

# The Factors and Impacts on South Korea's Fertility Decline: An Analysis of Social, Economic, and Demographic Impacts

SAS Hackathon 2023 | Team K-Analysts

# Team Members



**Victor Ahn**

B.A. in Geographic  
Information Systems,  
University of Washington

**Federico Chung**

M.S. in Statistics,  
University of Washington

**Sebin Lee**

M.S. in Information  
Management,  
University of Washington

**Yongjung Lee**

B.A. in Geographic  
Information Systems,  
University of Washington

**Jangwon Yun**

B.S. in Biomedical and  
Health Informatics,  
University of Washington

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# *Project Definition*

# Problem Statement

- Despite being the 10th place GDP out of the OECD countries, South Korea has been facing challenges in maintaining a sustainable fertility rate
- Since 2013, Korea is consistently rated as the lowest among OECD countries and dropped to new low of 0.78 in 2022
- Require a comprehensive and interdisciplinary approach considering the complex interplay of demographic, social, economic, and cultural factors



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What factors have contributed the most  
to South Korea's fertility decline?

# Project Objectives



## *Objective 1*

To determine the primary factors responsible for the decrease in fertility rates in South Korea.



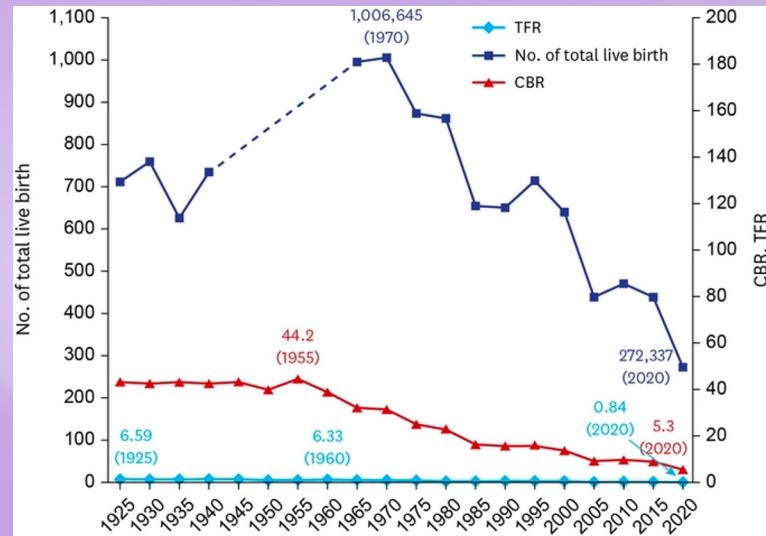
## *Objective 2*

To address what can be done to invalidate the top contributing factors to slow down the decline.

# Literature Review

## Birth Rate Transition in the Republic of Korea: Trends and Prospects (Yun et al., 2022)

- Classified the data according to the historical events that could affect the population trends, i.e., Japanese colonial period, Korean War, liberation period, birth control policy



Year	Events	Scope of South or North Korea
1925–1945	Japanese colonial era	South and North Korea
1945–1950s	1945–1953 (from liberation to the end of the Korean War) 1953–1959 (after the Korean War)	South Korea
1960–1990s	Period of birth control policy (1961–1995)	South Korea
2000–2020s	The 1st, 2nd, and 3rd plans for low birth rate and aging society in Korea	South Korea
2021–2060	Long-term demographic prospects (from the 4th plan for low birth rate and aging society in Korea)	South Korea

# Literature Review

## The Relationship Between Changes In The Korean Fertility Rate And Policies To Encourage Fertility (Jeong et al., 2022)

- Utilized data of the total fertility rate of 250 local governments between 2014 and 2018, and a casebook of local government birth promotion policies
- The higher the number of in-kind policies, the higher the fertility rate. On the other hand, cash policy, voucher policy, service policy, education and promotion policy did not affect the initial value of fertility rate

**Table 4 Effect of fertility promotion policies on changes in fertility rate**

From: [The relationship between changes in the korean fertility rate and policies to encourage fertility](#)

