The Rule of Law and Development:

An analysis on the Rule of Law and its impacts on the social and economic development of a country.

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In [29]:
```
# create a toggle to display or hide code
from IPython.display import HTML
HTML('''<script>
code_show=true;
function code_toggle() {
 if (code_show){
 $('div.input').hide();
 } else {
 $('div.input').show();
 }
 code_show = !code_show
}
$( document ).ready(code_toggle);
</script>
The raw code for this IPython notebook is by default hidden for easier reading.
To toggle on/off the raw code, click <a href="javascript:code_toggle()">here</a>.
```

Out[29]: The raw code for this IPython notebook is by default hidden for easier reading. To toggle on/off the raw code, click here.

Introduction

The rule of law has vast implications on macroeconomic theory, and is widely accepted as an effective measure of governance. Countries with high rule of law indices embody and encourage a just society, and is largely considered to be an enabler of growth. Inversely, it is reasoned that if the state of social and political institutions is deficient - meaning a low rule of law index - economic and social policy would not produce the desired results due to lack of enforcement and insufficient governance.

The following analysis aims to examine what this looks like on a per country basis. How extreme are the concrete impacts of ineffective governance, and to what temporal extent are these impacts realized by a country? An inspection on the effectiveness of specific policies against a countries measure's of governance may provide a clear estimate of this, but this analysis will follow another route. By measuring various economic and social indicators that tend to constitute desired policy outcomes against governance scores, we will address the following: Does a country's rule of law index predict its capacity for social and economic development?

Three levels of analysis will be used to examine the relationship between governance and development:

1) Governance Level on Development Level: 1996 Governance Indicators vs. 1996 Development Indicators

2) Governance Level on Development Growth: 1996 Governance Indicators vs. 1996-2014 Development Growth Rate

3) Governance Growth on Development Growth: 1996-2014 Governance Growth Rate vs. 1996-2014 Development Growth Rate

The cross-country examination will span the world geography with emphasis on the inclusion of countries in different stages of development, as determined by 2014 United Nations WESP classifications (http://www.un.org/en/development/desa/policy/wesp/wesp_current/wesp2014.pdf). Categorically, we will analyze the degree of correlation, if any, between governance and development indicators in i) developing economies, ii) economies in transition, and iii) developed economies.

Key goals and project outcomes will be to provide concrete evidence of the importance of accountability, protection of fundamental rights, and the accessibility and efficiency of legislative and judicial systems, to demonstrate short and long-term temporal impacts based on governance and development *levels* and *growths*, and to examine potential differences in the relationship between governance and development in countries at different stages of development.

Methodology

VIII. Bibliography

I. Packages

The following packages will be used in this report.

- `HTML` package to integrate a code toggle on/off button for easier viewing and to format text
- `Pandas` package to import, manipulate, merge, and analyze the data
- `matplotlib` to plot results
- `wbdata` package to directly pull data from World Bank API
- `pivottablejs` to create interactive, multivariable graphs in Jupyter // (note: this package does not have a method to "show" plots, so the code must be run in Jupyter CELL BY CELL)
- `math` to perform mathematical operations on data
- `numpy` to convert dataframes to arrays and to perform mathematical operations and statistical anlaysis on the data

In [78]:
```
%matplotlib inline
import pandas as pd
from pandas_datareader import wb
import matplotlib.patches as mpatches
import matplotlib.pyplot as plt
import wbdata
from pivottablejs import pivot_ui
import math
import numpy as np
```

II. Data

Indicator Selection

This analysis uses various indicators from 1996 and 2014 from two data catalogs published by the World Bank: i) Worldwide Governance Indicators (https://data.worldbank.org/data-catalog/worldwide-governance-indicators) and ii) World Development Indicators (https://data.worldbank.org/data-catalog/world-development-indicators). All data is called directly through the World Bank API. Indicators were selected based on the inclusion of geographical diversity and the availability of data for the largest possible time span.

Selections from the World Bank Worldwide Governance Indicators

- Rule of Law (RL.EST)
  - *Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.*
- Control of Corruption (CC.EST)
  - *Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of*

the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.

- Government Effectiveness (GE.EST)
  - *Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.*
- Political Stability and Absence of Violence/Terrorism^ (PV.EST)
  - *Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.*
- Regulatory Quality (RQ.EST)
  - *Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.*
- Voice and Accountability (VA.EST)
  - *Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.*

^ Shortened to "Political Stability" in project

(Note: All governance indicators were normalized between -2.5 and 2.5 by the World Bank. For graphical purposes, governance indicators were re-normalized between 0 and 1 in this project.)

Selections from the World Bank World Development Indicators

- GDP per capita (NY.GDP.PCAP.CD)
  - current US$
- Life Expectancy (SP.DYN.LE00.IN)
  - at birth, total years
- Child Mortality (SH.DYN.MORT)
  - under 5, per 1,000 live births
- Intentional Homicides^^ (VC.IHR.PSRC.P5)
  - per 100,000 people
- Children Out of School (SE.PRM.UNER.ZS)
  - % of primary school aged
- Access to Electricity (EG.ELC.ACCS.ZS)
  - % of population
- CO2 Emissions (EN.ATM.CO2E.KD.GD)
  - kg per 2010 US$ of GDP

^^ Shortened to "Homicide Rate" in project

Country Selection

Thirty countries were selected (ten per UN WESP development classification), with the intent of capturing countries in varying stages of development and spanning the world geography. Qualifying countries were determined to disinclude countries that experienced development volatility or a rapid decay of social and economic wellbeing, as a result of terrorism, devestation, or humanitarian crises (unavoidable by governance structures) during the 18 year period examined. Country selection was limited by the availability of data for the specified time periods.

Selections from UN WESP Category 1: Developing Economies

Algeria; South Africa; China; India; Brazil; Mexico; United Arab Emirates; Saudia Arabia; Venezuela, RB; Morocco

Selections from UN WESP Category 2: Economies in Transition

Moldova; Georgia; Russian Federation; Ukraine; Albania; Bosnia and Herzegovina; Turkmenistan; Belarus; Azerbaijan; Uzbekistan

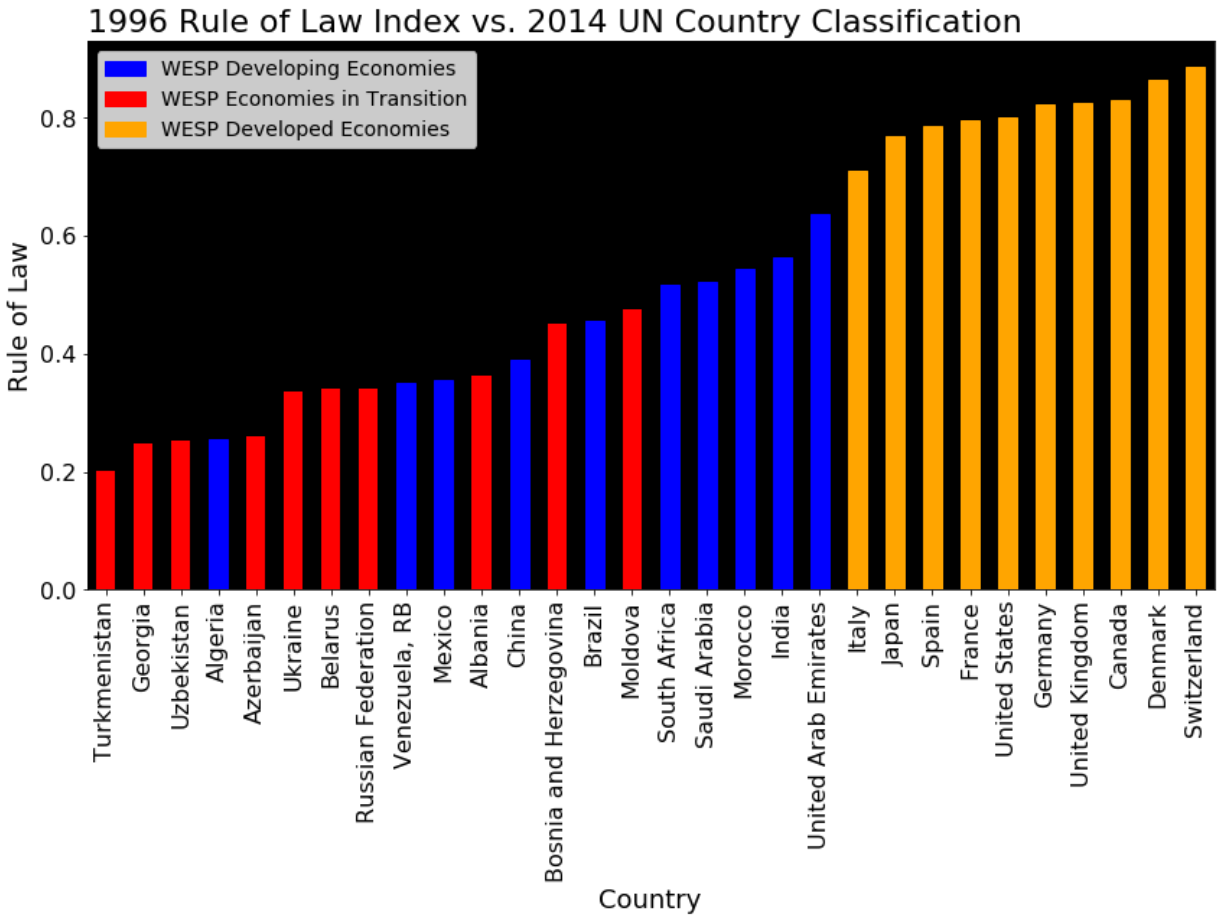
Selctions from UN WESP Category 3: Developed Economies

