Research Professional [redacted] Evaluation Assignment

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April 11, 2024

1 Introduction

This report is submitted to fulffill the requirements of Evaluation Assignment for the position of a Research Professional under Professors [redacted] Section 2 answers questions 1 to 3 and sections 2 and 3 answer question 4 summarising the research papers attached with the task

2 Empirical Exercise

2.1 Allowance shortfalls (year 2020)

Allowance shortfall by an installation i for the year 2020 is defined as $\frac{E_{i,2020}-F_{i,2020}}{E_{i,2020}}$ where $E_{i,2020}$ is emissions in ton of CO_2 in year 2020 and $F_{i,2020}$ is number of allowances allocated for free for the same year. Total number of installation units for the year 2020 is 10671 out of which 613 units did not emit any $CO2$. The descriptive statistics in the tables below excludes all such units because allowance shortfall will be undefined for them (division by zero).

Range of Allowance Shortfall	# of installation units
1	1672
[-1,1)	7317
[-2, -1)	280
$(-\infty, -2)$	789
Total Units	10058

For the illustration to be meaningful, I only take units whose shortfall lies in the range $[-1, 1)$. The histogram in figure 1 depicts 72.75% of the operating units that year.

Allowance shortfall is percentage emissions emitted in excess of the allowances that it got for free. Shortfall of one means that it did not get any free allowances; there are 1672 such units and are excluded from the distribution. Having a positive shortfall means that the unit have exceeded its emissions allowance and needs to purchase from the market or the regulator to compensate. By definition and assuming profit making behaviour of units, no unit would have shortfall greater than one. To keep the distribution symmetric, I have chosen its range to be $[-1, 1)$ which explains 87.25% of the remaining units. From the distribution, it is clearly visible that most of the units are exceeding their allowances. The distribution is increasing (on average) in the left half. There are two peaks : one is 0.21 and the other one is 0.82 (see figure 2). These two peaks might depict two different

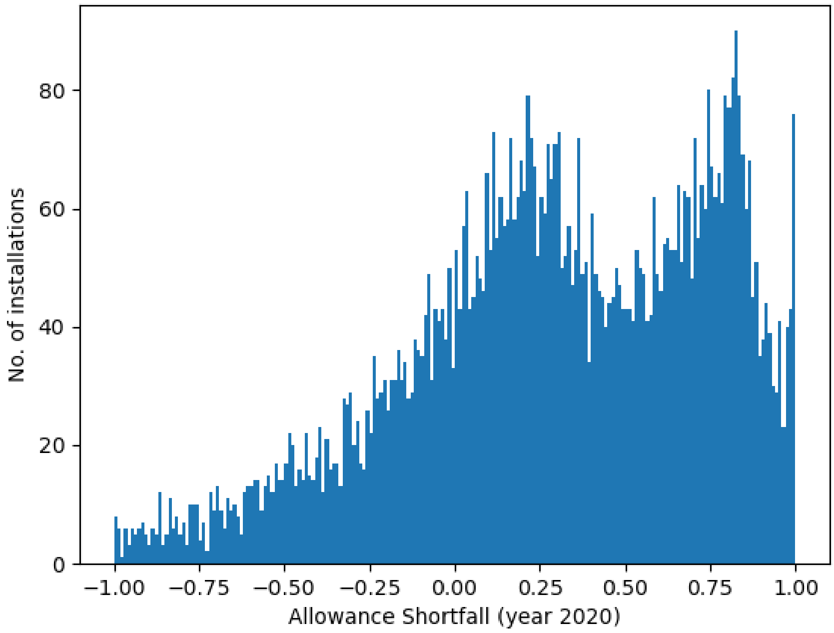

Figure 1: Distribution (histogram) of allowance shortfalls of installation units in the year 2020

countries with significant population of units. In such a case, one country(0.21) would be more climate friendlier than the other one(0.82).