Path between Variables		Coef.	S.E.
Cash Policy	→ Initial Fertility Rate	0.001	0.016
In-kind Policy	→ Initial Fertility Rate	0.080**	0.021
Voucher Policy	→ Initial Fertility Rate	0.030	0.035
Service Policy	→ Initial Fertility Rate	-0.008	0.005
Education and Promotion Policy	→ Initial Fertility Rate	-0.015	0.010
Cash Policy	→ The Rate of Linear Change in Fertility	0.001	0.006
In-kind Policy	→ The Rate of Linear Change in Fertility	-0.005	0.008
Voucher Policy	→ The Rate of Linear Change in Fertility	0.014	0.013
Service Policy	→ The Rate of Linear Change in Fertility	-0.001	0.004
Education and Promotion Policy	→ The Rate of Linear Change in Fertility	0.003	0.004
Cash Policy	→ The Rate of Quadratic Function Change in Fertility	0.001	0.001
In-kind Policy	→ The Rate of Quadratic Function Change in Fertility	0.001	0.002
Voucher Policy	→ The Rate of Quadratic Function Change in Fertility	-0.003	0.003
Service Policy	→ The Rate of Quadratic Function Change in Fertility	0.000	0.001
Education and Promotion Policy	→ The Rate of Quadratic Function Change in Fertility	0.000	0.001

\*\*\* $p < .001$

02

# *Data Analysis*

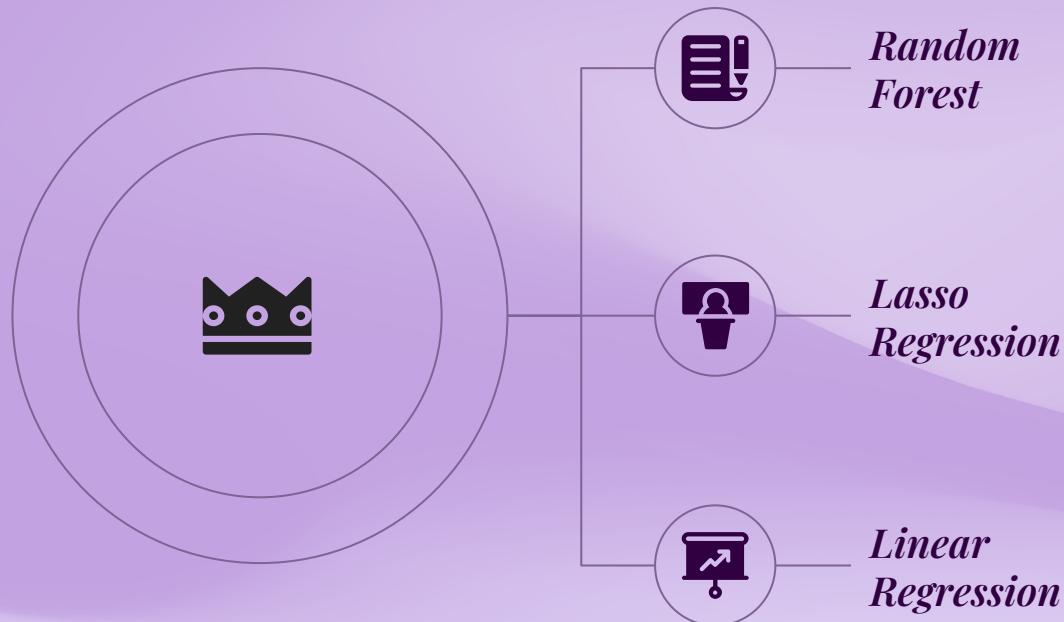
# Analysis Methods

- SAS Visual Analytics, Google Colab, and Tableau used for data visualization and Python programming
- OECD database used as a data source for analysis
- Merging of multiple datasets into a single dataset
- Application of machine learning algorithms for analysis
- Statistical analysis performed on the merged dataset



# Analysis Methods (Continued)

We conducted our analysis using these methods:

