Introduction

The United Nations Gender Inequality Index (GII) measures the progress of a country in providing equal opportunities to a quality life for women and men as well as the "loss in potential human development due to disparity between female and male achievements" (UNDP, 2020). The GII measurements include maternal mortality rate, adolescence births (15-19 years old), share of seats in the country's parliament, percent of women with some level of secondary education, and percent of women participating in the labor force. Climate change is not accounted for in the GII, although "climate change is globally acknowledged as one of the most significant development challenges facing humanity" (United Nations, 2013).

As with many human development measures, there is potential for a circular effect. Climate change can "directly affect the social, economic and human development of countries" (UNDP, 2019), but can social, economic and human development influence climate policy? This research addresses the question: how does gender equality effect the likeliness of countries to pass climate change policies?

The research hypothesis proposed in this model is that the more equal a country government is, measured by the share of seats women hold in parliament and women in the executive branch, the more evidence there is that the country values all life and therefore the country will be more inclined to address climate change through laws and policy. This research showed the hypothesis to be proven correct. Based on secondary research performed, there is also a positive relationship between the share of seats in parliament and action towards achieving climate targets set forth in the 2015 Paris Agreement. Furthermore, action towards climate change may be associated with improving other female equality measures like lowering adolescence birthrates.

Data Sources and Models

Regression Model

Independent Variables

A multi-regression model was developed using the GII measurements as independent variables on the effect of the number of climate policies a country has passed since 1997. Independent variables are from subsets of the 2019 UN Gender Inequality Index (UNDP, 2020). The index rating can range from 0.0 to 1.0; a lower score indicates that there is higher gender inequality in the country. An additional dummy variable was included to represent if a country had a

female head of state since 1997 using country leader data from the World Economic Forum (Zakarneh, 2019) and Pew Research (Geiger & Kent, 2017). Table 1 provides the summary data on the independent variables.

- AB_1 = Adolescence Births (births per 1,000 women ages 15–19)
- MM_2 = Maternal Mortality Rate, (deaths per 100,000 live births)
- SSP_3 = % share of seats held by women in nation's parliament
- $FemEd_4$ = % of women with some level of secondary education
- $FemLab_5$ = % of women who participate in the labor force
- $FemHead_6$ = If a country has had a female head of state since 1997 (1 = yes, 0 = no)

Dependent Variable

The number of climate laws are defined as national level laws and policies focused on greenhouse gas reduction and sustainability as determined by the Climate Change Laws of the World database managed by the Grantham Research Institute on Climate Change and the Environment (2020). Currently, 1809 policies and laws have been passed and tracked since 1997. The 1809 policies and laws are the metrics included in the analysis (LawTtl = # of Laws and Policies per Country Approved Since 1997). An adjusted variable is also added to include laws passed within the European Union; the EU has 32 laws addressing climate for all its member states. These numbers were applied to the adjusted totals (AdEULaw)[1]. The summary data for all laws passed is in Table 2, in the appendix.

The full multi-regression equation is:

$$\mathbf{LawTtl} = \mathbf{b_0} + \beta_1 \mathbf{AB_i} + \beta_2 \mathbf{MM_i} + \beta_3 \mathbf{SSP_i} + \beta_4 \mathbf{FemEd_i} + \beta_5 \mathbf{FemLab_i} + \beta_6 \mathbf{FemHead_i} + \varepsilon$$

$$\mathbf{AdEULaw^1} = \mathbf{b_0} + \beta_1 \mathbf{AB_i} + \beta_2 \mathbf{MM_i} + \beta_3 \mathbf{SSP_i} + \beta_4 \mathbf{FemEd_i} + \beta_5 \mathbf{FemLab_i} + \beta_6 \mathbf{FemHead_i} + \varepsilon$$

Results

[1] Adjusted Climate Law Total for EU: The Climate Change Laws tracked by the Grantham Research Institute measures countries and the EU (as one unit), but the UN GII only measures country level data. Therefore, the laws passed for the EU as a whole were not included in the LawTtl variable, which means that 32 additional laws are not accounted for in the base analysis. The Adjusted Climate Law (AdEULaw) adds the 32 laws to each EU country. Since this is an imperfect metric it was only used as a secondary dependent variable in the research. While the UK will no longer part of the EU, since the data is pulled from 1997 to January 2020, the UK is included as an EU member state.

