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A LEAST HUMAN-RESTRICTIVE GATT ENVIRONMENTAL MODEL AT THE G-20

1. Introduction

McCarthy[2] discusses different approaches dealing with environmental governance. For him, environmental governance is an increasingly central and urgent challenge to international political economy but it has difficulty theorizing. He finds that the specialists use to sidestep or downplay the significance of the global dynamics of capital accumulation to their arguments. Future work examining the environmental governance would do well to retain a strong focus on states and capital, while remaining open to analyses making use of unfamiliar theoretical framework.

In this paper, we try to follow McCarthy's recommendations. We seek to meet state and capital in environmental governance, recognizing the importance of the unfamiliar approach of the bounded rationality to reach an environmental agreement.

Goals related to environmental governance require long-term environmental policies. Then, we face strong challenges. Sprinz[3] highlights three overarching challenges for research: (i) overcome the time inconsistency problem in practical political life, (ii) whether democracies and decentralized political systems can successfully pursue long-term environmental policies, and (iii) institutional design options to prevent and recover from undesirable outcomes. We focus on the last challenge.

The global environmental governance remains strongly fragmented. Biermann, Pattberg, Asselt and Zelli[4] investigate the global climate governance with focus on the fragmentation of this governance. They conclude that negotiations leading to future agreements should address topics—such as deforestation, technology transfer, or capacity building – in only one forum. Also, they argue that the UN climate regime needs to be better coordinated with non-environmental institutions, such as the WTO.

After Copenhagen Conference in 2010, many questions arise about UN climate process. Dimitrov evaluate that "there is a sharp contrast between multilateral climate governance and "aggregate" climate governance (regional, national, local policies). Today we face two concurrent realities: the UN climate process is seriously damaged, while aggregate climate policy is making significant progress." [5]

Instead UN, we argue for the formation of an agreement under flexible institution, like the General Agreement on Tariffs and Trade (GATT), using initially the G-20 countries[6].

2. GATT and G-20

Our premise is that the GATT provides a good starting point. It was created on 1 January 1948, after the failure to launch an International Trade Organization (ITO). The main problem with the ITO was its far-reaching mandate, even for the present World Trade Organization (WTO). The Geneva Conference (1947) prepared the GATT signed by 23 countries to regulate only tariffs barriers on goods. The GATT, that it is not an international treaty but just a contract with treaty status, provided the basis for the trading system.

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[2] McCarthy, 2007.

[3] Sprinz, 2009,

[4] Biermann, Pattberg, Asselt & Zelli, 2009.

[5] Dimitrov, 2010, p.18.

[6] The Group of Twenty (G-20) Finance Ministers and Central Bank Governors was established in 1999 . The Group attempts to support growth and development, contributing to the strengthening of the international financial architecture and providing opportunities for dialogue on national policies. The G-20 is made up of the finance ministers and central bank governors of 19 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Italy, Indonesia, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the United Kingdom and the United States. The European Union (EU) is the 20th member of the G-20. Besides these countries and the EU, the Group cooperates closely with other international organizations and fora, such as the International Monetary Fund, the World Bank, and the Financial Stability Forum.

Koul[7] asserts that the developing countries tried to confront GATT at the United Nations Conference on Trade and Development (UNCTAD) and New International Economic Order (NIEO) but GATT managed to survive by customizing ingenious doctrines such those that provide special and differential treatment and the "Enabling Clause" that permitted preferential market access to developing countries. Narlikar[8] highlights the flexibility, institutional weakness, cheapness and bias regarding free trade of the GATT. Jackson[9] argues that the WTO has no more real power than that which existed for the GATT under previous agreements.

To deal with challenges involving trade and the environment, the WTO uses GATT principles: i) Non-discrimination. One country cannot use arbitrary and unjustifiable discrimination against products from a specific country; ii) Like products. Trade restrictions cannot be imposed on a product because of the way in which it is produced. Countries cannot impose its standards of production on another country; iii) Least trade-restrictive. Environmental actions must not be more trade-restrictive to fulfil a legitimate regulation; iv) Least GATT-inconsistent. The action must observe if there is no other measure available that it is less inconsistent with GATT.