Switzerland; Canada; Japan; France; Germany; Italy; United Kingdom; United States; Denmark; Spain

III. Rule of Law

In [85]:
```
# plotting Rule of Law indices for countries examined, color coded by UN WESP cla

var = ['RL.EST']
# country list (ISO codes)
iso = ['DZA', 'ZAF', 'CHN', 'IND', 'BRA', 'MEX', 'ARE', 'SAU', 'VEN', 'MAR',
       'MDA', 'GEO', 'RUS', 'UKR', 'ALB', 'BIH', 'TKM', 'BLR', 'AZE', 'UZB',
       'CHE', 'CAN', 'JPN', 'FRA', 'DEU', 'ITA', 'GBR', 'USA', 'DNK', 'ESP']
year = 1996

# get Rule of Law data from World Bank
RLdf = wb.download(indicator=var, country=iso, start=year, end=year)

# munge data
RLdf = RLdf.reset_index(level='year', drop=True)
RLdf.columns = ['Rule of Law']
# current data is normalized from -2.5 to 2.5
min = -2.5
max = 2.5
# normalizes data to fall between 0 and 1
RLdf_norm = (RLdf - min) / (max - min)
# sort data by least to greatest Rule of Law Index
RLdf_norm = RLdf_norm.sort_values(by=['Rule of Law'])

# plot data with bar graph
fig, ax = plt.subplots(figsize = (14, 7))
RLdf_norm.plot(ax=ax, kind='bar', alpha = 1.0, color = 'red')
ax.set_title('1996 Rule of Law Index vs. 2014 UN Country Classification', loc='le
ax.set_xlabel('Country').set_fontsize(18)
plt.xticks(fontsize=16)
ax.set_ylabel('Rule of Law').set_fontsize(18)
plt.yticks(fontsize=16)
ax.set_facecolor('black')

## color code bars based on 2014 WESP/UN classifications (use same coloring as de
## unable to add colors/key as third variable using subplots method... indivdually

# change bar color to blue for WESP classified 'Developing Economies'
ax.get_children()[3].set_color('blue')
ax.get_children()[8].set_color('blue')
ax.get_children()[9].set_color('blue')
ax.get_children()[11].set_color('blue')
ax.get_children()[13].set_color('blue')
ax.get_children()[15].set_color('blue')
ax.get_children()[16].set_color('blue')
ax.get_children()[17].set_color('blue')
ax.get_children()[18].set_color('blue')
ax.get_children()[19].set_color('blue')
# create bar legend patch for 'Developing Economies'
blue_patch = mpatches.Patch(color='blue', label='WESP Developing Economies')


# leave bar color red for WESP classified 'Economies in Transition'
# create red legend patch for 'Economies in Transition'
red_patch = mpatches.Patch(color='red', label='WESP Economies in Transition')

# change bar color to orange for WESP classified 'Developed Economies'
```

```
ax.get_children()[20].set_color('orange')
ax.get_children()[21].set_color('orange')
ax.get_children()[22].set_color('orange')
ax.get_children()[23].set_color('orange')
ax.get_children()[24].set_color('orange')
ax.get_children()[25].set_color('orange')
ax.get_children()[26].set_color('orange')
ax.get_children()[27].set_color('orange')
ax.get_children()[28].set_color('orange')
ax.get_children()[29].set_color('orange')
# create orange legend patch for 'Developed Economies'
orange_patch = mpatches.Patch(color='orange', label='WESP Developed Economies')

# add all patches to legend
ax.legend(handles=[blue_patch, red_patch, orange_patch], fontsize=14)
plt.show()
```



A simple graph of Rule of Law indices, coded by UN WESP Development Categories, already shows a relationship between Rule of Law and Development.

Two Observations:

- There is a jump in index level as we get to classified "Developed Countries". This implies a more significant gap in governance levels between Developed and less developed countries.
- Most of the countries with the lowest Rule of Law Indexes actually fall in the medium UN WESP Classification ("Economies in Transition"), while most of the countries with Rule of Law Indexes in the middle range fall in the lowest UN WESP Classification ("Developing Economies").

IV. LEVEL 1 ANALYSIS: Governace Level (1996) vs. Development Level (1996)

Governance Indicators (1996)

In [86]:
```
## display a chart of Governance Indicators for all thirty countries from 1996

var = ['RL.EST', 'CC.EST', 'GE.EST', 'PV.EST', 'RQ.EST', 'VA.EST']
# country list (ISO codes)
iso = ['DZA', 'ZAF', 'CHN', 'IND', 'BRA', 'MEX', 'ARE', 'SAU', 'VEN', 'MAR',
       'MDA', 'GEO', 'RUS', 'UKR', 'ALB', 'BIH', 'TKM', 'BLR', 'AZE', 'UZB',
       'CHE', 'CAN', 'JPN', 'FRA', 'DEU', 'ITA', 'GBR', 'USA', 'DNK', 'ESP']
year = 1996

# get Governance Indicator data from World Bank
GOVdf = wb.download(indicator=var, country=iso, start=year, end=year)

# munge data
GOVdf = GOVdf.reset_index(level='year', drop=True)
GOVdf.columns = ['Rule of Law', 'Control of Corruption', 'Government Effectivenes
              'Political Stability', 'Regulatory Quality',
              'Voice and Accountability']
# sort data by country name
GOVdf = GOVdf.sort_index(axis=0, kind='mergesort')
# current Governance Indicator data is normalized from approx -2.5 to 2.5
min = -2.5
max = 2.5
# normalizes data to fall between 0 and 1
GOVdf_norm = (GOVdf - min) / (max - min)

# wrap text by setting column width
GOVdf_norm_styled = GOVdf_norm.style.set_table_styles([dict(selector="th",props=[

GOVdf_norm_styled
```

Out[86]:

