Thesis Proposal: International cooperation and technological change

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1 Introduction and Motivation:

Climate change occupies a central place in the contemporary social discourse as becomes apparent by opening any major daily newspaper. The 16th of February 2022 was no different, the front page of the Financial Times titled "Biden's petrol problem: president eyes gas tax cut as pump prices soar" (Brower and McCormick 2022) reporting on potential gas tax cuts in contradiction with Biden's electoral promises. This example highlights the fact that climate change is at the center the political debate at the national and the international level. The motivation for this thesis originated from the Stern Review which dedicates two chapters on technological innovation and international cooperation for technological innovation (Stern, Stern, and Treasury 2007) as well as the work I am undertaking on international treaty networks for Prof. Holloway. While the Stern review provides readers with a good introduction into the complementary nature of national and international technological policy with respect to other measures such as carbon pricing, I am interested in investigating empirically the impact of the structure of the international environmental governance complex on innovation outcomes such as patent applications and patent citations.

2 Litterature review, research question and methodology:

My tentative research question can be therefore stated as follows:

Does international environmental regulation serve as a credible commitment tool for governments to set policy expectations of firms when making eco-innovation decisions?

To the best of my knowledge, there are no similar empirical analyses of the impact of the structure of the international environmental governance complex on technological innovation. However, there exist two complementary strands of literature in political science and innovation economics that could be bridged by this thesis to answer the question at hand. The political science part of the literature uses network analysis techniques to understand the structure of multimodal networks of international agreements and is interested in how political actors make choices in such a network (see Knoke et al. (2021)). An example of this could be the determinants of the choice of a country to join a multilateral environmental agreement for instance. While these networks are multimodal in nature (e.g. countries are not directly connected with each other but are signatories to a given treaty), I plan on using a one-mode country projection of the network of international environmental agreements thereby reducing its complexity. I would then extract centrality measures from this one-mode projection for each country and compute yearly averages. Naturally, depending on the scope of the analysis, the breath of the network will need to be adjusted since firms active in the energy sector will not see fisheries regulation as relevant to their R&D decisions. A similar adjustment will need to be made when considering which countries to include in the panel (contingent on data availability).

The second strand of literature I considered relevant is the literature on the economics of climate change and the economics of innovation, with a particular focus on eco-innovation. The central issue facing

policy-makers trying to mitigate the effects of emissions is one that is characterized by the dual environmental and knowledge externality. This dual externality leads to both an underprovision of environmental quality and an underprovision of knowledge to counteract the first market failure. Starting with a macro-perspective, one can find substantial simulation exercises that highlight the complementary role R&D plays with marked based approaches such as carbon pricing (Acemoglu et al. 2012; Bosetti et al. 2009). Acemoglu et al. argue for instance that a combination between carbon prices and subsidies to mitigate both externalities respectively is less costly than isolated policy strategies. Furthermore, when taking a more micro-economic point of view, one can find extensive evidence on the impact of environmental policy on incentivizing innovation (Veugelers 2012). The main body of this subset of the environmental innovation literature focused on the relationship between a proxy for environmental policy stringency and the an innovation proxy (patent applications and citations or R&D expenditures). The evidence from these studies suggests a positive link between environmental policy stringency and rates/quality of innovation e.g. Porter's hypothesis (see Veugelers (2012) and Martínez-Zarzoso, Bengochea-Morancho, and Morales-Lage (2019) for more recent evidence on OECD countries). However, none of the readings I was able to cover analyse the effect of the changing structure of the international environmental policy complex (i.e. the countries within this complex) on these innovation measures. The main idea here being to test whether more embedded countries generate a greater innovative output than less embedded ones due to their increased "international credibility" making their policy commitment more credible and increasing the expected stringency of environmental policy.

As hinted in the literature review above, the methodology will take the form of a panel model in which the main variable of interest will be a node/country level measure of "embeddedness" in the international environmental governance network. The main dependent variable will be a set of proxies for innovative activity in a given country such as patent counts or R&D expenditures. For validation, I will also try to include the Community Innovation Survey data or any similar but more aggregate data into the regressions to validate the results.

3 Data:

This subsection will strive to give a preliminary overview of the data I plan on using to answer the research question stated above and provide the reader with a descriptive `{skimr}` snapshot.

3.1 Policy network data:

You can find the descriptive snapshots of the International Environmental Agreements and the Ecolex databases for 1980 to illustrate the network data. Each observation in this dataset links a country to a treaty and gives additional information about their connection such as the nature of the treaty (bilateral or multilateral), its ratification status, the date of signature/ratification/exit, etc.