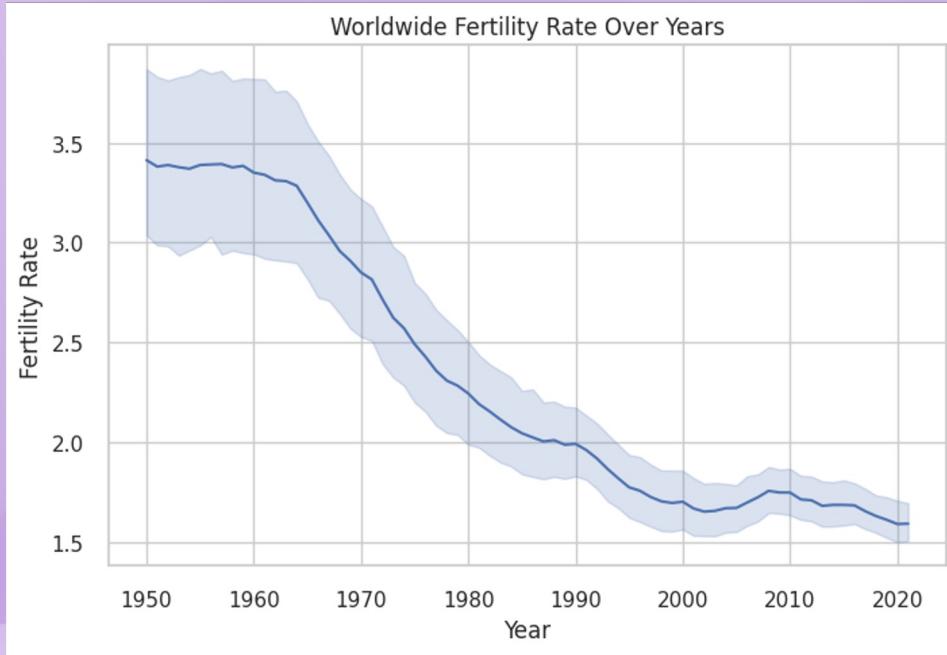


# Statistics of South Korea

Graph presents a comparison of various factors obtained from the OECD database, focusing on South Korea and covering the time period from 2005 to the present day.

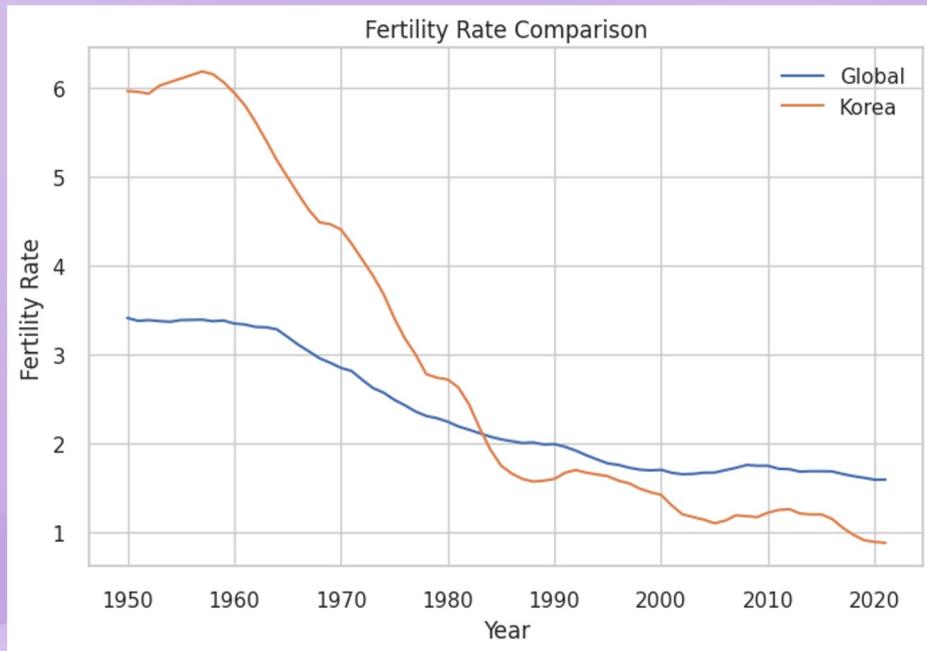


# Global Fertility Rate



- Global fertility rate has decreased over time from 1950 to the present date
- In the 1950s, rates ranged from 3 to 4, whereas in 2020, rates range from 1.5 to 2