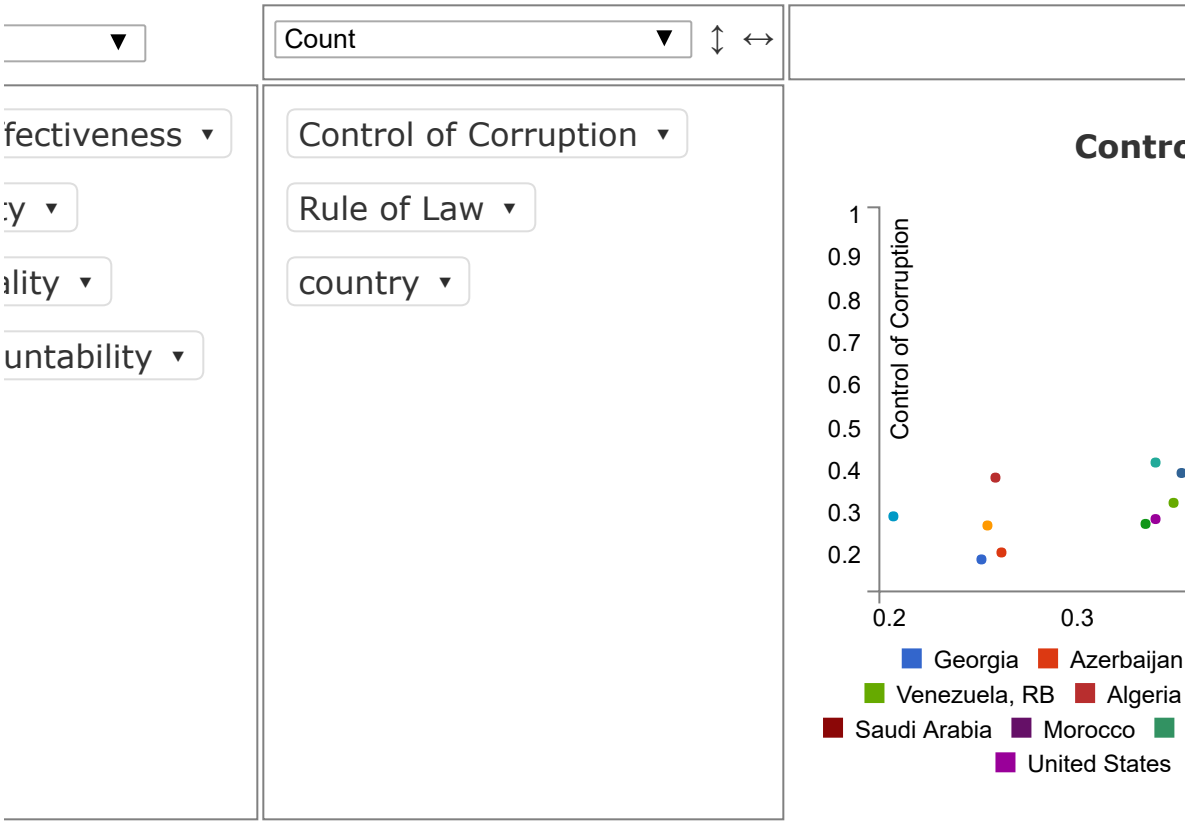
country	Rule of Law	Control of Corruption	Government Effectiveness	Political Stab
Albania	0.363104	0.321219	0.362282	0.433
Algeria	0.256361	0.386652	0.282247	0.143
Azerbaijan	0.259768	0.210876	0.316722	0.334
Belarus	0.340203	0.422078	0.423887	0.518
Bosnia and Herzegovina	0.451663	0.445886	0.261591	0.381
Brazil	0.4553	0.496284	0.471373	0.456
Canada	0.829451	0.906282	0.848473	0.746
China	0.390882	0.445762	0.430269	0.480
Denmark	0.864162	0.946262	0.85181	0.788
France	0.796737	0.749482	0.750371	0.677
Georgia	0.248735	0.194547	0.372613	0.186
Germany	0.821906	0.881043	0.844935	0.757
India	0.562691	0.423782	0.477679	0.306

country	Rule of Law	Control of Corruption	Government Effectiveness	Political Stab
Italy	0.711285	0.58157	0.668065	0.722
Japan	0.769566	0.738462	0.682058	0.73
Mexico	0.354671	0.397514	0.545065	0.315
Moldova	0.475774	0.412515	0.456907	0.502
Morocco	0.544246	0.478615	0.479118	0.45
Russian Federation	0.341162	0.289332	0.409555	0.265
Saudi Arabia	0.522913	0.467339	0.463274	0.46
South Africa	0.517586	0.646585	0.704099	0.424
Spain	0.787017	0.725842	0.824005	0.535
Switzerland	0.88631	0.897395	0.851416	0.791
Turkmenistan	0.202522	0.295701	0.270064	0.589
Ukraine	0.335291	0.277973	0.365984	0.469
United Arab Emirates	0.637683	0.498884	0.655328	0.692
United Kingdom	0.825747	0.896104	0.876439	0.69
United States	0.800044	0.814208	0.804984	0.687
Uzbekistan	0.252164	0.274236	0.259871	0.390
Venezuela, RB	0.34996	0.327411	0.391857	0.383

Rule of Law as a Measure of Governance (1996 levels)

In [87]:
```
# plot governance indicators against Rule of Law to show existing correlation, co
pivot_ui(GOVdf_norm, rows = ['Control of Corruption', 'Rule of Law', 'country'],
```

Out[87]:



Graphically, we see a clear positive association with Rule of Law indices and other governance indices from the Worldwide Governance Indicators catalog. This makes sense, as the Rule of Law Index is calculated with varying governance inputs that cross over with the rest of the data catalog. The data confirms this! For simplification here on out, Rule of Law will be used as *the* measure of governance. Of course, the code is structured to allow easy revisions, should it be beneficial to plot other indicators.

Note on pivot_ui graph: This is an interactive graph package implemented in Jupyter. The code used sets up the default x-variable and key + legend. To view correlations with other indicators, drag an indicator from the left column to the top of the right column and replace the previous y-variable from the right column to the left columm.

Development Indicators (1996)

In [88]:
```
## display a chart of Development Indicators for all thirty countries from 1996

var = ['NY.GDP.PCAP.CD', 'SP.DYN.LE00.IN', 'SH.DYN.MORT', 'VC.IHR.PSRC.P5', 'SE.P
       'EG.ELC.ACCS.ZS', 'EN.ATM.CO2E.KD.GD']
# country list (ISO codes)
iso = ['DZA', 'ZAF', 'CHN', 'IND', 'BRA', 'MEX', 'ARE', 'SAU', 'VEN', 'MAR',
       'MDA', 'GEO', 'RUS', 'UKR', 'ALB', 'BIH', 'TKM', 'BLR', 'AZE', 'UZB',
       'CHE', 'CAN', 'JPN', 'FRA', 'DEU', 'ITA', 'GBR', 'USA', 'DNK', 'ESP']
year = 1996

# get Development Indicator data from World Bank
DEVdf = wb.download(indicator=var, country=iso, start=year, end=year)

# munge data
DEVdf = DEVdf.reset_index(level='year', drop=True)
DEVdf.columns = ['GDP Per Capita', 'Life Expectancy', 'Child Mortality', 'Homicid
                 'Access to Electricity', 'CO2 Emissions']
# sort data by country name
DEVdf = DEVdf.sort_index(axis=0, kind='mergesort')

# wrap text by setting column width
DEVdf_styled = DEVdf.style.set_table_styles([dict(selector="th",props=[('min-widt

DEVdf_styled
```

Out[88]:

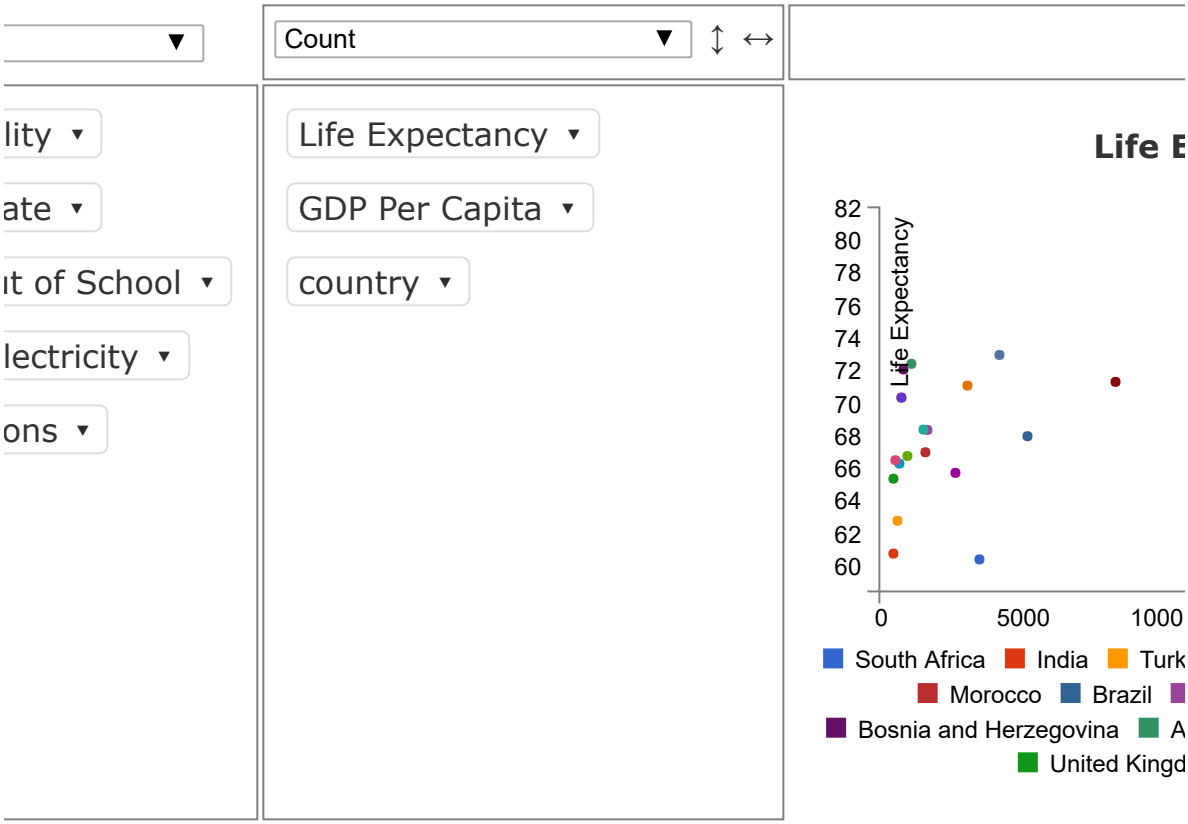
country	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Albania	1046.36	72.5515	31.5	7.96762
Algeria	1596.03	68.491	42.3	nan
Azerbaijan	409.217	65.4944	91.9	nan
Belarus	1452.45	68.5122	15.5	9.46863
Bosnia and Herzegovina	736.975	72.2069	12.2	nan
Brazil	5156.81	68.1047	46	nan
Canada	21183.2	78.2305	6.7	1.94373
China	709.414	70.4814	45.5	nan
Denmark	35650.7	75.5915	6.2	1.31298
France	27015.3	77.9537	6.1	2.01696
Georgia	670.461	70.466	42.6	5.40829
Germany	30564.2	76.6732	6.2	1.68126
India	396.015	60.893	105.7	4.39508
Italy	23020.1	78.522	7	1.67374
Japan	38436.9	80.2002	5.5	0.49353
Mexico	4153.15	73.0989	33.7	15.4541
Moldova	462.172	66.6291	38.5	9.28573