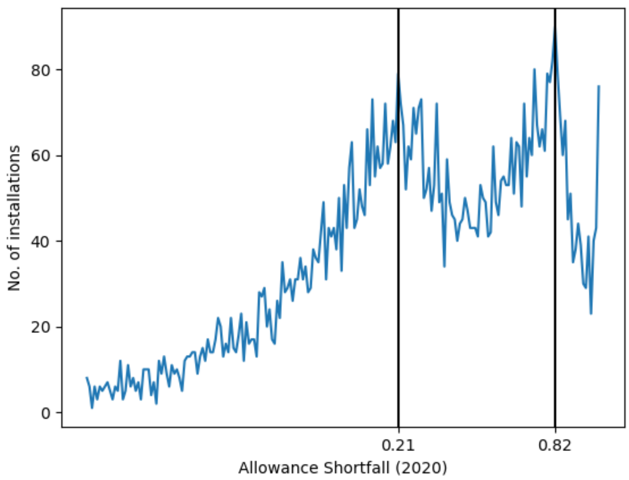

Figure 2: Distribution (curve form) of allowance shortfalls of installation units (2020)

2.2 Scatter Plot

There are 21 countries whose aggregate shortfall in the year 2013 is greater than 20 millions tons of CO_2. Table below lists the countries in descending order of their aggregate emissions.

Country	CO2 Emissions (in millions tons)	Country	CO2 Emissions (in millions tons)
Germany	489.74	Bulgaria	32.94
The UK	231.72	Finland	32.37
Poland	206.35	Austria	30.82
Italy	166.78	Norway	26.78
Spain	125.97	Portugal	25.84
France	118.66	Ireland	23.36
The Netherlands	89.15	Sweden	22.86
Czech Republic	68.13	Denmark	22.16
Greece	59.37	Slovakia	21.85
Belgium	46.38	Hungary	20.23
Romania	42.89	-	-

Scatter plot of country-level aggregate shortfall of allowances in the year 2013 and the growth rate of emissions between year 2013 and 2020 is in figure 3.

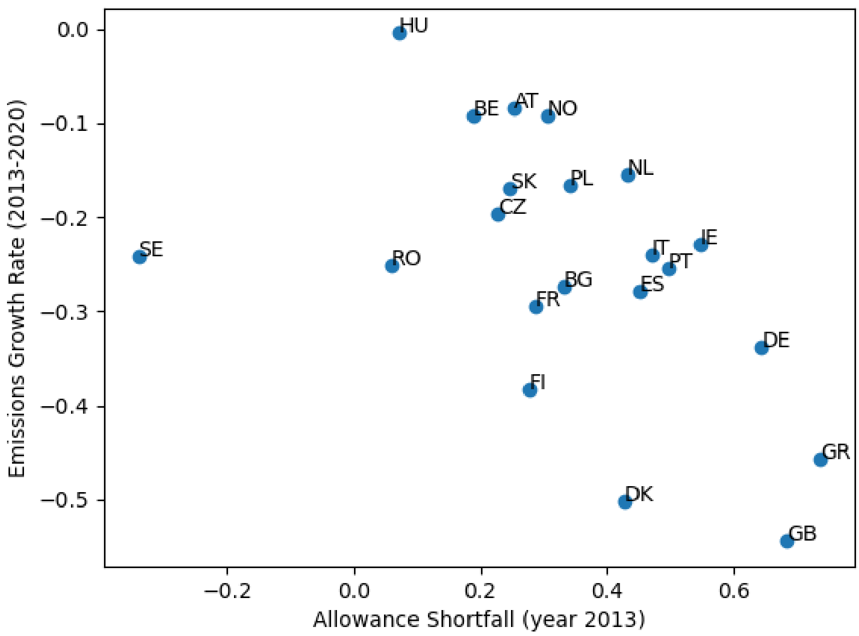

Figure 3: Scatter plot of allowances shortfall (2013) and emissions growth rate (2013-2020)

2.3 OLS

I now estimate the OLS based on the data from scatter plot (see appendix A for regression data). Estimating the OLS is equivalent to finding a line of best fit such that vertical distance between the line and the points is minimized. The OLS equation is given by $\text{EmissionGrowth}_{\text{i, 2013-2020}} = \alpha + \beta\text{Shortfall}_{\text{i, 2013}} + \epsilon_i$ where ϵ_i is the vertical distance between the line and the points; also known as residual error in the econometric parlance. Line of best fit is illustrated along with the scatter plot in figure 4. Emission growth rate should be understood as how fast the country transitioned to adopt climate friendly policies by reducing the emissions between 2013 and 2020. All the countries were able to reduce the emissions albiet, Hungary kept the emissions level more or less the same (its growth rate is -0.44%). Allowance shortfall is the percentage of emissions emitted more than it was allowed for that year. The coefficient of the OLS (β) clearly supports the fact that the cap and trade system implemented by EU facilitated faster transition of countries towards adoption of climate friendlier practicies. It shows that countries having higher shortfalls in 2013 reduced their emissions more (between 2013 and 2020) in percentage terms. The results of the regression are detailed in the table below.