# Fertility Rate Comparison



## *Global*

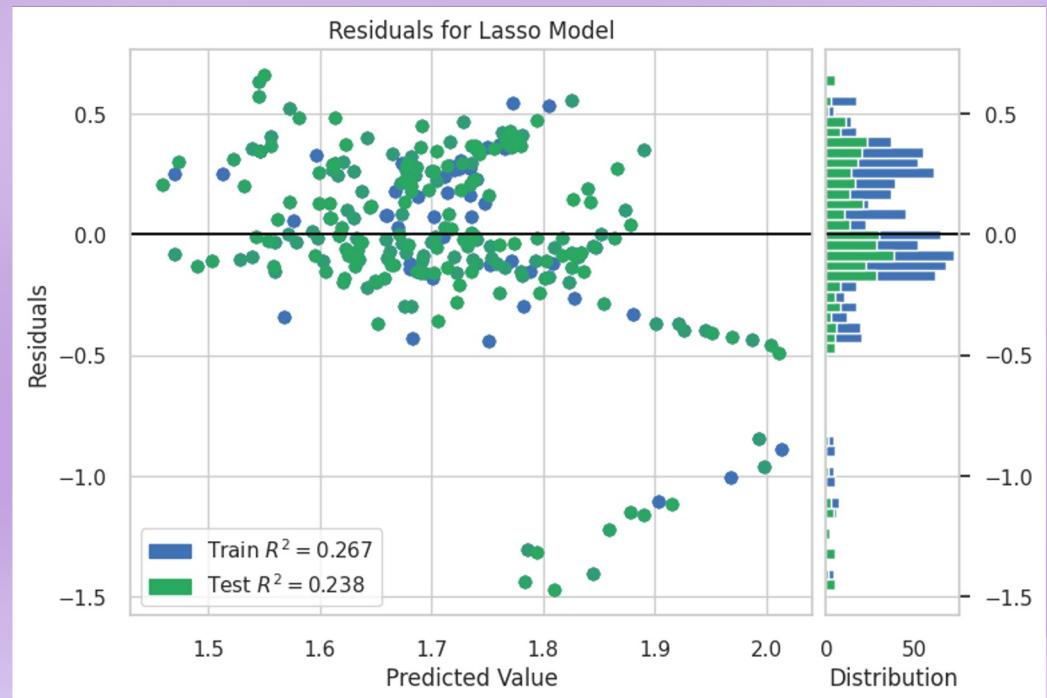
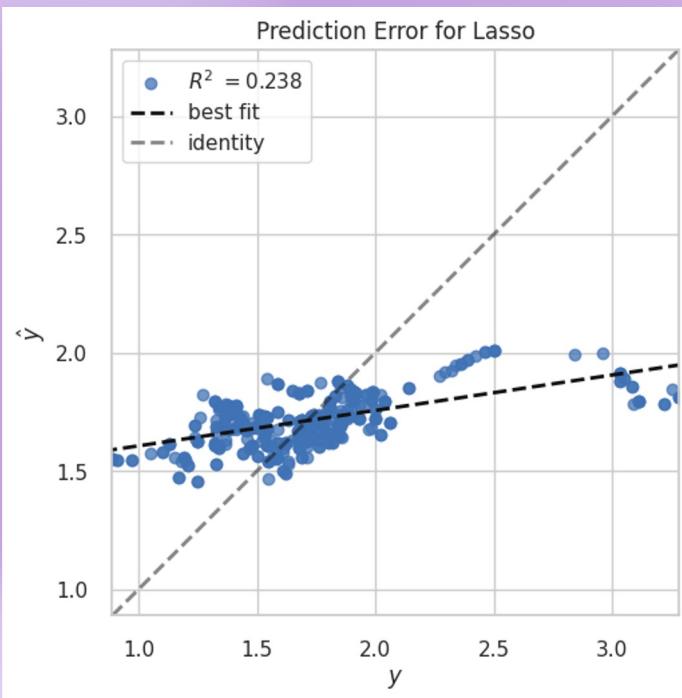
Overall decline from 3.5 to 1.5, but fairly consistent in their downward trend



