Demographic Time-Bombs

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What is a Demographic Time-Bomb?

When the ageing population of a country is exacerbated by declining birth rates, which reduces the number of working age adults.

Demographic Time-Bombs form over years, sometimes decades and are worsened by the increase in life expectancy.

Why should we care about them?

- Economic contraction
- Country debt
- Higher tax rates
- Shortage of pension/social security-type funds
- Increase in retirement age

Demographic Time Bomb Risk Model

Data Sources:

- World Bank
- Gapminder

Breakdown:

- 2000 - 2015
- 163 countries

Target:

- Potential Support Ratio (PSR)
- PSR (log) *

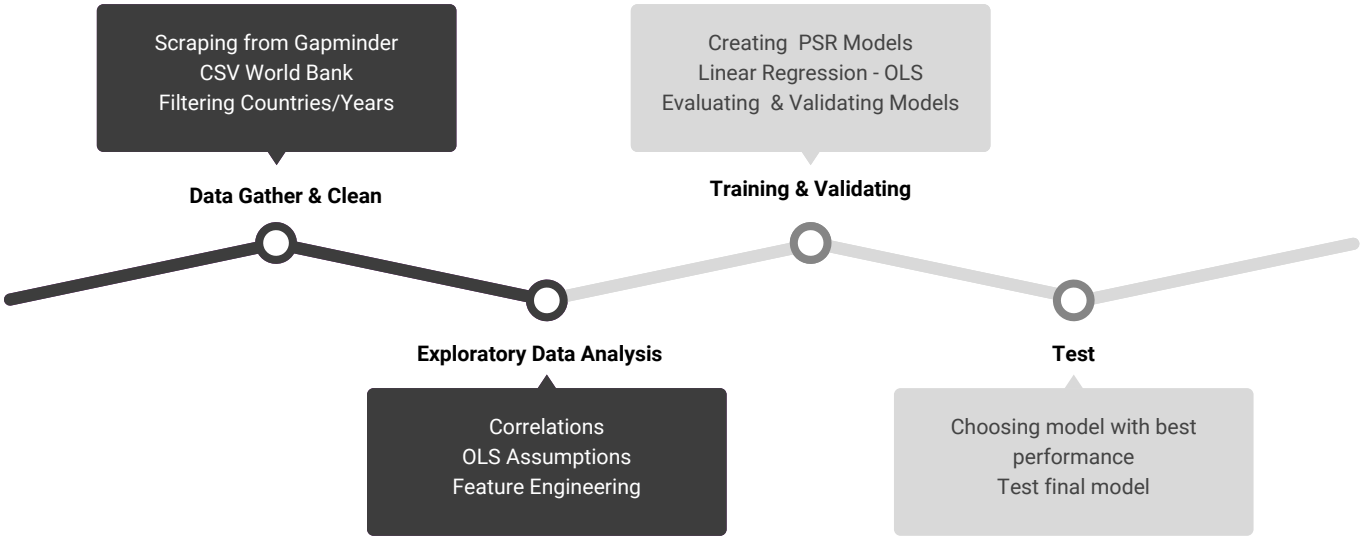
$$\frac{\text{Working-age population}}{\text{Population over 60}}$$

Features:

- Fertility
- Birth Rate
- Death Rate
- Life Expectancy
- GDP
- Fertility (log) *
- Death/Birth Rate *
- Death Rate (2) *