In simple linear regressions, both the share of seats in parliament held by women (SSP) and if a country had a female head of state (FemHead) since 1997 did have a positive and statistically significant impact at a 95% confidence level on the number of climate laws passed in a country. As the percent of women in parliament increased by 1 percentage point, the number of climate laws increased by approximately .15 (Results: Regression 1, appendix). If a county had a woman head of state since 1997, on average the country had 4.12 more climate laws passed since 1997 (Results: Regression 2, appendix).

In a multiple regression, SSP and FemHead both showed a positive and statistically significant impact at a 95% confidence level on the number of climate laws passed (Results: Regression 3, appendix). The equation from the calculation is: LawTtl = 5.15 + .127 SSP_i + 3.57FemHead + ε. This indicates that holding SSP fixed, countries who have had a female head of state since 1997 have 3.57 more climate laws than those that have not. Holding heads of state fixed, for every percent increase in the share of seats held by women in parliament, the country will have .127 more climate laws passed. When adjusting climate laws to include the European Union laws, the β_3 SSP_i coefficient increased .29 and β_6 $FemHead_i$ increased to 8.05 in the multiple regression, both statistically significant at a 95% confidence level (Results: Regression 4, appendix). R-squared values for both multiple regressions were approximately 14%; indicating 14% of the variation in the climate laws passed can be explained by the two variables.

Using the variable FemHead, a diagnostic examined whether the means of countries who have had female heads of state since 1997 are statistically significantly different than those who have not (Results: T-Test 1, appendix). To conduct these analyses, a t-test of group means was used. Based on the t-test. countries who have had female leaders since 1997 are statistically different than those that have not (Critical-t: 1.96 < t: 4.45). The results indicate that there is positive relationship between climate laws passed and the number of women in government.

Full Model Results

When running the full econometric model with the total laws and six independent variables, the share of seats in parliament and whether women have served as heads of state were statistically significant factors on the number of climate laws passed a 95% confidence level (Results: Regression 5, appendix). Women as heads of state had a coefficient of 2.60, (t = 2.94, critical t: 1.96) and shared of seats in parliament had a coefficient of .11 (t = 2.45, critical t: 1.96). This indicates countries who have had a female head of state since 1997 are predicted to have 2.60 more climate laws passed on average since 1997 than countries who have not had a female head of state, holding all other variables fixed. Additionally, a percent increase in the share of seats in parliament is associated with .11 more climate laws passed since 1997, holding all other variables fixed, on average. Other factors were not significant at a 95% confidence level. The full regression model did present a low r-squared (.12) indicating a low proportion of the variance for a dependent variable is explained by the independent variables. An f-test was performed to compare whether the total laws multiple regression including just SSP and FemHead provides a better overall fit to the full regression. Based on 159 observations, the full regression did not prove to be an overall better fit than the two-variable regression models (f-statistic: .64 < F_C 2.37). This indicates that the other variables are not significant in the model.

When adjusting for the EU climate laws, the model appears to have a better goodness of fit level represented by a higher r-squared of .2524 (Results: Regression 6, appendix). Female heads of state and shared seats in parliament continued to be statistically significant variables in the equation. Every percent increase in share of seats in parliament is associated with .23 more climate laws passed on average, holding other variables fixed. Countries with female heads of state have 5.67 more climate laws on average than those without female heads of state since 1997, holding other variables fixed. Additionally, adolescent births were also statistically significant. Holding all other variables fixed, an increase in 1,000 adolescence births is associated .09 fewer climate laws.