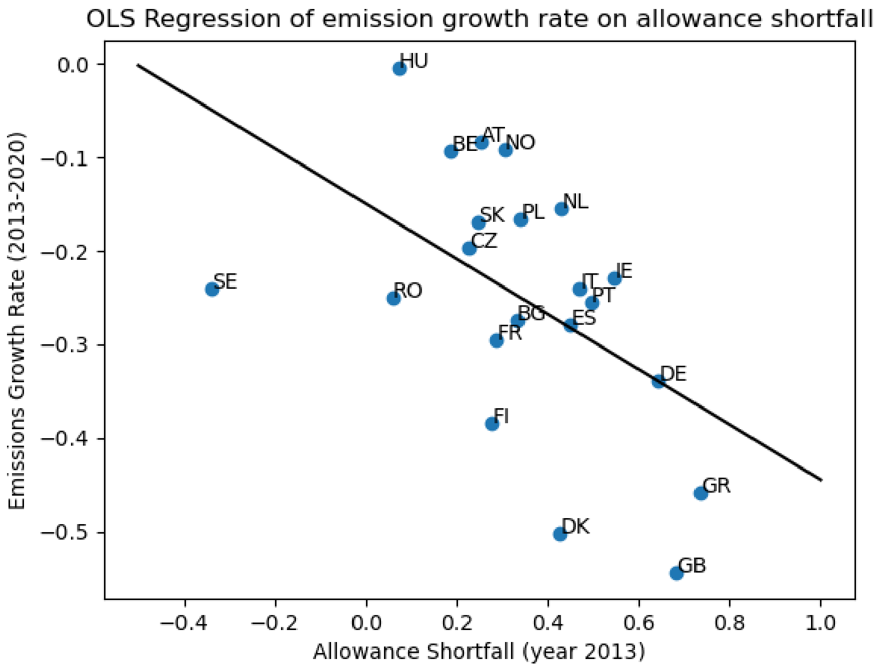

Figure 4: Line of best fit (using OLS)

Table 1: OLS Regression Results

Dep. Variable:	$\text{EmissionGrowth}_{\text{i, 2013-2020}}$	**R-squared:**	0.260
Model:	OLS	**Adj. R-squared:**	0.221
Method:	Least Squares	**F-statistic:**	6.662
No. Observations:	21	**Prob (F-statistic):**	0.0183
Df Residuals:	19	**Log-Likelihood:**	15.328
Df Model:	1		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
α	-0.1496	0.047	-3.173	0.005	-0.248	-0.051
$\textbf{Shortfall}_{\textbf{i, 2013}}$	-0.2948	0.114	-2.581	0.018	-0.534	-0.056

Notes: Standard Errors assume that the covariance matrix of the errors is correctly specified.

Looking at the scatter plot closely, it can be observed that Sweden (SE) is an outlier in two sense - first, it is the only country which has negative shortfall in 2013 and second, it lies away from the trend line and group of other countries. To make the regression better, Sweden has been removed from the data and the same regression is run and the plot is in figure 5 and results are presented in the table below. Indeed, the regression has become better both visually and numerically. R-squared value has increased from 0.26 to 0.43 and the coefficient on $\text{Shortfall}_{i,\,2013}$ has also considerably increased (in absolute sense) giving a better estimate of the effect of EU's cap and trade system. Last thing to comment is that countries lying below the line of best fit have done better than the average in terms of reducing their emissions (% terms).