country	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Morocco	1556.79	67.1182	59.9	nan
Russian Federation	2643.9	65.8541	21.7	nan
Saudi Arabia	8293.22	71.4419	27.9	nan
South Africa	3496.97	60.5344	59.1	60.3902
Spain	16069.2	78.1205	6.4	1.00457
Switzerland	46676.9	78.8961	6.1	1.17548
Turkmenistan	554.955	62.91	88	7.82625
Ukraine	872.709	66.8878	20.3	9.64286
United Arab Emirates	28615.6	73.4586	12.7	nan
United Kingdom	24219.6	77.0878	7	1.32075
United States	30068.2	76.0268	9.2	7.2923
Uzbekistan	600.598	66.421	69.7	4.93844
Venezuela, RB	3013.84	71.2157	25.5	22.0496

Wealth and Development (1996 levels)

In [89]:
```
# plot development indicators against wealth to show existing correlation, color
pivot_ui(DEVdf, rows = ['Life Expectancy', 'GDP Per Capita', 'country'], renderer
```

Out[89]:



Of course, governance isn't the only contributor to measures of social and economic well-being; wealth and level of capital (especially per capita) have an obvious association. We can expect the effect of wealth to amplify any associations between governance and development we find.

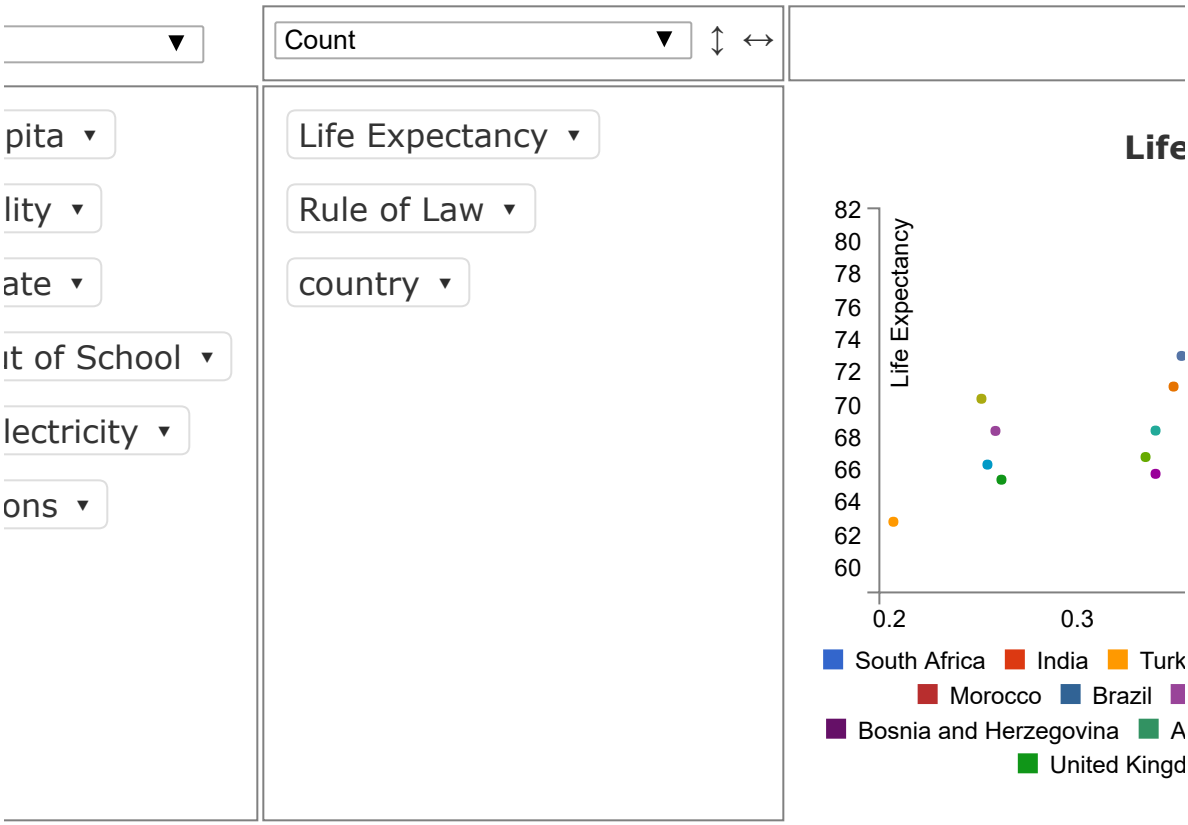
Interesting to note: this graph is spotty (there are gaps caused by clustered data around the beginning and middle of the wealth spectrum). This graphs shows a steeper association between poorer countries and development indicators.

Important note on pivot_ui graph: For Homicide Rates, Children Out of School, and Access to Electricity, data was not available for all thirty countries. Nan values are treated as '0' in the pivot_ui package. Any '0' values in the plots should be disregarded. Nan values are NOT factored into the calculated Pearson Correlation Coefficients.

Rule of Law vs. Development (1996 levels)

In [90]:
```
# combine Rule of Law indexes with Development indicators in a dataframe
RLdf_norm = RLdf_norm.sort_index(axis=0, kind='mergesort')
combined_df = pd.concat([RLdf_norm, DEVdf], axis=1)

# plot Rule of Law against Development indicators by country
pivot_ui(combined_df, rows = ['Life Expectancy', 'Rule of Law', 'country'], rende
```

Out[90]:



A positive association with the Rule of Law and development indicators is observed among the thirty countries.

In comparison to the previous plot (Wealth vs. Development), there are fewer gaps in the data. The data points are more spread out. The association here appears smoother and steadier, showing a more equal distribution of the impact of governance on development.

Pearson Standard Correlation Coefficient, All Countries

In [91]:
```
# find pearson correlations for all data
combined_df = combined_df.corr()
# drow all rows except Rule of Law
combined_df = combined_df.drop(combined_df.index[[1, 2, 3, 4, 5, 6, 7]])
# drop Rule of Law column (shows a correlation of 1 with itself)
combined_df = combined_df.drop('Rule of Law', 1)

# wrap text by setting column width
combined_df_styled = combined_df.style.set_table_styles([dict(selector="th",props=

combined_df_styled
```