* Feature Engineered

Methodology

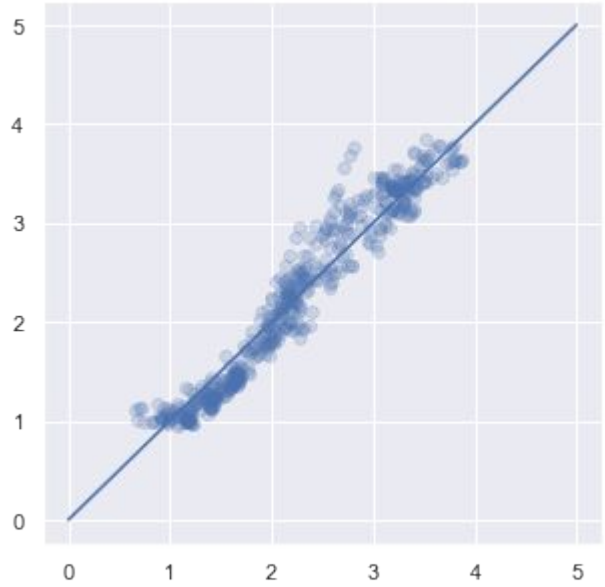


Model Performance

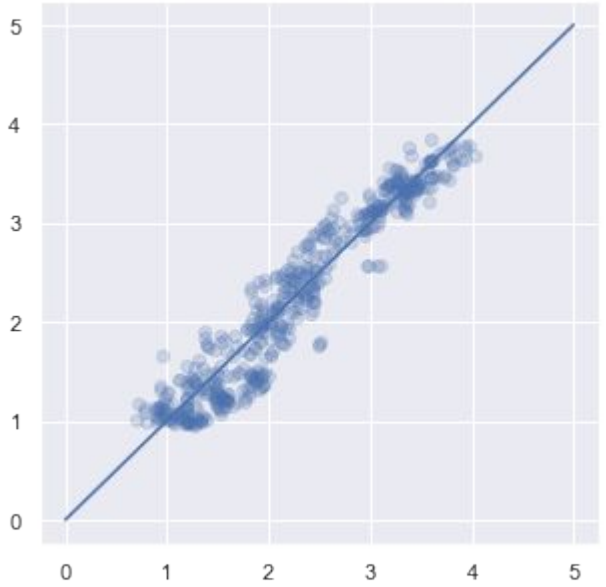
Model	Root Mean Squared Error (RMSE)	R^2 (Validation)
Model 1	2.819	0.936
Model 2	0.278	0.900
Model 3	2.766	0.938
Model 4	0.247	0.920
Model 5 (LASSO)	2.398	0.954
Model 6 (LASSO)*	0.216	0.939
Model 7 (Ridge M2)	0.278	0.900
Model 8 (Ridge M4)*	0.216	0.920
Model 9 (Random Forest)	0.245	0.922

Comparing Predictions

Model 6 (LASSO y_log)



Model 8 (Ridge on Model 4)



Conclusion - Testing Final Model

Applied Model on Test

- Select countries representing low, medium, high PSR values
- R2 = 0.937
- RMSE = 0.239

Features

- Fertility
- Life Expectancy
- Death Rate (Squared)
- Death/Birth Ratio

Future Work

- Try model with additional features such as:
  - Men/Women Ratio
  - Unemployment
  - Women Education
  - Immigration

Appendix

Model 1

Dep. Variable:	psr	**R-squared:**	0.929
Model:	OLS	**Adj. R-squared:**	0.929
Method:	Least Squares	**F-statistic:**	6771.
Date:	Thu, 24 Jan 2019	**Prob (F-statistic):**	0.00
Time:	19:38:44	**Log-Likelihood:**	-3888.1
No. Observations:	1560	**AIC:**	7784.
Df Residuals:	1556	**BIC:**	7806.
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-5.7877	0.230	-25.132	0.000	-6.239	-5.336
fertility	6.9858	0.052	134.445	0.000	6.884	7.088
death_rate	-0.1508	0.025	-6.108	0.000	-0.199	-0.102
gdp	0.0361	0.013	2.680	0.007	0.010	0.063

Omnibus:	185.843	**Durbin-Watson:**	2.082
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	641.375
Skew:	0.566	**Prob(JB):**	5.34e-140
Kurtosis:	5.930	**Cond. No.**	31.8

Model 2

Dep. Variable:	psr_log	**R-squared:**	0.871
Model:	OLS	**Adj. R-squared:**	0.871
Method:	Least Squares	**F-statistic:**	3502.
Date:	Thu, 24 Jan 2019	**Prob (F-statistic):**	0.00
Time:	19:38:45	**Log-Likelihood:**	-382.34
No. Observations:	1560	**AIC:**	772.7
Df Residuals:	1556	**BIC:**	794.1
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	1.1375	0.024	46.735	0.000	1.090	1.185
fertility	0.5560	0.005	101.252	0.000	0.545	0.567
death_rate	-0.0614	0.003	-23.537	0.000	-0.067	-0.056
gdp	0.0050	0.001	3.510	0.000	0.002	0.008

Omnibus:	40.533	**Durbin-Watson:**	2.017
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	48.042
Skew:	0.332	**Prob(JB):**	3.70e-11
Kurtosis:	3.546	**Cond. No.**	31.8

Model 3

Dep. Variable:	psr	R-squared:	0.930
Model:	OLS	Adj. R-squared:	0.930
Method:	Least Squares	F-statistic:	5159.
Date:	Thu, 24 Jan 2019	Prob (F-statistic):	0.00
Time:	19:38:45	Log-Likelihood:	-3876.2
No. Observations:	1560	AIC:	7762.
Df Residuals:	1555	BIC:	7789.
Df Model:	4		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-8.4058	0.446	-18.834	0.000	-9.281	-7.530
fertility	7.4748	0.114	65.485	0.000	7.251	7.699
gdp	0.0313	0.013	2.329	0.020	0.005	0.058
death_birth_ratio	0.3680	0.078	4.702	0.000	0.214	0.521
death_rate2	-0.0171	0.002	-7.288	0.000	-0.022	-0.012

Omnibus:	188.823	Durbin-Watson:	2.063
Prob(Omnibus):	0.000	Jarque-Bera (JB):	583.764
Skew:	0.610	Prob(JB):	1.73e-127
Kurtosis:	5.737	Cond. No.	677.

Model 4

Dep. Variable:	psr_log	R-squared:	0.915
Model:	OLS	Adj. R-squared:	0.915
Method:	Least Squares	F-statistic:	5575.
Date:	Thu, 24 Jan 2019	Prob (F-statistic):	0.00
Time:	19:38:46	Log-Likelihood:	-58.003
No. Observations:	1560	AIC:	124.0
Df Residuals:	1556	BIC:	145.4
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	0.9627	0.031	31.111	0.000	0.902	1.023
fertility_log	1.5230	0.019	81.624	0.000	1.486	1.560
gdp	0.0068	0.001	5.878	0.000	0.005	0.009
death_birth_ratio	-0.0491	0.004	-12.242	0.000	-0.057	-0.041

Omnibus:	12.609	Durbin-Watson:	2.059
Prob(Omnibus):	0.002	Jarque-Bera (JB):	12.791
Skew:	-0.201	Prob(JB):	0.00167
Kurtosis:	3.188	Cond. No.	37.1