We look for a self-enforcing environmental agreement with clear principles for the environment, like the GATT was for trade liberalization. We investigate a possible binding agreement among the G-20 countries to establish principles or safe minimum standards with regard to environmental problems.

Firstly, because of the special characteristics of the G-20 which involves the most relevant countries in the world, both developed and developing, whose domestic policies have the economic and political power to influence other countries. Secondly, the level of development of the G-20 countries permits the market-oriented policies to find a relatively stable rule of law and political order. The markets require a certain level of sound, stable legal rules governing their rights and duties regarding carrying out their transactions. Thirdly, we recognize the collective-action problem, whereby small groups have more power to establish and enforce policies. Last but not least, the G-20 members are much more present in all relevant fora, such as the WTO.

Beeson and Bell[10] see that "the G-20 does not mark a fundamental departure from US or group hegemony, but nor should it be understood as simple hegemony by other means…. [They] argue that the G-20 network is helping to produce modified variants of hegemony and collectivism within the system"[11]. Carin and Mehlenbacher[12] discuss how the G-20 could achieve an agreement on the climate change issue. They conclude that it is theoretically possible for a group of twenty leaders to reach a consensus agreement on climate change, provided that the leaders are farsighted about the effects of their decisions, seek opportunities for issue linkage, and give full disclosure about their values and interests. Garrett[13] considers that the institutional innovation of the G20 may well end up being the most important silver lining to the 2008 crisis by creating an institution that charts the course to a better future for the global economy.

Such justifications for using the G-20 allow us to foresee that this group of countries could lead other countries to accept the international environmental standards. The decisions of the G-20 group can represent a huge step towards improving the enforcement of multilateral decisions into domestic. These could be good for the world while preserving democracy and free competition.

In this paper, we do not focus on problems like possible climate change, since we recognize that many environmental problems that have strong domestic and international consequences are unrelated to climate change and remain unsolved. For instance, all over its territory, Brazil faces local environmental problems. The Brazilian Institute of Geography and Statistics (IBGE)[14] showed that of 5,564 Brazilian municipalities, 54.2% presented problems with burning (mainly slash-and-burn agriculture), 53.5% with deforestation, 53.0% with rivers silting up, 42.7% with water pollution and 24.2% with soil contamination. Furthermore, 53.0% of the Brazilian population still lives with untreated sewage. These problems are not related to climate change or to Brazil.

The bottom line is that the development of

[7] Koul, 2005.

[8] Narlikar, 2005.

[9] Jackson, 2000.

[10] Beeson & Bell, 2009.

[11] Idem, pages 68-69.

[12] Carin & Mehlenbacher,. 2010.

[13] Garrett 2010.

[14] IBGE, 2008.

each country depends on its own institutions. The best capital for providing sustainable environment is intangible capital, which includes the judicial system, governance, human capital and social capital. We consider g-20 intagible capital in the next section.

3. The G-20 Intangible Capital

To present the intangible capital of the G-20 countries, we use the governance data from Kaufmann, Kraay, and Mastruzzi[15], called the Worldwide Governance Indicators (WGI) research project. They define governance consisting of the traditions and institutions by which authority in a country is exercised. The WGI covers 212 countries and territories and measures six dimensions of governance: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

The Voice and Accountability captures the extent to which a country's citizens are able to participate in selecting government. Political Stability and Absence of Violence observes the likelihood that the government will be destabilized. Government Effectiveness captures the quality of formulation and implementation. Regulatory Quality reflects the ability of the government to formulate and implement sound policies that permit and promote private sector development. Rule of Law shows the extent to which the agents have confidence in and abide by the rules of society. Control of Corruption observes the extent to which public power is exercised for private gain.

The units in which governance is measured follow a normal distribution, with a mean of zero and a standard deviation of one in each period. All scores lie between -2.5 and 2.5, with higher scores corresponding to better outcomes. The WGI are based exclusively on subjective or perceptions-based data on governance, reflecting the views of a diverse range of informed stakeholders. The WGI are available biannually from 1996 to 2002, and annually from 2002 to 2008.