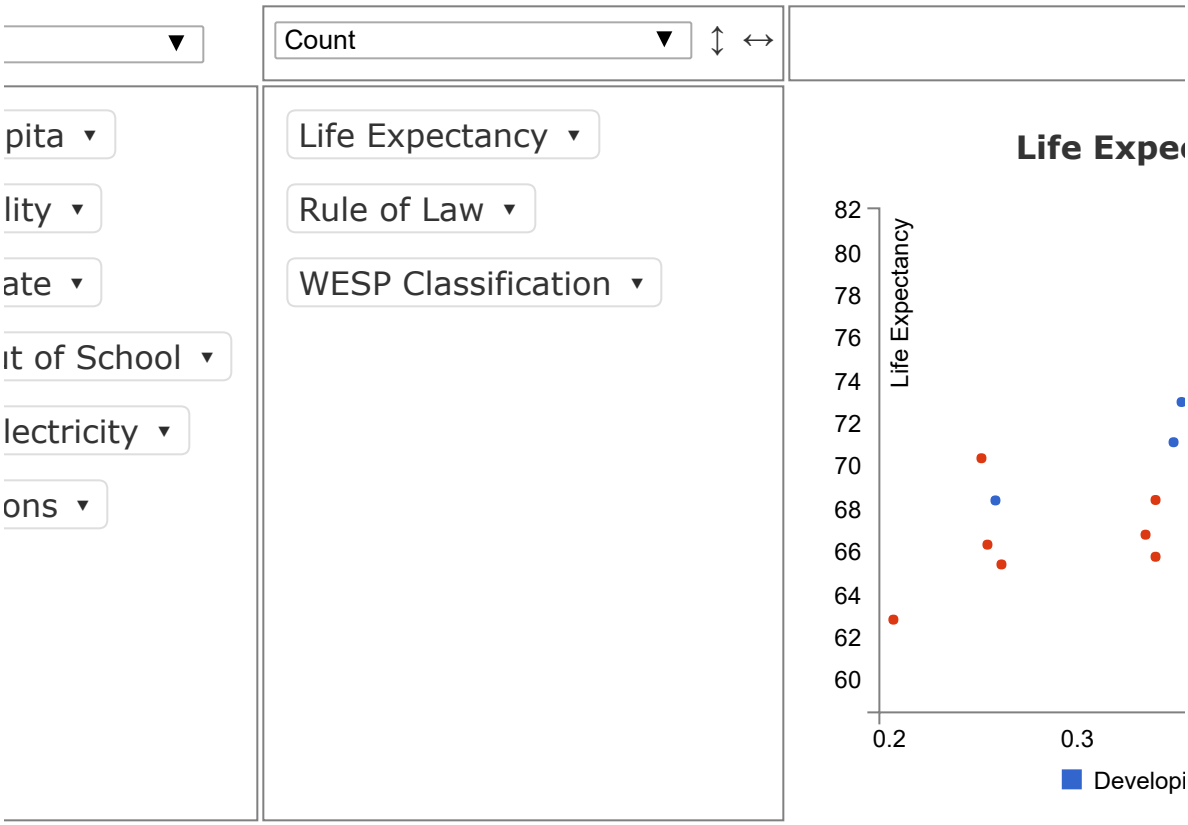
Out[91]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.878372	0.736153	-0.618813	-0.326889

The correlation coefficients for all countries provide on average much higher values then the correlation coefficients for specific country categories below. This may indicate that the data is too spread out, but this variation in the categorical correlations may also result from a lack of data points (each category only has ten countries).

In [92]:
```
# create df with WESP Country classifications
countries = ['Albania', 'Algeria', 'Azerbaijan', 'Belarus', 'Bosnia and Herzegovi
             'Brazil', 'Canada', 'China', 'Denmark', 'France', 'Georgia', 'Germany
             'India', 'Italy', 'Japan', 'Mexico', 'Moldova', 'Morocco', 'Russian
             'Saudi Arabia', 'South Africa', 'Spain', 'Switzerland', 'Turkmenista
            'United Arab Emirates', 'United Kingdom', 'United States', 'Uzbekista
classification = [ 'Economies in Transition', 'Developing Economies', 'Economies
                  'Economies in Transition', 'Economies in Transition', 'Developi
                  'Developed Economies', 'Developing Economies', 'Developed Econo
                 'Developed Economies', 'Economies in Transition', 'Developed Eco
                  'Developing Economies', 'Developed Economies', 'Developed Econo
                  'Developing Economies', 'Economies in Transition', 'Developing
                  'Economies in Transition', 'Developing Economies', 'Developing
                  'Developed Economies', 'Developed Economies', 'Economies in Tra
                  'Economies in Transition', 'Developing Economies', 'Developed E
                  'Developed Economies', 'Economies in Transition', 'Developing E

WESPdf = pd.DataFrame(data=classification, index=countries,columns=["WESP Classif

# combine Rule of Law indexes with Development indicators and WESP classification
combined_df_byWESP = pd.concat([RLdf_norm, DEVdf, WESPdf], axis=1)

# change index to WESP classifications
combined_df_byWESP = combined_df_byWESP.set_index('WESP Classification')

# plot Rule of Law against Development indicators, indexed by country classificat
pivot_ui(combined_df_byWESP, rows = ['Life Expectancy', 'Rule of Law', 'WESP Clas
        rendererName='Scatter Chart')
```

Out[92]:



A side note: despite the inconsistency between governance and UN WESP classifications observed earlier on (III. Rule of Law), the graph still shows a relatively steady positvie association between Rule of Law and Development (with possible outliers being South Africa and India). This calls these classifications into question for non-"Developed Economies", as the remaining classifications don't appear to follow suit with either governance or development levels. This inconsistency remains throughout this analysis.

Pearson Standard Correlation Coefficient, Developing Economies

In [93]:
```
# sort combined dataframe by WESP classification
combined_df_byWESP = combined_df_byWESP.sort_index(axis=0, kind='mergesort')

# separate Developing Economies into own dataframe (for purposes of regression an
developing_df = combined_df_byWESP.drop(combined_df_byWESP.index[[0, 9]])
developing_df = developing_df.drop(developing_df.index[[10,19]])

developing_df = developing_df.corr()
developing_df = developing_df.drop(developing_df.index[[1, 2, 3, 4, 5, 6, 7]])
developing_df = developing_df.drop('Rule of Law', 1)

# wrap text by setting column width
developing_df_styled = developing_df.style.set_table_styles([dict(selector="th",p

developing_df_styled
```

Out[93]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.54356	-0.247288	0.195003	0.159882

Pearson Standard Correlation Coefficient, Economies in Transition

In [94]:
```
# separate Economies in Transition into own dataframe (for purposes of regression
transition_df = combined_df_byWESP.drop(combined_df_byWESP.index[[0,19]])

transition_df = transition_df.corr()
transition_df = transition_df.drop(transition_df.index[[1, 2, 3, 4, 5, 6, 7]])
transition_df = transition_df.drop('Rule of Law', 1)

# wrap text by setting column width
transition_df_styled = transition_df.style.set_table_styles([dict(selector="th",p

transition_df_styled
```

Out[94]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.126167	0.474673	-0.699078	0.625323

On a level vs. level analysis of governance and development, the association appears the strongest for Economies in Transition (countries in the middle of the UN development spectrum), with the exception of the correlation with wealth. However, these countries also tend to have the lowest Rule of Law indices, so, this level of analysis also shows that the association between governance and development is highest for countries with the lowest levels of governance.

Pearson Standard Correlation Coefficient, Developed Economies

In [95]:
```
# separate Developed Economies into own dataframe (for purposes of regression ana
developed_df = combined_df_byWESP.drop(combined_df_byWESP.index[[19,29]])

developed_df = developed_df.corr()
developed_df = developed_df.drop(developed_df.index[[1, 2, 3, 4, 5, 6, 7]])
developed_df = developed_df.drop('Rule of Law', 1)

# wrap text by setting column width
developed_df_styled = developed_df.style.set_table_styles([dict(selector="th",pro

developed_df_styled
```

Out[95]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.505362	-0.344931	-0.147472	-0.0621861

V. LEVEL 2 ANALYSIS: Governance Level (1996) vs. Development Growth (1996-2014)

Development Indicators, Continously Compounded Annualized Growth (1996 - 2014)

In [96]:
```
var = ['NY.GDP.PCAP.CD', 'SP.DYN.LE00.IN', 'SH.DYN.MORT', 'VC.IHR.PSRC.P5', 'SE.P
       'EG.ELC.ACCS.ZS', 'EN.ATM.CO2E.KD.GD']
# country list (ISO codes)
iso = ['DZA', 'ZAF', 'CHN', 'IND', 'BRA', 'MEX', 'ARE', 'SAU', 'VEN', 'MAR',
       'MDA', 'GEO', 'RUS', 'UKR', 'ALB', 'BIH', 'TKM', 'BLR', 'AZE', 'UZB',
       'CHE', 'CAN', 'JPN', 'FRA', 'DEU', 'ITA', 'GBR', 'USA', 'DNK', 'ESP']
year = 2014

# get Development Indicator data from World Bank
DEV14df = wb.download(indicator=var, country=iso, start=year, end=year)

# munge data
DEV14df = DEV14df.reset_index(level='year', drop=True)
DEV14df.columns = ['GDP Per Capita', 'Life Expectancy', 'Child Mortality', 'Homic
                   'Access to Electricity', 'CO2 Emissions']
# sort data by country name
DEV14df = DEV14df.sort_index(axis=0, kind='mergesort')
```