The main challenge I foresee with this data is to correctly map the scope of the network to take into account when constructing the relevant network measures as my variable of interest. Since I will focus primarily on the energy sector, I will need to detect whether the main focus area of a given treaty is indeed the energy sector. This will likely go beyond the metadata presented here and involve some level of text analysis on the actual agreements.

Table 3.1: Data summary

Name	membership_1980IEADB
Number of rows	171
Number of columns	13

Column type frequency:	
character	12
numeric	1
Group variables	None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
many_ID	0	1.00	12	18	0	50	0
CountryID	0	1.00	3	6	0	80	0
Title	0	1.00	16	159	0	52	0
Beg	0	1.00	10	10	0	96	0
End	165	0.04	10	10	0	3	0
SignatureC	60	0.65	10	10	0	50	0
Signature	0	1.00	10	10	0	48	0
Rat	34	0.80	10	10	0	121	0
Force	0	1.00	10	10	0	104	0
L	0	1.00	1	1	0	2	0
treaty_ID	0	1.00	12	18	0	51	0
year	0	1.00	4	4	0	1	0

Variable type: numeric

Table 3.3: Data summary

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
IEADB_ID	0	1	2686.76	809.79	596	2800	2911	2914	4787	

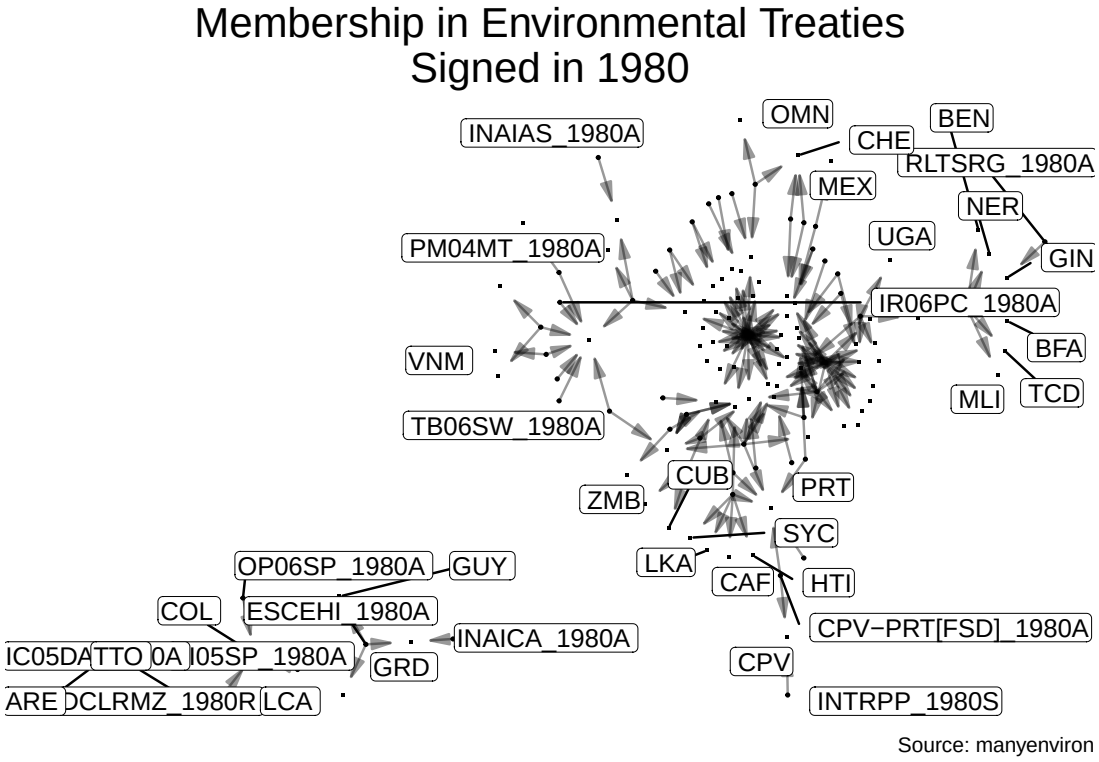
Name	membership_1980ECOLEX
Number of rows	288
Number of columns	11
Column type frequency:	
character	11
Group variables	None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
many_ID	0	1.00	12	29	0	63	0
CountryID	0	1.00	3	3	0	109	0
Title	0	1.00	20	269	0	65	0
Beg	0	1.00	10	10	0	141	0
End	279	0.03	10	10	0	9	0

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
SignatureC	158	0.45	10	10	0	50	0
Force	14	0.95	10	10	0	160	0
Rat	21	0.93	10	10	0	208	0
ECOLEX_ID	0	1.00	10	10	0	65	0
treaty_ID	0	1.00	12	29	0	63	0
year	0	1.00	4	4	0	1	0

Here is a quick illustration of how one can conceptualize the international governance complex as a bimodal network where countries are members of agreements.