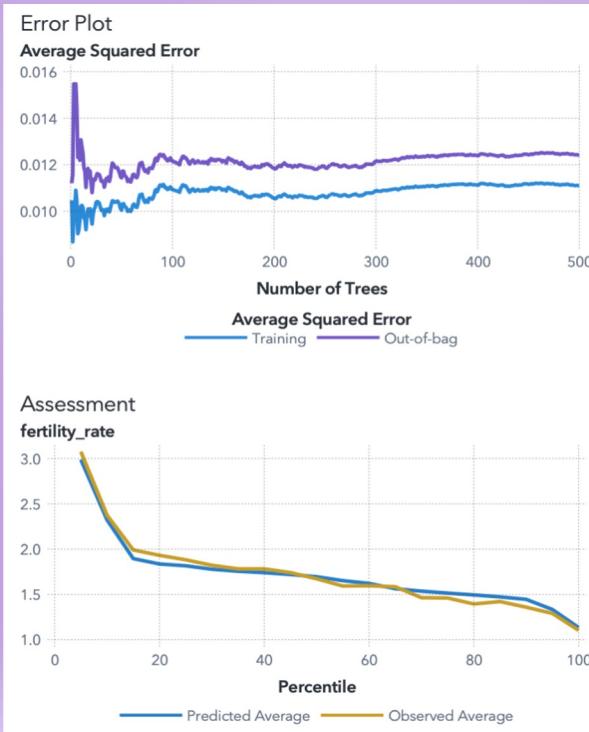
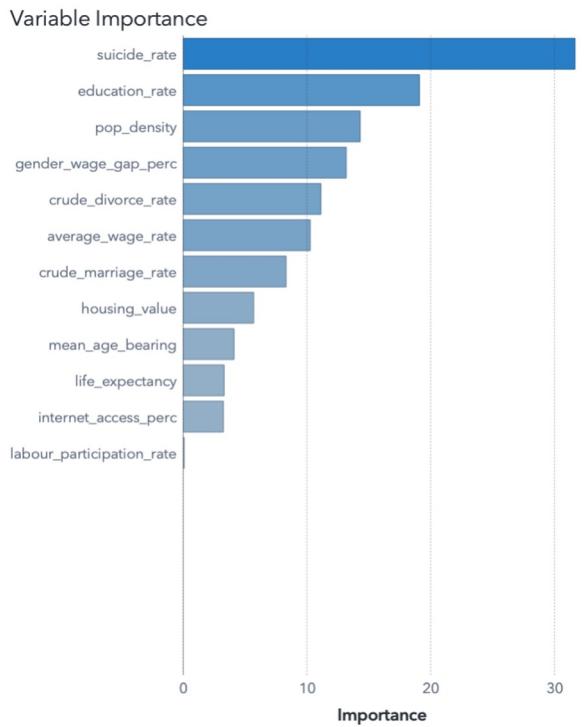
## *Korea*

Significant decline from 6 to below 1, marked lower than the global average fertility rate

# Lasso Regression



# Random Forest Regression



- Employed Random Forest to identify most important variables
- Overwhelming importance of suicide rate in determining fertility rates
- May reflect social and economic pressures that people face, discouraging people from having children