Removing the statistically insignificant factors in the adjusted climate laws full model, the r-squared remained relatively constant (.2415) and the regression equation is: $\text{AdEULaw} = 11.21 \ -.11\text{AB}_i + .25\text{SSP}_i + 7.40\text{FemHead}_i + \varepsilon$. The coefficients in the modified model further indicate positive associations between women in government and climate laws passing, and negative associations with increasing adolescence birthrates and climate laws passing. This modified model holds promise that helping to decrease adolescence births, may be associated with the potential to increase additional climate laws being passed in a country.

Policy vs. Progress

Recognizing that policy does not necessarily mean action, nor are policies accounted for in the dependent variable (LawTtl) weighted by impact, there is an additional analysis that could evaluate the action countries are taking against climate change. The Climate Action Tracker grades countries on their progress towards the Paris Agreement on a scale of 1-5: 1: Critically Insufficient; 2: Highly Insufficient; 3: Insufficient; 4: 2^{o}C Sufficient; and 5: 1.5^{0}C Role Model (New Climate and Cliimate Analytics, 2020). The database includes 29 countries, plus the EU as one unit, rather than separate countries. As a precursor to future research, a secondary regression model was run between climate progress towards the Paris Agreement targets (Y = Progress) and the previously defined dependent variables (Results: Regression 8, appendix). This econometric model is:

$$\text{Progress} = b_0 + \beta_1 AB_i + \beta_2 MM_i + \beta_3 SSP_i + \beta_4 FemEd_i + \beta_5 FemLab_i + \beta_6 FemHead_i + \varepsilon$$

The results indicate β_2 MM (maternal mortality rate) and β_3 SSP_i (shared seats in parliament) are statistically significant at a 95% confidence level, although the MM coefficient was only .005 (t: 3.45) (critical t: 2.00). The SSP coefficient is .024, t: 2.22 (critical t: 2.00). Based on the full regression, this analysis indicates that for every percentage increase in the share of seats in parliament held by women, progress towards reaching climate goals increases by 2%. The full model for climate action had an r-squared of 0.3111, or 31% of the variance in progress can be explained by the independent variables (Results: Regression 8, appendix). While small, the MM significance should be reviewed further in future research. Countries described as less developed tend to have a higher maternal mortality rates according to the GII (UNDP, 2020). One hypothesis is that while climate change impacts all socioeconomic levels, developing countries have fewer resources to avoid disasters but may be doing more to help prevent them.

Possible extensions and limitations of the study

There were limitations to the data. First, the climate laws are not weighted based on potential impact or results. In future analysis, the association between climate laws and climate actions can be explored, since passing laws does not necessarily mean action is being taken. The Climate Action Tracker begins to address the results, however the data is limited to the 29 countries and the EU, and more research should be done on the impact of climate policy. Furthermore, with the members of the European Union being grouped as one, specific differences towards climate action progress for EY member states was not possible in this research. In other words, all the EU member states

received the same progress score, regardless of individual country differences. Finally, research could be conducted looking at the timing of women heads of state and climate laws being passed, as the timing of women in the executive branch was not associated with any specific climate law. Likewise, the SSP variable is based on 2019 data, while the climate laws were tracked from 1997 to present.

Summary and Implications of Model

The results demonstrate the complexity of climate change and government policies. While having female heads of state and women holding a higher share of seats in parliament were statistically significant and positively associated with the number of climate laws passed in a country, other gender equality measures were not as significant in the full model. Women in government may be related to countries being more progressive and those countries valuing all citizens' lives in the face of climate change. Lower adolescence birth rates were also a significant factor in climate laws being passed when the EU data was included on a country level (AdEULaw). While lower adolescence births appear to be associated with more climate laws, there is caution in making any causation conclusions. Further research can be done on climate action, based on the full UN Human Development Index and the UN poverty index.