In [39]:
```
## display a chart of continuously compounded Development Indicator growth rates j

# set new dataframe using formula for continuously compounded annualized growth r

# convert dataframes to numpy arrays before performing math
endval = DEV14df.values
beginningval = DEVdf.values
# t = 18 years from 1996 to 2014
t = 18
devgrowth = np.log(endval/beginningval)/t
# convert numpy array back to data frame
devgrowth_df = pd.DataFrame(devgrowth)
devgrowth_df.index = DEVdf.index
devgrowth_df.columns = DEVdf.columns

# wrap text by setting column width
devgrowth_df_styled = devgrowth_df.style.set_table_styles([dict(selector="th",pro

devgrowth_df_styled
```

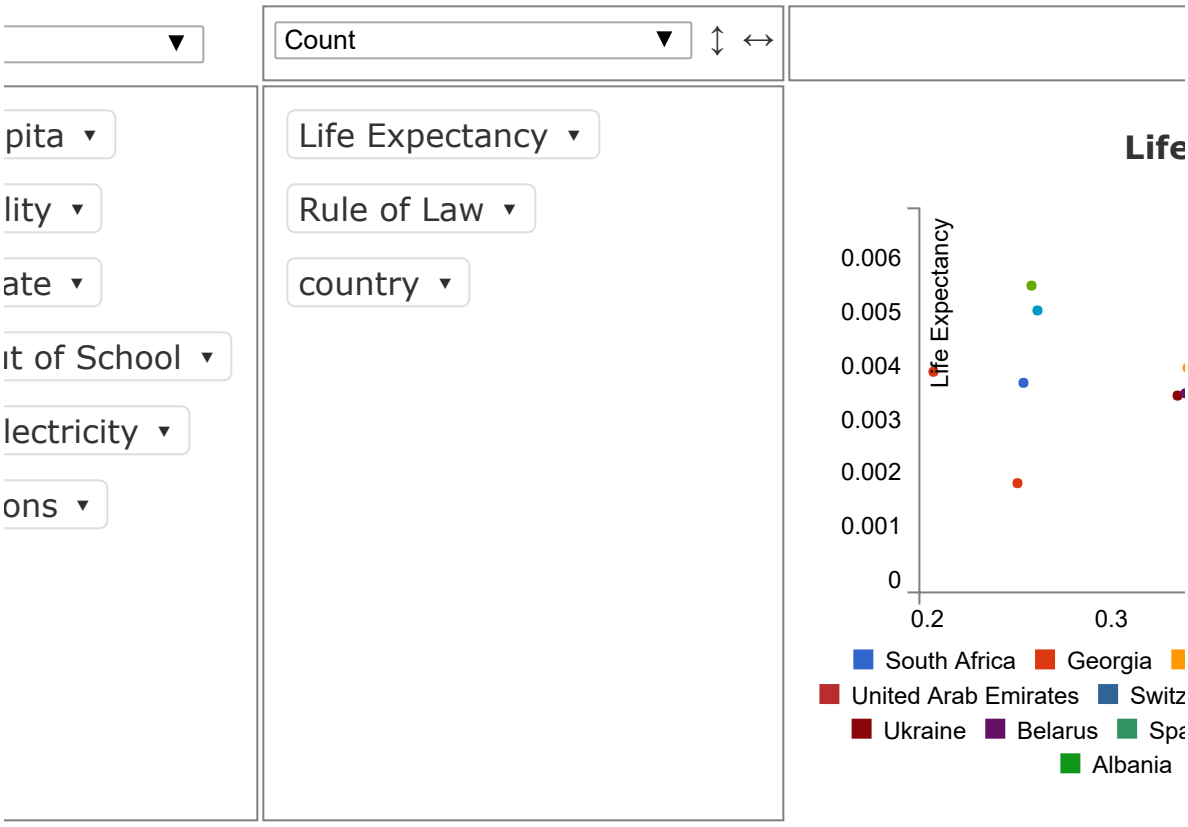
Out[39]:

country	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Albania	0.0820051	0.00402176	-0.0434866	-0.0382829
Algeria	0.0683948	0.00551204	-0.0278997	nan
Azerbaijan	0.164404	0.00504844	-0.056564	nan
Belarus	0.0969574	0.00350259	-0.072542	-0.053725
Bosnia and Herzegovina	0.108593	0.00318219	-0.0385082	nan
Brazil	0.0470447	0.00532692	-0.0572978	nan
Canada	0.0481991	0.00258261	-0.0140805	-0.014397
China	0.132355	0.00415674	-0.0764092	nan
Denmark	0.0312323	0.00363307	-0.0216369	-0.000552034
France	0.0257643	0.00326395	-0.0234441	-0.0288484
Georgia	0.104895	0.00182602	-0.0690142	-0.0385934
Germany	0.0251254	0.00311171	-0.025754	-0.0347168
India	0.0766313	0.00617363	-0.0442041	-0.0176297
Italy	0.0239028	0.00314162	-0.0369431	-0.0410114
Japan	-0.000494654	0.00229839	-0.0375071	-0.0276557
Mexico	0.0512779	0.00267097	-0.0435072	0.00192845
Moldova	0.087801	0.00365628	-0.0474098	-0.0591849
Morocco	0.0392339	0.00635719	-0.0402989	nan
Russian Federation	0.0930976	0.00397892	-0.053392	nan

country	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Saudi Arabia	0.0603504	0.002252	-0.0391088	nan
South Africa	0.0343072	0.000384436	-0.0157634	-0.0335733
Spain	0.0339807	0.00351926	-0.0351401	-0.0200684
Switzerland	0.0343398	0.00294924	-0.0207336	-0.0474901
Turkmenistan	0.147977	0.00390469	-0.0266187	nan
Ukraine	0.0705031	0.00346043	-0.0404577	nan
United Arab Emirates	0.0244671	0.00285285	-0.0263744	nan
United Kingdom	0.0365759	0.00295894	-0.0245463	-0.0213091
United States	0.033141	0.00194909	-0.0167934	-0.0280675
Uzbekistan	0.068216	0.00369851	-0.0514658	nan
Venezuela, RB	0.0916645	0.00230017	-0.0231833	0.0574355

In [97]:
```
# combine Rule of Law indexes with Development indicators in a dataframe
combined_df1 = pd.concat([RLdf_norm, devgrowth_df], axis=1)

# plot Rule of Law against Development growth by country
pivot_ui(combined_df1, rows = ['Life Expectancy', 'Rule of Law', 'country'], rend
```

Out[97]:



Already, the associations between governance levels and development growths are much less consistent across variables. While the general association is strongly positive, swap out y-variables to see clearly different levels of correlation. The growth rates from 1996-2014 for Life Expectancy and those for Children Out of School, for example, show very different assocations with Governance Levels in 1996.

Pearson Standard Correlation Coefficient, All Countries

In [98]:
```
combined_df1 = combined_df1.corr()
combined_df1 = combined_df1.drop(combined_df1.index[[1, 2, 3, 4, 5, 6, 7]])
combined_df1 = combined_df1.drop('Rule of Law', 1)

# wrap text by setting column width
combined_df1_styled = combined_df.style.set_table_styles([dict(selector="th",prop

combined_df1_styled
```

Out[98]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.878372	0.736153	-0.618813	-0.326889

In [99]:
```
combined_df1_byWESP = pd.concat([RLdf_norm, devgrowth_df, WESPdf], axis=1)

# change index to WESP classifications
combined_df1_byWESP = combined_df1_byWESP.set_index('WESP Classification')

# plot Rule of Law against Development indicators, indexed by country classificat
pivot_ui(combined_df1_byWESP, rows = ['Life Expectancy', 'Rule of Law', 'WESP Cla
        rendererName='Scatter Chart')
```

Out[99]:

Since this level of analysis compares governance *levels* with development *growth*, the graphs and Pearson Correlation Coefficients for All Countries provide a much clearer understanding of trends. The categorical correlations below appear to comment too greatly on the variation in the smaller categorical data sets, as opposed to the overall trends that we can view graphically. This may be remedied in future analysis by examining more countries per category.