# Correlation Matrix

	labour_participation_rate	birth_rate	mean_age_bearing	housing_value	total_deaths	death_rate	life_expectancy	total_pop	male_pop	female_pop	pop_density	median_age	pop_growth_rate	gender_wage_gap_perc	average_wage_rate	internet_access_perc	education_rate	crude_marriage_rate	crude_divorce_rate	suicide_rate	fertility_rate	labour_participation_rate	birth_rate	mean_age_bearing	housing_value	total_deaths	death_rate	life_expectancy	total_pop	male_pop	female_pop	pop_density	median_age	pop_growth_rate	gender_wage_gap_perc	average_wage_rate	internet_access_perc	education_rate	crude_marriage_rate	crude_divorce_rate	suicide_rate	fertility_rate	
labour_participation_rate	1	-0.0087	0.15	-0.048	0.016	-0.059	0.2	0.0033	0.0043	0.0024	-0.096	0.033	0.14	0.037	0.22	0.22	0.23	0.12	0.075	-0.15	0.12	1	-0.0087	0.15	-0.048	0.016	-0.059	0.2	0.0033	0.0043	0.0024	-0.096	0.033	0.14	0.037	0.22	0.22	0.23	0.12	0.075	-0.15	0.12	
birth_rate	-0.0087	1	-0.54	-0.064	0.91	-0.28	-0.23	0.96	0.96	0.96	-0.13	-0.38	0.18	0.17	0.03	-0.33	-0.045	0.27	-0.023	-0.18	0.18		-0.0087	1	-0.54	-0.064	0.91	-0.28	-0.23	0.96	0.96	0.96	-0.13	-0.38	0.18	0.17	0.03	-0.33	-0.045	0.27	-0.023	-0.18	0.18
mean_age_bearing	0.15	-0.54	1	0.26	-0.29	-0.016	0.79	-0.37	-0.37	-0.38	0.37	0.57	0.03	0.067	0.48	0.76	0.54	-0.13	0.12	0.11	-0.25		0.15	-0.54	1	0.26	-0.29	-0.016	0.79	-0.37	-0.37	-0.38	0.37	0.57	0.03	0.067	0.48	0.76	0.54	-0.13	0.12	0.11	-0.25
housing_value	-0.048	-0.064	0.26	1	0.03	0.37	-0.019	-0.014	-0.013	-0.014	0.065	0.37	-0.34	-0.13	-0.073	0.24	0.014	-0.089	-0.098	-0.025	-0.24		-0.048	-0.064	0.26	1	0.03	0.37	-0.019	-0.014	-0.013	-0.014	0.065	0.37	-0.34	-0.13	-0.073	0.24	0.014	-0.089	-0.098	-0.025	-0.24
total_deaths	0.016	0.91	-0.29	0.03	1	-0.11	-0.056	0.98	0.98	0.98	-0.039	-0.055	0.023	0.19	0.19	-0.12	0.072	0.23	0.13	-0.075	-0.02		0.016	0.91	-0.29	0.03	1	-0.11	-0.056	0.98	0.98	0.98	-0.039	-0.055	0.023	0.19	0.19	-0.12	0.072	0.23	0.13	-0.075	-0.02
death_rate	-0.059	-0.28	-0.016	0.37	-0.11	1	-0.43	-0.22	-0.22	-0.22	-0.33	0.66	-0.78	-0.4	-0.16	0.066	-0.28	-0.15	0.37	0.2	0.42		-0.059	-0.28	-0.016	0.37	-0.11	1	-0.43	-0.22	-0.22	-0.22	-0.33	0.66	-0.78	-0.4	-0.16	0.066	-0.28	-0.15	0.37	0.2	0.42
life_expectancy	0.2	-0.23	0.79	0.019	-0.056	0.43	1	-0.11	-0.1	-0.11	0.37	0.27	0.43	0.14	0.64	0.59	0.59	-0.14	-0.046	0.14	0.03		0.2	-0.23	0.79	0.019	-0.056	0.43	1	-0.11	-0.1	-0.11	0.37	0.27	0.43	0.14	0.64	0.59	-0.14	-0.046	0.14	0.03	
total_pop	0.0033	0.96	-0.37	-0.014	0.98	-0.22	-0.11	1	1	1	-0.041	-0.19	0.093	0.23	0.13	-0.19	0.057	0.27	0.079	-0.072	0.036		0.0033	0.96	-0.37	-0.014	0.98	-0.22	-0.11	1	1	1	-0.041	-0.19	0.093	0.23	0.13	-0.19	0.057	0.27	0.079	-0.072	0.036
male_pop	0.0043	0.96	-0.37	-0.013	0.98	-0.22	-0.1	1	1	1	-0.04	-0.19	0.094	0.23	0.14	-0.18	0.061	0.27	0.082	-0.07	0.035		0.0043	0.96	-0.37	-0.013	0.98	-0.22	-0.1	1	1	1	-0.04	-0.19	0.094	0.23	0.14	-0.18	0.061	0.27	0.082	-0.07	0.035