Mitigating climate change has political, social, and economic barriers and influences. Additional qualitative and quantitative research is necessary in identifying what is effective in increasing action towards mitigating climate change, and not just increasing climate laws. However, policy from diverse and representative governments will be needed to reach country specific climate goals. This research identified possible qualitative variables that could improve climate resilience through laws and policy. While there is no magic bullet to act on reducing the human impact of climate change, there may be a relationship women in national leadership roles and a country's willingness to outline policies that support lowering greenhouse gases in the atmosphere. Additional economic and gender-focused research should look at the interconnection between progressive pollical climates and other factors that improve gender equality as well as the fight against climate change.

Works Cited

Geiger, A. W., & Kent, L. (2017, March 8). *Number of women leaders around the world has grown, but they're still a small group*. Retrieved from Pew Research Center: https://www.pewresearch.org/fact-tank/2017/03/08/women-leaders-around-the-world/

Grantham Research Institute on Climate Change and the Environment. (2020). *Climate Change Laws of the World Database*. Retrieved from https://climate-laws.org/

Landefeld, J. S., & Seskin, E. P. (1982). The economic value of life: linking theory to practice. *American Journal of Public Health, 72*(6), 555-566.

New Climate and Cliimate Analytics. (2020). *Climate Action Tracker*. Retrieved from https://climateactiontracker.org/countries/

UNDP. (2019). *Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century.* Retrieved from United Nations Development Program: http://hdr.undp.org/sites/default/files/hdr2019.pdf

UNDP. (2020). *Human Development Index Database*. Retrieved from United Nations Development Program: http://hdr.undp.org/en/content/human-development-index-hdi

United Nations. (2013). *Kenya National Development Report: Climate Change and Human Development*. Retrieved from http://hdr.undp.org/en/content/climate-change-and-human-development

Zakarneh, R. (2019, April 5). *A new generation of women leaders is making waves in the Arab world*. Retrieved from World Economic Forum: https://www.weforum.org/agenda/2019/04/a-new-generation-of-arab-women-leaders/

rECOMMENDED

Appendix

Table 1: Summary Independent Variables

```
. sum AB MM SSP FemEd FemLab FemHead
```

Variable	Obs	Mean	Std. Dev.	Min	Max
AB	184	48.02796	40.4578	.283	186.538
MM	181	166.442	229.5614	3	1360
SSP	192	22.04492	11.44928	0	55.66038
FemEd	167	61.57615	29.4355	1.738381	100
FemLab	179	51.99441	15.41861	6	84.2
FemHead	211	.3270142	.4702381	0	1

Table 2: Laws and Policies Passed since 1997; Country Specific and Adjusted EU Totals

```
. sum LawTtl AdEULaw
```

Variable	Obs	Mean	Std. Dev.	Min	Max
LawTtl	191	9.151832	6.377839	1	38
AdEULaw	195	13.55897	14.31963	0	70

Regression 1: Climate Laws = $b_0 + \beta_3 SSP_i + \varepsilon$

LawTtl = 5.85 + .15 $SSP_i + \varepsilon$

```
. reg LawTtl SSP
```

Source	SS	df	MS		
				Number of obs	= 189
				F(1, 187)	= 14.76
Model	562.759094	1	562.759094	Prob > F	= 0.0002
Residual	7128.99752	187	38.1229814	R-squared	= 0.0732
				Adj R-squared	= 0.0682
Total	7691.75661	188	40.913599	Root MSE	= 6.1744

LawTtl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SSP	.1516174	.0394622	3.84	0.000	.0737691	.2294657
_cons	5.847346	.9804275	5.96	0.000	3.913226	7.781466