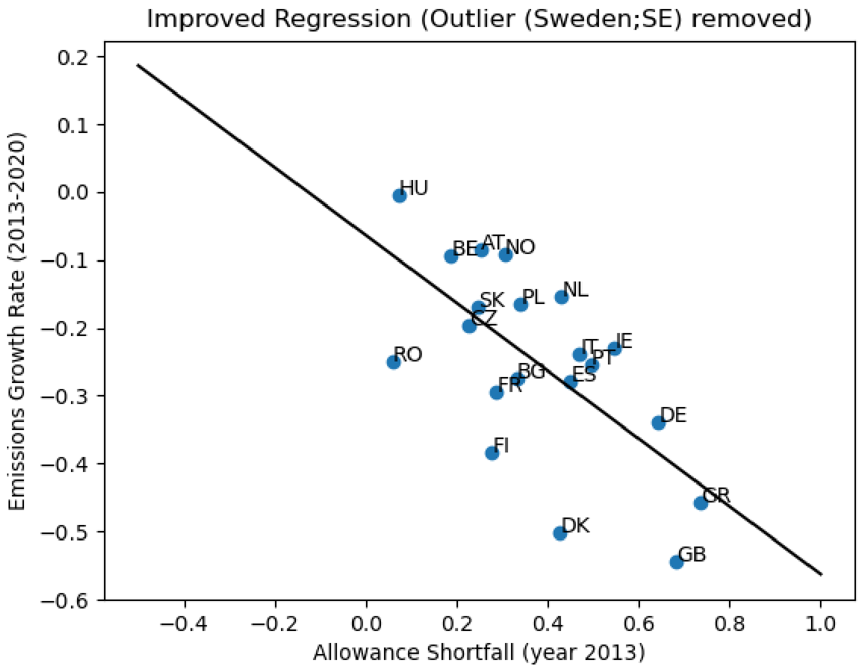

Figure 5: Line of best fit (using OLS)

Table 2: OLS (outlier removed) Regression Results

Dep. Variable:	$\text{EmissionGrowth}_{i,\,2013\text{-}2020}$	**R-squared:**	0.432
Model:	OLS	**Adj. R-squared:**	0.400
Method:	Least Squares	**F-statistic:**	13.68
No. Observations:	20		
Df Residuals:	18		

	coef	**std err**	**t**	**P> |t|**	**[0.025**	**0.975]**
α	-0.0635	0.056	-1.131	0.273	-0.182	0.054
$\textbf{Shortfall}_{\textbf{i, 2013}}$	-0.4994	0.135	-3.698	0.002	-0.783	-0.216

Notes: Standard Errors assume that the covariance matrix of the errors is correctly specified.

3 *Summary of* "Long-run returns to impact investing in emerging markets and developing economies"

This is an empirical paper that tests the claim that impact investing is adding to social welfare by making sure that capital reaches commercially viable projects that would otherwise have failed to secure funding. The authors make use of data on equity investments by the International Finance Corporation (an impact investor and a member of the World Bank Group). The authors selected this dataset because of its extensive history (up to 1961), to avoid selection bias (like survivorship bias), which is usually found in other similar datasets, and because of its diversified portfolio, which includes very poor countries.

3.1 About the Data

The IFC data comprises cash flows to and from 2509 equity investments starting in 1956 (actually 1961) until June 30, 2019. The dataset has the month of cash flow, the value of cash flow in USD, and the latest mark-to-market valuation of the investments still held in portfolios. Each investment has been assigned a "vintage year"—the year of first cash flow to the company. Each company has been assigned one of the 23 sectors and a "country of risk"—where the company generates its maximum revenue. Cash flows are divided into distributions and contributions to calculate the PME (public market equivalent) using the Kaplan and Schoar (2005) formula. They use S&P 500 Index as a market reference to calculate the realized total return of the market index in the PME formula. PME is a proxy for returns from investments. It also makes sure that returns across time can be compared and investment-specific risks are normalized. They also extract tertiary data for country characteristics such as -

1. Market size - Population and GDP per capita from World Development Indicators
2. Market (financial) openness - Index from Chinn and Ito (2006,2008) and data derived from IMF's Annual Reports
3. Sovereign risk - many indices some of which are political risk index of the PRS group, economic freedom index by the heritage foundation and ease of doing business distance to frontier measure
4. Financial Development - private sector credit to GDP, and stock market capitalization to GDP from Global Financial Development Database (World Bank)
5. Other variables - real GDP growth, inflation, local currency depreciation, central government debt as share of GDP, and sovereign debt rating index (by Oxford economics)

3.2 Regression Specification

The authors use the basic regression of the form: $r_i = r_0 + X'_{c(i)}\beta + \epsilon_i$, where r_i is the risk adjusted return of asset i, r_0 is the average return on all assets, and $X_{c(i)}$ has characteristics of the country c where the investment was made. Their focus is on β. If it is not zero, then markets are considered to be segmented. The idea of impact investing exists because there is a general notion that frictions exist that prevent capital flows across markets. Impact investors (such as IFC itself) try to invest to make sure that capital reaches even when projects fail to receive financing that are otherwise commercially viable. The test of whether β is zero or not essentially tries to assess the usefulness of impact investing.

Authors modify the basic regression equation to include time effects and sector-specific effects as follows - $PME_{it} = \tau_t + \alpha_{s(i)} + X'_{c(i)}\beta + \epsilon_{it}$ where t is the vintage year, $s(i)$ and $c(i)$ are the sector and country in which the investment is made. τ_t represents time fixed effects which captures variation in capital price not explained by S&P 500 index. and $\alpha_{s(i)}$ is sector fixed effects. Here also $\beta = 0$ signifies that markets are perfectly integrated and $\beta \neq 0$ signals otherwise.