female_pop	0.0024	0.96	-0.38	-0.014	0.98	-0.22	-0.11	1	1	1	-0.043	-0.19	0.091	0.23	0.13	-0.19	0.054	0.27	0.077	-0.073	0.036		0.0024	0.96	-0.38	-0.014	0.98	-0.22	-0.11	1	1	1	-0.043	-0.19	0.091	0.23	0.13	-0.19	0.054	0.27	0.077	-0.073	0.036
pop_density	-0.096	-0.13	0.37	0.065	-0.039	-0.33	0.37	-0.041	-0.04	-0.043	1	0.039	0.064	0.47	0.13	0.28	0.32	-0.0023	-0.055	0.3	-0.054		-0.096	-0.13	0.37	0.065	-0.039	-0.33	0.37	-0.041	-0.04	-0.043	1	0.039	0.064	0.47	0.13	0.28	0.32	-0.0023	-0.055	0.3	-0.054
median_age	0.033	-0.38	0.57	0.37	-0.055	0.66	0.27	-0.19	-0.19	-0.19	0.039	1	-0.6	1	0.046	0.31	-0.039	0.29	0.074	-0.3	0.62		0.033	-0.38	0.57	0.37	-0.055	0.66	0.27	-0.19	-0.19	-0.19	0.039	1	-0.6	1	0.046	0.31	-0.039	0.29	0.074	-0.3	0.62
pop_growth_rate	0.14	0.18	0.03	-0.34	0.023	-0.78	0.43	0.093	0.094	0.091	0.064	-0.6	1	0.046	0.31	-0.039	0.29	0.074	-0.3	0.62		0.14	0.18	0.03	-0.34	0.023	-0.78	0.43	0.093	0.094	0.091	0.064	-0.6	1	0.046	0.31	-0.039	0.29	0.074	-0.3	0.62		
gender_wage_gap_perc	0.037	0.17	0.067	-0.13	0.19	-0.4	0.14	0.23	0.23	0.23	0.47	-0.14	0.046	1	-0.13	0.07	0.29	0.41	0.033	0.37	-0.11		0.037	0.17	0.067	-0.13	0.19	-0.4	0.14	0.23	0.23	0.23	0.47	-0.14	0.046	1	-0.13	0.07	0.29	0.41	0.033	0.37	-0.11
average_wage_rate	0.22	0.03	0.48	-0.073	0.19	-0.16	0.64	0.13	0.14	0.13	0.13	0.34	0.31	-0.13	1	0.5	0.48	-0.058	0.3	-0.11	-0.045		0.22	0.03	0.48	-0.073	0.19	-0.16	0.64	0.13	0.14	0.13	0.13	0.34	0.31	-0.13	1	0.5	0.48	-0.058	0.3	-0.11	-0.045
internet_access_perc	0.22	-0.33	0.76	0.24	-0.12	0.066	0.59	-0.19	-0.18	-0.19	0.28	0.55	-0.039	0.07	0.5	1	0.59	-0.018	0.27	0.2	0.25		0.22	-0.33	0.76	0.24	-0.12	0.066	0.59	-0.19	-0.18	-0.19	0.28	0.55	-0.039	0.07	0.5	1	0.59	-0.018	0.27	0.2	0.25
education_rate	0.23	-0.045	0.54	0.014	0.072	-0.28	0.59	0.057	0.061	0.054	0.32	0.068	0.29	0.29	0.48	0.59	1	0.27	0.24	0.21	0.22		0.23	-0.045	0.54	0.014	0.072	-0.28	0.59	0.057	0.061	0.054	0.32	0.068	0.29	0.29	0.48	0.59	1	0.27	0.24	0.21	0.22
crude_marriage_rate	0.12	0.27	-0.13	-0.089	0.23	-0.15	-0.14	0.27	0.27	0.27	-0.0023	-0.28	0.074	0.41	-0.058	-0.018	0.27	1	0.31	0.21	0.26		0.12	0.27	-0.13	-0.089	0.23	-0.15	-0.14	0.27	0.27	0.27	-0.0023	-0.28	0.074	0.41	-0.058	-0.018	0.27	1	0.31	0.21	0.26
crude_divorce_rate	0.075	-0.023	0.12	-0.098	0.13	0.37	-0.046	0.079	0.082	0.077	-0.055	0.4	-0.3	0.033	0.3	0.27	0.24	0.31	1	0.43	-0.56		0.075	-0.023	0.12	-0.098	0.13	0.37	-0.046	0.079	0.082	0.077	-0.055	0.4	-0.3	0.033	0.3	0.27	0.24	0.31	1	0.43	-0.56
suicide_rate	-0.15	-0.18	0.11	-0.025	-0.075	0.2	-0.14	-0.072	-0.07	-0.073	0.3	0.32	-0.44	0.37	-0.11	0.2	0.1	0.21	0.43	-0.56		-0.15	-0.18	0.11	-0.025	-0.075	0.2	-0.14	-0.072	-0.07	-0.073	0.3	0.32	-0.44	0.37	-0.11	0.2	0.1	0.21	0.43	-0.56		
fertility_rate	0.12	0.18	-0.25	-0.24	-0.02	-0.42	0.03	0.036	0.035	0.036	-0.054	-0.73	0.62	-0.11	0.045	-0.25	0.22	0.26	-0.1	-0.56	1		0.12	0.18	-0.25	-0.24	-0.02	-0.42	0.03	0.036	0.035	0.036	-0.054	-0.73	0.62	-0.11	0.045	-0.25	0.22	0.26	-0.1	-0.56	1

