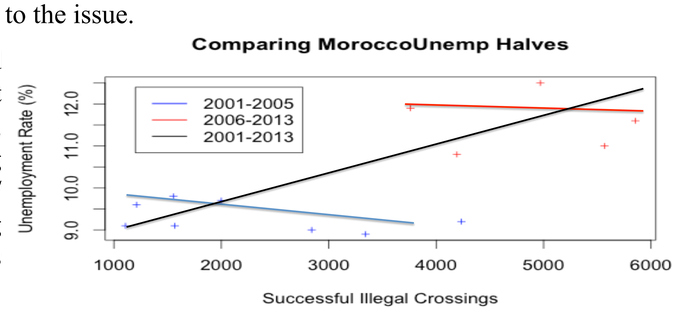
Through the running of an ANOVA test, we determine that Moroccan, Algerian and Libyan unemployment rates are statistically significant at 0.05. The North African unemployment rate is statistically significant with p-value=0.0005.

Another variable to strongly consider is total monetary investment on the borders to prevent illegal immigration into the two cities. The available data, albeit limited, shows a strong negative correlation of -0.72 and statistical significance with p-value=0.001.

Correlations	2001-2005	2006-2013	2001-2013
SpainUnemp	-0.39	0.69	-0.12
MoroccoUnemp	-0.05	-0.44	0.68
AlgeriaUnemp	-0.05	-0.40	0.67
NoAfricaUnemp	-0.04	0.83	0.85
SSA GDP Growth	-0.38	-0.17	-0.03
Border Investment	NaN, S = 0	0.16	-0.72
LibyaUnemp	-0.23	0.10	0.61
TunisiaUnemp	0.50	0.51	0.52
EUUnemp	-0.57	0.85	0.44

The data suggest that while economic conditions play an important role in illegal immigration into Ceuta and Melilla, the conditions in the immigrants' origin countries are more significant than those of the region they are immigrating to. The tangible difference between the correlation coefficients of *SpainUnemp* and *EUUnemp* may be a result of a lurking variable or collinearity. This is supported by the ANOVA test for *Illegals~SpainUnemp*EUUnemp*. Furthermore, while total expenditure on the border is statistically significant, it is important to note the gradual increase in illegal crossings after 2005, when the fence heights were doubled. This reflects temporal decay in the effectiveness of allocating money to the issue, causing it to be an impractical long term solution to the issue.

Splitting the data does not yield verifiable conclusions without power graph analytics. It does, however, provide interesting examples of Simpson's paradox/ environmental fallacy/modeling with small data sets, one of which is shown in the figure to the right.



Conclusions

Given the statistical significance of several economic indicators across multiple North African provinces, the probability that the findings presented in this study are merely a coincidence is extremely low. Therefore, we make the conclusion that economic conditions are important motivators for illegal North African immigration into Ceuta and Melilla.

Based on the data, the Spanish government's current political policies on immigration into the two cities seems to be ineffective. Despite several interventions, some of which are listed on the above timeline, illegal immigration rates are still highly correlated with economic conditions in North Africa. Given that interventions have been made by the Spanish government but correlations between economic indicators and illegal immigration still remain high, we cannot conclude that the measures Spain has taken have effective in reducing illegal immigration flow into the cities.

This study suggests that keeping illegal immigration rates low, such as those from 2007-2009, is not about keeping illegal immigrants out, but rather decreasing the economic pressures that impel people to emigrate. This is to say that a long term solution is necessary to stop the problem, rather than an ineffective one of short term such as a policy enactment. Based on our conclusions, it is thereby logical to claim that instead of passing more legislation, Spain should direct its attention and resources to the standards of living in the countries from which the immigrants originate. By doing this, Spain may finally be able to address the problem at its roots.

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