Regression 2: Climate Laws =$b_0 + \beta_6$ $FemHead_i + \varepsilon$

LawTtl = 7.73 + 4.12$FemHead_i + \varepsilon$

```
. reg LawTtl FemHead
```

Source	SS	df	MS		
				Number of obs	= 191
				F(1, 189)	= 19.81
Model	733.36001	1	733.36001	Prob > F	= 0.0000
Residual	6995.23685	189	37.0118352	R-squared	= 0.0949
				Adj R-squared	= 0.0901
Total	7728.59686	190	40.6768256	Root MSE	= 6.0837

LawTtl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FemHead	4.120485	.9256782	4.45	0.000	2.294497	5.946473
_cons	7.728	.5441458	14.20	0.000	6.654621	8.801379

Regression 3: Climate Laws $=b_0 + \beta_3 SSP_i + \beta_6 FemHead_i + \varepsilon$

LawTtl = 5.15 + .127 SSP_i + 3.57FemHead + ε

```
. reg LawTtl FemHead SSP
```

Source	SS	df	MS	Number of obs	=	189
				F(2, 186)	=	15.44
Model	1095.29563	2	547.647816	Prob > F	=	0.0000
Residual	6596.46098	186	35.464844	R-squared	=	0.1424
				Adj R-squared	=	0.1332
Total	7691.75661	188	40.913599	Root MSE	=	5.9552

LawTtl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FemHead	3.571268	.921609	3.88	0.000	1.753117	5.389418
SSP	.1266373	.0386036	3.28	0.001	.0504801	.2027945
_cons	5.151914	.9625087	5.35	0.000	3.253076	7.050751

Regression 4: EU Adjusted Climate Laws $=b_0 + \beta_3 SSP_i + \beta_6 FemHead_i + \varepsilon$

AdEULaw = 4.54 + .289 SSP + 8.04FemHead+ ε

```
. reg AdEULaws FemHead SSP
```

Source	SS	df	MS	Number of obs	=	192
				F(2, 189)	=	16.27
Model	5812.78932	2	2906.39466	Prob > F	=	0.0000
Residual	33755.1273	189	178.598557	R-squared	=	0.1469
				Adj R-squared	=	0.1379
Total	39567.9167	191	207.161867	Root MSE	=	13.364

AdEULaws	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FemHead	8.048357	2.057822	3.91	0.000	3.989107	12.10761
SSP	.2896586	.0858924	3.37	0.001	.1202277	.4590896
_cons	4.535123	2.129875	2.13	0.035	.3337419	8.736504

T-Test 1: Group Mean t-Tests, Female Heads of State

```
. ttest LawTtl, by(FemHead)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	125	7.728	.4916563	5.496885	6.754874	8.701126
1	66	11.84848	.8701854	7.069419	10.1106	13.58637
combined	191	9.151832	.4614842	6.377839	8.241542	10.06212
diff		-4.120485	.9256782		-5.946473	-2.294497

```
    diff = mean(0) - mean(1)                                      t =  -4.4513
Ho: diff = 0                     degrees of freedom =      189

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

Regression 5: Full Model

$LawTtl = b_0 + \beta_1 AB_i + \beta_2 MM_i + \beta_3 SSP_i + \beta_4 FemEd_i + \beta_5 FemLab_i + \beta_6 FemHead_i + \varepsilon$

```
. reg LawTtl MM AB SSP FemEd FemLab FemHead
```

Source	SS	df	MS	Number of obs	=	159
				F(6, 152)	=	3.71
Model	874.001765	6	145.666961	Prob > F	=	0.0018
Residual	5970.99195	152	39.2828417	R-squared	=	0.1277
				Adj R-squared	=	0.0933
Total	6844.99371	158	43.322745	Root MSE	=	6.2676

LawTtl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
MM	-.0067602	.0039075	-1.73	0.086	-.0144802	.0009597
AB	.0123122	.0205465	0.60	0.550	-.0282814	.0529059
SSP	.1146822	.0467644	2.45	0.015	.02229	.2070744
FemEd	-.0182233	.0262324	-0.69	0.488	-.0700505	.0336038
FemLab	.0344318	.0366222	0.94	0.349	-.0379224	.106786
FemHead	2.598531	1.047062	2.48	0.014	.5298568	4.667206
_cons	6.083526	2.607891	2.33	0.021	.9311326	11.23592