Pearson Standard Correlation Coefficient, Developing Economies

In [100]:
```
# sort combined dataframe by WESP classification
combined_df1_byWESP = combined_df1_byWESP.sort_index(axis=0, kind='mergesort')
combined_df1_byWESP

# separate Developing Economies into own dataframe (for purposes of regression an
developing_df1 = combined_df1_byWESP.drop(combined_df1_byWESP.index[[0, 9]])
developing_df1 = developing_df1.drop(developing_df1.index[[10,19]])

developing_df1 = developing_df1.corr()
developing_df1
developing_df1 = developing_df1.drop(developing_df1.index[[1, 2, 3, 4, 5, 6, 7]])
developing_df1 = developing_df1.drop('Rule of Law', 1)

# wrap text by setting column width
developing_df1_styled = developing_df1.style.set_table_styles([dict(selector="th"

developing_df1_styled
```

Out[100]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	-0.501916	-0.0467936	0.109335	-0.775404

Pearson Standard Correlation Coefficient, Economies in Transition

In [101]:
```
# separate Economies in Transition into own dataframe (for purposes of regression
transition_df1 = combined_df1_byWESP.drop(combined_df1_byWESP.index[[0,19]])

transition_df1 = transition_df1.corr()
transition_df1 = transition_df1.drop(transition_df1.index[[1, 2, 3, 4, 5, 6, 7]])
transition_df1 = transition_df1.drop('Rule of Law', 1)

# wrap text by setting column width
transition_df1_styled = transition_df1.style.set_table_styles([dict(selector="th"

transition_df1_styled
```

Out[101]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	-0.400727	-0.0455163	0.0821224	-0.735405

For the two UN WESP categories for non-"Developed Economies", governance levels had the highest association with Homicide Rates in following decades. Below, the table of Pearson Coefficients for "Developed Economies" shows a *much* smaller degree of correlation.

Pearson Standard Correlation Coefficient, Developed Economies

In [102]:
```
# separate Developed Economies into own dataframe (for purposes of regression ana
developed_df1 = combined_df1_byWESP.drop(combined_df1_byWESP.index[[19,29]])

developed_df1 = developed_df1.corr()
developed_df1 = developed_df1.drop(developed_df1.index[[1, 2, 3, 4, 5, 6, 7]])
developed_df1 = developed_df1.drop('Rule of Law', 1)

# wrap text by setting column width
developed_df1_styled = developed_df1.style.set_table_styles([dict(selector="th",p

developed_df1_styled
```

Out[102]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.460629	0.136763	0.691093	0.236711

VI. LEVEL 3 ANALYSIS: Governance Growth (1996-2014) vs. Development Growth (1996-2014)

Governance Indicators, Continuously Compounded Annualized Growth (1996 - 2014)

In [103]:
```
## display a chart of continuously compounded Governance Indicator growth rates fo

# create df for 2014 values
var = ['RL.EST', 'CC.EST', 'GE.EST', 'PV.EST', 'RQ.EST', 'VA.EST']
# country list (ISO codes)
iso = ['DZA', 'ZAF', 'CHN', 'IND', 'BRA', 'MEX', 'ARE', 'SAU', 'VEN', 'MAR',
       'MDA', 'GEO', 'RUS', 'UKR', 'ALB', 'BIH', 'TKM', 'BLR', 'AZE', 'UZB',
       'CHE', 'CAN', 'JPN', 'FRA', 'DEU', 'ITA', 'GBR', 'USA', 'DNK', 'ESP']
year = 2014

# get Governance Indicator data from World Bank
GOV14df = wb.download(indicator=var, country=iso, start=year, end=year)

# munge data
GOV14df = GOV14df.reset_index(level='year', drop=True)
GOV14df.columns = ['Rule of Law', 'Control of Corruption', 'Government Effectiven
              'Political Stability', 'Regulatory Quality',
              'Voice and Accountability']
# sort data by country name
GOV14df = GOV14df.sort_index(axis=0, kind='mergesort')
# current Governance Indicator data is normalized from approx -2.5 to 2.5
min = -2.5
max = 2.5
# normalizes data to fall between 0 and 1
GOV14df_norm = (GOV14df - min) / (max - min)
```

In [75]:
```
# set new dataframe using formula for continuously compounded annualized growth r

# convert dataframes to numpy arrays before performing math
endval1 = GOV14df_norm.values
beginningval1 = GOVdf_norm.values
# t = 18 years from 1996 to 2014
t = 18
govgrowth = np.log(endval1/beginningval1)/t
# convert numpy array back to data frame
govgrowth_df = pd.DataFrame(govgrowth)
govgrowth_df.index = GOVdf_norm.index
govgrowth_df.columns = GOVdf_norm.columns
govgrowth_df

# wrap text by setting column width
govgrowth_df_styled = govgrowth_df.style.set_table_styles([dict(selector="th",pro


govgrowth_df_styled
```

Out[75]:

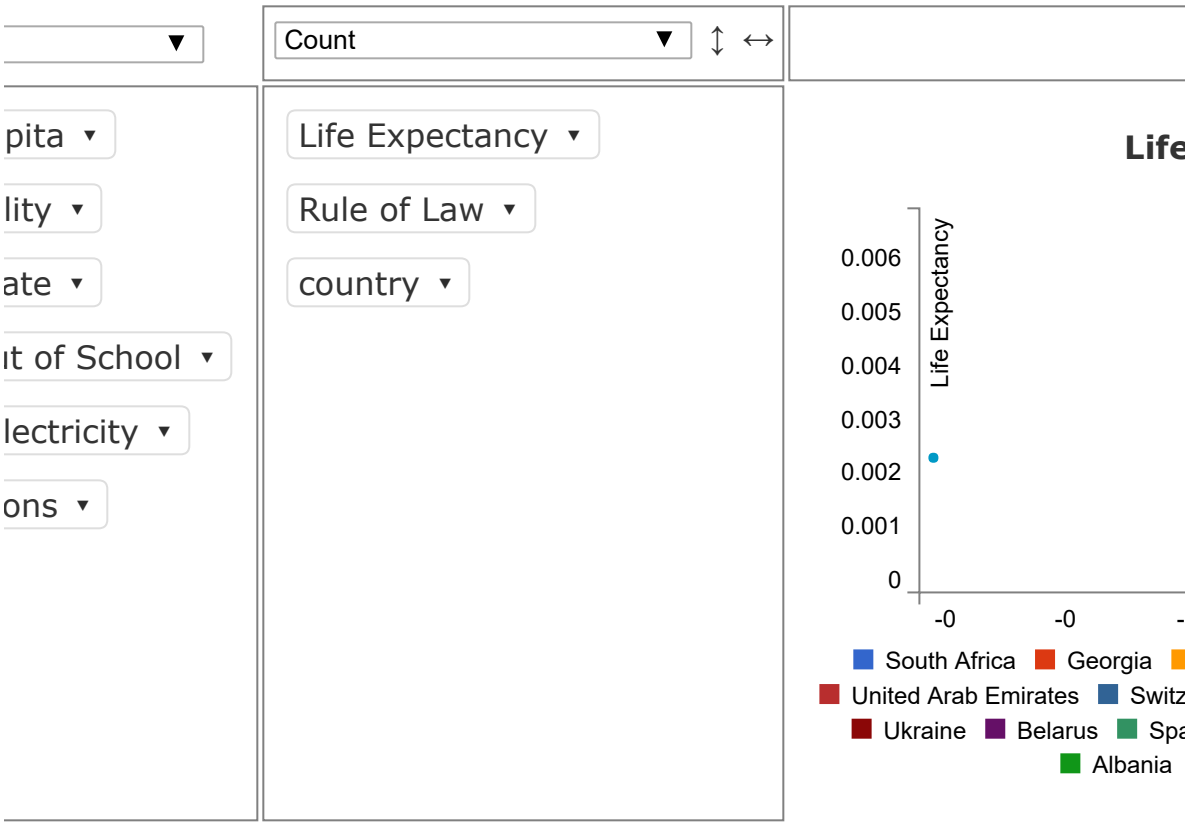
country	Rule of Law	Control of Corruption	Government Effectiveness	Political Stab
Albania	0.00970703	0.0108303	0.0159645	0.0178
Algeria	0.0165566	-0.000964922	0.0199913	0.0332
Azerbaijan	0.018979	0.0188853	0.0166286	0.00825
Belarus	-0.00136622	0.00218568	-0.00283953	0.00181
Bosnia and Herzegovina	0.00136249	-0.000941434	0.0249343	0.0145
Brazil	0.00408377	-0.0076671	8.89881e-05	0.00348
Canada	0.00316878	-0.00244345	0.000237301	-0.000872
China	0.00360728	-0.00174399	0.0150926	-0.0108
Denmark	0.00343451	0.000186999	0.000776664	-0.00737
France	-0.000126271	0.000988695	0.00219656	-0.0105
Georgia	0.0428787	0.0676269	0.0262655	0.0471
Germany	0.00324651	-0.000849363	8.82315e-05	-0.0056
India	-0.00798592	-0.00124438	-0.00223167	-0.00113
Italy	-0.0117706	-0.00905833	-0.00835074	-0.011
Japan	0.00354744	0.00708577	0.0130398	-0.00302
Mexico	0.00878535	-0.00744505	-0.000596231	0.00238
Moldova	-0.0030408	-0.0124196	-0.0051682	-0.00388
Morocco	-0.00617762	-0.00381345	0.000688579	-0.00611
Russian Federation	0.00169139	0.00492546	0.00860149	0.00891
Saudi Arabia	0.000373172	0.00566035	0.00867274	-0.0024(

country	Rule of Law	Control of Corruption	Government Effectiveness	Political Stab
South Africa	0.00199997	-0.0156677	-0.0119119	0.00573
Spain	-0.00726624	-0.00822405	-0.00658206	0.00134
Switzerland	0.000788879	0.00200083	0.00445188	-0.000760
Turkmenistan	0.00635998	-0.0122639	0.0113971	-0.0075
Ukraine	0.00106914	0.00445115	0.00729194	-0.0882
United Arab Emirates	-0.000634131	0.0219579	0.0101792	-0.00320
United Kingdom	0.00340337	-0.00308526	-0.00333693	-0.00986
United States	0.0015105	-0.00272653	-0.000797068	-0.00602
Uzbekistan	0.00462746	-0.0023336	0.0202759	0.00725
Venezuela, RB	-0.0609952	-0.0220661	-0.0239455	-0.00845

Already, we see very little growth in governace indicators over the 18 year period examined. Almost all values can be rounded to zero.