3.3 Results

The authors use the basic regression model and also the quantile regression model in various ways (using only year effects, using both effects, or using a subset of observations) to check for market segmentation by factors like market size, financial openness and development, and alternative risk factors. From the analyses, it is found that higher returns are generated from investments made in more populous countries; all the coefficients are negative when including factors of financial openness and development, but only the coefficient on stock market capitalization to GDP ratio is statistically significant; and there is weak evidence that various risk measures are negatively associated with returns.

Next, they use the modified regression to see how returns vary with various macroeconomic variables (at the time of investment) and find that there is less significant association with investment performance, whereas changes in macro-variables over the life of investment predict the investment performance well. They also tested the association between financial returns and investment duration and found it to be positive at statistically significant levels.

3.4 Conclusion

Using the data and the regressions, authors categorize their findings in the following ways

1. Macroeconomic conditions (ex-post i.e. after investment) has considerable effect on returns. Authors look at real GDP growth, local currency depreciation, local inflation, and soveriegn risk.

2. Economic covariates (such as population, measures of capital controls, and banking system) measured at the time of investment predict the performance of investment to statistically significant levels.

3. IFC achieves competitive returns over the long run when compared to S&P 500 index (PME = 1.15) but the returns have been lower in the latest decade (PME =0.7).

4 *Summary of* "The Allocation of Socially Responsible Capital"

The authors develop a game-theoretic framework to study how competition between investors to own socially valuable assets affects social welfare. From the model framework, they conclude that the nature of social preferences will decide whether investors and firms will match assortatively (assortativeness means like-mindedness or similar characteristics) or not. They use the model to argue that values-aligned investing is inefficient for the purpose of creating social value. Their main empirical finding is that "socially guided mutual funds allocate their capital inefficiently from the perspective of generating both impact and financial returns".

4.1 Results from the framework

Values-aligned investors care about the financial returns and social value generated by the firms in which they invest. On the other hand, impact-aligned investors care about total social welfare while making investment decisions. They "derive utility equally from all social output, regardless of who financed it". The key assumption of the model is the difference between the utility functions of the two kinds of investors. The authors analyze the framework in different settings: 1) all social investors are values-aligned (here it is found that "social investors with relatively higher altruism have a relatively higher willingness to pay per unit of social value of a given enterprise"), 2) all social investors are impact-aligned (here they find that "impact-aligned investors don't finance commercially viable entrepreneurs regardless of their social value"), and 3) both kinds of investors exist (here they found that the results from the previous two cases remain true).

They show that "values-aligned social investors and entrepreneurs exhibit positive assortative matching," whereas there is negative assortative matching between impact-aligned investors and entrepreneurs. In other words, investors who care more about social welfare match to entrepreneurs who create less social value. Contrary to popular opinion, "competition between social investors generates a financial concession that is wasteful from the perspective of generating impact".

4.2 Empirical finding

To judge the strategies of social investors, authors present empirical evidence from the portfolio data of 1,870 US equity mutual funds, of which 82 are classified as sustainable. They find that "sustainable mutual funds hold companies that have a higher return on assets—their proxy for profitability.". By plotting the "portfolio weighted average ESG score (an indicator of sustainability) and return on assets of mutual funds in their sample, sustainable mutual funds appear to act as if they are values-aligned". Moreover, "sustainable mutual funds (on average) do not invest in companies that are less profitable".

4.3 Conclusion

"One fundamental message of their paper is that investors who care about impact should not pay a premium to make investments that could have been financed by any investor less interested in social impact. In their model, values-aligned investment strategies lead to exactly such a premium."

A Regression data

Country ID	Emissions growth(2013-20)	Allowance shortfall (2013)
AT	-0.084	0.253
BE	-0.093	0.188
BG	-0.274	0.332
CZ	-0.196	0.227
DE	-0.338	0.643
DK	-0.502	0.427
ES	-0.279	0.451
FI	-0.383	0.277
FR	-0.294	0.287
GB	-0.544	0.684
GR	-0.457	0.737
HU	-0.004	0.072
IE	-0.229	0.547
IT	-0.240	0.470
NL	-0.155	0.431
NO	-0.093	0.306
PL	-0.166	0.341
PT	-0.254	0.496
RO	-0.251	0.059
SE	-0.241	-0.339
SK	-0.169	0.246