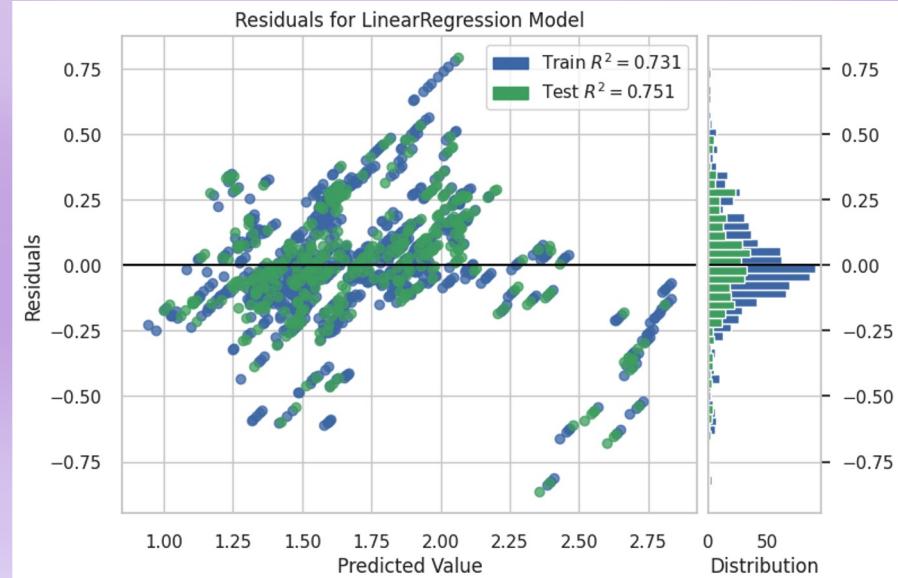
# Linear Mixed Effects Model

$$\text{Fertility Rate} = X\beta + Zb$$

$X$  = Education Rate, Crude Divorce Rate, Population Density, Suicide Rate, Gender Wage Gap Percentage

$Z$  = Country, Time

Mixed Linear Model Regression Results						
Model:	MixedLM	Dependent Variable:	fertility_rate			
No. Observations:	1280	Method:	REML			
No. Groups:	31	Scale:	0.0026			
Min. group size:	10	Log-Likelihood:	1793.7325			
Max. group size:	80	Converged:	Yes			
Mean group size:	41.3					
	Coef.	Std. Err.	z	P> z	[0.025	0.975]
Intercept	1.951	0.125	15.665	0.000	1.707	2.195
education_rate	-0.005	0.002	-2.531	0.011	-0.009	-0.001
gender_wage_gap_perc	-0.005	0.001	-4.353	0.000	-0.007	-0.003
crude_divorce_rate	-0.022	0.012	-1.842	0.065	-0.045	0.001
pop_density	0.000	0.000	0.150	0.881	-0.001	0.001
suicide_rate	0.001	0.002	0.340	0.734	-0.003	0.004
Group Var	0.177	0.949				
Group x time Cov	-0.003	0.031				
time Var	0.000	0.002				



03

# *Our Findings*

# Study Results

- Consistent decrease in South Korea's fertility rate since the 1950s, dropping from over 7 to just 0.78 births per woman. This decline is significant when compared to other OECD countries that are also struggling with low fertility rates
- Clear correlation between South Korea's fertility rate and suicide rate, with the country recording the highest suicide rate among OECD countries at 24.1/100,000 persons
  - These results suggest that South Korea may be a particularly challenging and stressful country to live in, which could be contributing to the decline in fertility rates
- Importance of policies aimed at addressing the factors identified as potential contributors to the decline in South Korea's fertility rate
  - Include reducing the gender wage gap and addressing the root causes of high suicide rates
  - By implementing targeted policies to tackle these issues, South Korea may be able to mitigate the decline in its fertility rate and improve overall well-being for its citizens



# Suggestions

- Based on our results, **suicide rate** is most associated with a low fertility rate
- Factors that cause the **high suicide rate** in South Korea:
  - *Social*
    - High Level of Education = Proof of successful life
    - Low employment rate: Excessive people with high education level = high competence in employment
  - *Economical*
    - High private education spending, housing prices, etc.
- **Possible Solutions:**
  - Raising the quality of public education by spending more funds
  - Granting priority of national house sales to less financially stable families
  - Providing more blind recruitment during employment process

# Limitations

- Underlying factors that cannot be easily quantified or measured
  - *Example:* Historical events, cultural attributes towards marriage and childbearing, changing gender roles and expectations, societal pressures, and personal preferences
- Our study does not establish causation between identified factors and decline of fertility rate
- Our study may contain selection and measurement biases that could affect the result accuracy
- As the decision of bearing a child occurs before birth, we might want to also include lagged variables and see what its effects are on fertility

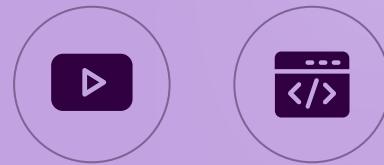
# Further Research

- The South Korean government may utilize our analysis to inform policies that aims the factors identified in our study
- Conduct more qualitative research to incorporate additional variables, such as underlying factors, and perform data analysis
- Expand on our research, such as using lagged variables, and see the impacts on fertility rates
- May use alternative methods, such as quasi-experimental designs, to establish causation



# Thanks!

**Team K-Analysts** | Victor Ahn, Federico Chung,  
Sebin Lee, Yongjung Lee, Jangwon Yun



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# Resources

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