In [104]:
```
# combine Rule of Law indexes with Development indicators in a dataframe
RLgrowth_df = govgrowth_df.drop(govgrowth_df.columns[[1, 2, 3, 4, 5]], axis=1)
combined_df2 = pd.concat([RLgrowth_df, devgrowth_df], axis=1)

# plot Rule of Law against Development indicators by country
pivot_ui(combined_df2, rows = ['Life Expectancy', 'Rule of Law', 'country'], rend
```

Out[104]:



The data is much more clustered vertically! Why? Because governance indicators are *much* less volatile than development indicators over the 18 year period examined. Even so, the graph of Rule of Law Index growth vs. Homicide Rate growth shows a remarkable correlation.

Pearson Standard Correlation Coefficient, All Countries

In [105]:
```
combined_df2 = combined_df2.corr()
combined_df2 = combined_df2.drop(combined_df2.index[[1, 2, 3, 4, 5, 6, 7]])
combined_df2 = combined_df2.drop('Rule of Law', 1)
combined_df2
```

Out[105]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate	Children Out of School	Access to Electricity	CO2 Emissions
Rule of Law	0.160174	0.040357	-0.3139	-0.621126	0.029467	-0.097809	-0.130703

The Pearson Coefficients confirm the highest association between growths of Rule of Law and Homicide Rates.

In [106]:
```
combined_df2_byWESP = pd.concat([RLgrowth_df, devgrowth_df, WESPdf], axis=1)

# change index to WESP classifications
combined_df2_byWESP = combined_df2_byWESP.set_index('WESP Classification')

# plot Rule of Law against Development indicators, indexed by country classificat
pivot_ui(combined_df2_byWESP, rows = ['Life Expectancy', 'Rule of Law', 'WESP Cla
        rendererName='Scatter Chart')
```

Out[106]:

Coding the graph by UN WESP category shows that the relationship between governance growth

and development growth is much less existent for Developed Economies. We actually see the most association in the middle WESP category (Economies in Transition), aka the lower sect of the Rule of Law Index range.

Pearson Standard Correlation Coefficient, Developing Economies

In [107]:
```
# sort combined dataframe by WESP classification
combined_df2_byWESP = combined_df2_byWESP.sort_index(axis=0, kind='mergesort')
combined_df2_byWESP

# separate Developing Economies into own dataframe (for purposes of regression an
developing_df2 = combined_df2_byWESP.drop(combined_df2_byWESP.index[[0, 9]])
developing_df2 = developing_df2.drop(developing_df2.index[[10,19]])

developing_df2 = developing_df2.corr()
developing_df2
developing_df2 = developing_df2.drop(developing_df2.index[[1, 2, 3, 4, 5, 6, 7]])
developing_df2 = developing_df2.drop('Rule of Law', 1)

# wrap text by setting column width
developing_df2_styled = developing_df2.style.set_table_styles([dict(selector="th"

developing_df2_styled
```

Out[107]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	-0.261881	0.198559	-0.282105	-0.872291

Pearson Standard Correlation Coefficient, Economies in Transition

In [108]:
```
# separate Economies in Transition into own dataframe (for purposes of regression
transition_df2 = combined_df2_byWESP.drop(combined_df2_byWESP.index[[0,19]])

transition_df2 = transition_df2.corr()
transition_df2 = transition_df2.drop(transition_df2.index[[1, 2, 3, 4, 5, 6, 7]])
transition_df2 = transition_df2.drop('Rule of Law', 1)

# wrap text by setting column width
transition_df2_styled = transition_df2.style.set_table_styles([dict(selector="th"

transition_df2_styled
```

Out[108]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.315228	-0.446263	-0.404733	0.753655

On average, the correlations between growth rates from 1996-2014 are most significant for the

middle UN WESP category (Economies in Transition), which on average exhibited the lowest Rule of Law indices in 1996. This is in line with the trend we saw when anlayzing 1996 governance levels with 1996 development levels (IV. LEVEL 1 ANALYSIS: Governace Level (1996) vs. Development Level (1996)).

Pearson Standard Correlation Coefficient, Developed Economies

In [109]:
```
# separate Developed Economies into own dataframe (for purposes of regression ana
developed_df2 = combined_df2_byWESP.drop(combined_df2_byWESP.index[[19,29]])

developed_df2 = developed_df2.corr()
developed_df2 = developed_df2.drop(developed_df2.index[[1, 2, 3, 4, 5, 6, 7]])
developed_df2 = developed_df2.drop('Rule of Law', 1)

# wrap text by setting column width
developed_df2_styled = developed_df2.style.set_table_styles([dict(selector="th",p

developed_df2_styled
```

Out[109]:

	GDP Per Capita	Life Expectancy	Child Mortality	Homicide Rate
Rule of Law	0.0197092	-0.339341	0.586427	0.345269

VII. Conclusions and Limitations

As anticipated, we observed positive (relative to indicator, for example: a negative correlation with homicide rates) correlations between governance indicators and devlepment indicators at all stages of analysis, with the strongest correlations occuring on a level vs. level comparison of Governance Indicators and Development Indicators in 1996.

However, we observed vast spreads in data caused by key limitations to data collection. Namely, the World Bank's catalog of Worldwide Governance Indicators, or that which is publicly available, only dates back to 1996. For simplicity, this study primarily focused on Rule of Law Indices as a measure of governance. This is a relatively recent measure, first used by the World Justice Project. Even this data source does not have measures of governance preceding the decades of this examination, again, at least not publicly available.

In describing the methodology for country selection used, we mentioned the disinclusion of crisis-affected areas to avoid volatility in social and economic indicators. Particularly, we wanted to avoid using data that included volatility unrelated or unpredicatble by governance levels. If data on governance levels was available for a larger period of time, however, examining these countries specifically in the time periods during and post-crisis could provide insight into the long term impacts of governance on a country's ability to withstand crisis. Or, inversely, we this examination might show amplified effects of crisis on governance.

An important observation was the heightened correlation between measures of governance and measures of development for countries that began with lower Rule of Law Indices in 1996. Yet, when contrasted with the lack of governance growth seen across the board over an almost two decade period, we might conclude: perhaps, the countries that would benefit most from improved governance are the ones who are most unable to acheive higher governance - pre-existing instability creates a cyclical exchange with poor social and economic health and ineffective governance. Given governance data spanning a larger temporal frame, it may be interesting to examine the development growth rates for countries who may have experienced large governance growth. Unfortunately, no countries over the time period of available date showed any remarkable governance growth.

Consistently throughout the data, we saw a relationship between Rule of Law and development that held despite the inconsistencies between Rule of Law and WESP classifications, specifically on the lower end of WESP-classified development. This raised an unanticipated question about the effectivenses of WESP classifications as a measure of social, economic, and governance development.

Lastly, our findings showed a more consistent degree of correlation for all countries between governance and development than wealth and development, on a level vs. level basis (LEVEL 1 ANALYSIS: Governance Level (1996) vs. Development Level (1996)). Despite level of development (as classified by WESP) or level of wealth (quantified by GDP per capita), the Rule of Law Index showed a consistent association between governance and wealth. This offers potential for an analysis of the role and degree of role of governance in overall national production (For example, arguing for or against the inclusion of governance and/or the Rule of Law as a measure of Total Factor Productivity assuming the Cobb-Douglas Production Function).

VIII. Bibliography

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