Regression 6: Full Model, Adjusted for EU Laws

$AdEULaw = b_0 + \beta_1 AB_i + \beta_2 MM_i + \beta_3 SSP_i + \beta_4 FemEd_i + \beta_5 FemLab_i + \beta_6 FemHead_i + \varepsilon$

```
. reg AdEULaw AB MM SSP FemEd FemLab FemHead
```

Source	SS	df	MS	Number of obs	=	162
				F(6, 155)	=	8.72
Model	9216.96936	6	1536.16156	Prob > F	=	0.0000
Residual	27293.3578	155	176.086179	R-squared	=	0.2524
				Adj R-squared	=	0.2235
Total	36510.3272	161	226.772218	Root MSE	=	13.27

AdEULaw	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AB	-.0919541	.043311	-2.12	0.035	-.1775101	-.0063982
MM	.0026641	.0081643	0.33	0.745	-.0134635	.0187917
SSP	.2349107	.0981812	2.39	0.018	.0409648	.4288565
FemEd	.0961856	.0544667	1.77	0.079	-.0114073	.2037785
FemLab	.0804021	.0773502	1.04	0.300	-.0723946	.2331987
FemHead	5.661472	2.200135	2.57	0.011	1.315354	10.00759
_cons	1.54664	5.450303	0.28	0.777	-9.219818	12.3131

Regression 7: Adjusted EU Model of significant variables

$AdEULaw = b_0 + \beta_1 AB_i + \beta_3 SSP_i + \beta_6 FemHead_i + \varepsilon$

$AdEULaw = 11.21 + -.11AB_i + .25SSP_i + 7.40\ FemHead_i + \varepsilon$

```
. reg AdEULaw AB SSP FemHead
```

Source	SS	df	MS	Number of obs	=	182
				F(3, 178)	=	18.89
Model	9334.48875	3	3111.49625	Prob > F	=	0.0000
Residual	29318.5277	178	164.71083	R-squared	=	0.2415
				Adj R-squared	=	0.2287
Total	38653.0165	181	213.552577	Root MSE	=	12.834

AdEULaw	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AB	-.1128371	.0236913	-4.76	0.000	-.1595891	-.066085
SSP	.2538369	.0848108	2.99	0.003	.0864729	.4212009
FemHead	7.398366	2.007728	3.68	0.000	3.436353	11.36038
_cons	11.21292	2.507041	4.47	0.000	6.265574	16.16027

Regression 8: Full Progress towards climate targets model

$Progress = b_0 + \beta_1 AB_i + \beta_2 MM_i + \beta_3 SSP_i + \beta_4 FemEd_i + \beta_5 FemLab_i + \beta_6 FemHead_i + \varepsilon$

```
. reg Progress AB MM SSP FemEd FemLab FemHead
```

Source	SS	df	MS	Number of obs	=	59
				F(6, 52)	=	3.91
Model	13.9853844	6	2.33089741	Prob > F	=	0.0027
Residual	30.9637681	52	.595457079	R-squared	=	0.3111
				Adj R-squared	=	0.2317
Total	44.9491525	58	.774985389	Root MSE	=	.77166

Progress	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AB	-.0104651	.0065694	-1.59	0.117	-.0236475	.0027174
MM	.0046052	.0013367	3.45	0.001	.0019228	.0072875
SSP	.0244373	.0110029	2.22	0.031	.0023584	.0465162
FemEd	-.0043163	.0061654	-0.70	0.487	-.0166881	.0080554
FemLab	-.0114348	.0110091	-1.04	0.304	-.0335263	.0106566
FemHead	.203096	.2140216	0.95	0.347	-.2263698	.6325617
_cons	2.962342	.6690885	4.43	0.000	1.619718	4.304966