3.2 Innovation data:

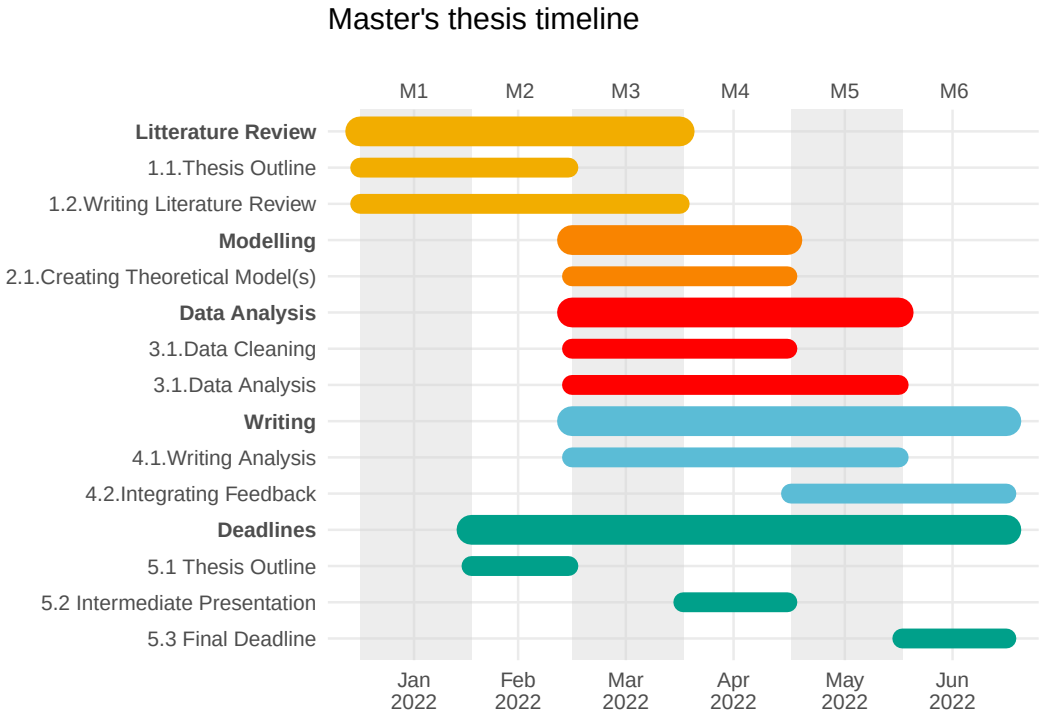
Innovation, being an indirectly measurable economic phenomenon, will be measured with a range of proxies. I plan on using country level patent indicators from the OECD and R&D expenditure as well as their MSTI database. Alternatively, data could be sourced from PATSTAT directly if needed.

4 Format:

I will most certainly use R as the primary data analysis programming language to execute my analysis since I am most familiar with it and since there is a very wide ecosystem of packages for network analysis. This also implies that I will be writing the thesis in R-Markdown using the `{iheiddown}` dissertation template which will neatly integrate the code with the analysis. Furthermore, I will be able to use version control (GitHub) to track changes throughout the thesis writing and data analysis processes which will improve the transparency of the results and ensure academic honesty. To that effect, the repository will be made public before the 15th of June 2022. Note that since my thesis is still in its early stages, the repository is private but I can grant you or my potential second reader early access if you would like to.

5 Schedule:

The following Gantt chart outlines the projected timeline of the thesis by breaking down key tasks into smaller goals. This will allow me to track progress over the course of the coming months and will be updated once a month to reflect eventual changes.



6 Conclusion and feedback:

Thank you in advance for taking the time to read this thesis outline. I would be extremely grateful for any feedback regarding the overall idea, tentative methodology, and the format of the thesis.

7 References:

The references below include the majority of the relevant literature I read to write this outline.

10 Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn, and David Hemous. 2012. "The Environment and Directed Technical Change." *American Economic Review* 102 (1): 131–66. https://doi.org/10.1257/aer.102.1.131.

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