Using WGI 2010 data, we prepared the Table 1, shown below, with the 2009 scores for each G-20 country for each indicator, from the country with the highest mean (Canada) to that with the lowest (Russia). Also, the Table presents the mean and the worst governance indicators for 2009, as well as the worst indicators for 1996-2009 (the lowest mean for the entire period) for each country.

Among the G-20 countries with higher positions the worst indicator is regularly Political Stability, reflecting the policy changes even in countries with a long well-established democracy. Japan, however, presents fragility in Regulatory Quality, when we consider the 1996-2009 period. Observing the whole group, we see the low governance over the Control of Corruption in Italy and Russia and the low Voice and Accountability indicators in China and Saudi Arabia. The Rule of Law is the worst indicator only for all three Latin American countries in 1996-2009 period.

Now, we carry out panels to observe the relationship between the G-20 governance and economic and development factors. As a development factor, we use the Human Development Index (HDI). It is worth noting that the HDI includes a kind of intangible capital – human capital.

Then, in the panel, besides a trend variable for capturing factor movements in time (@trend), we consider the governance indicators from Kaufmann, Kraay, and Mastruzzi against economic data, from Moody's Statistical Handbook – Country Credit[16] – and HDI, from the United Nations Development Programme's Human Development Report[17]. We use the following 15 variables, being the first seven dependent variables: 1) Voice and Accountability (VA); 2) Political Stability and Absence of Violence (PS); 3) Government Effectiveness (GE); 4) Regulatory Quality (RQ); 5) Rule of Law (RL); 6) Control of Corruption (CC); 7) Governance Worst Indicator (GWI); 8) GDP per capita (US$) – (GPC); 9) Real GDP (% change) – (GRW); 10) Inflation (CPI, % change Dec/Dec) – (INF); 11) Gross Investment/GDP – (INV); 12) Openness of the Economy – (OE); 13) General Government Debt/GDP – (DBT); 14) General Government Primary Balance/GDP – (PRI); 15) Human Development Index (HDI).

We also consider lagged independent variables, but, since perceptions can be related to the past, present and future conditions, lagged variables add complexity to the analysis. Fortunately, the lagged variables are not significant in most cases. But, still, the results are problematic. Every variable presents significance in some test, and some of them change the sign depending on the test.

The only variable that regularly reached significance and always maintained its sign (positive) was contemporaneous General Government Primary Balance/GDP (PRI). This shows that a

[15] Kaufmann, Kraay & Mastruzzi, 2009.

[16] MOODY'S, 2009.

[17] UNDP, The, 2009.

positive PRI, which is the difference between total revenue and total expenditure excluding interest payments on the existing debt, could lead to a better institutional capital, possibly because it indicates that debt is under control, so the policies can focus on governance or investment. The better defined dependent variable is the Rule of Law (RL), which has the highest R-square (99%) and GPC, PRI, INF and DBT were significant.

Below, in the Table 2, we present the number of times each variable was significant and their signs. We can see that PRI was the best indicator

Table 1
Governance Indicators for the G-20 Countries – 2009

	Country	VA	PS	GE	RQ	RL	CC	Mean 2009	Worst Indicator 2009	Worst Indicator 1996-2009
1	Canada	1,44	1,02	1,78	1,64	1,78	2,04	**1,62**	**PS**	**PS**
2	Australia	1,39	0,83	1,74	1,74	1,73	2,03	**1,58**	**PS**	**PS**
3	Germany	1,39	0,85	1,48	1,47	1,63	1,70	**1,42**	**PS**	**PS**
4	United Kingdom	1,31	0,91	1,48	1,54	1,71	1,54	**1,41**	**PS**	**PS**
5	France	1,26	0,55	1,44	1,19	1,43	1,41	**1,21**	**PS**	**PS**
6	Japan	1,03	0,95	1,26	1,07	1,31	1,35	**1,16**	**PS**	**RQ**
7	United States	1,11	0,30	1,39	1,36	1,53	1,18	**1,15**	**PS**	**PS**
8	Korea (South)	0,69	0,21	1,11	0,85	1,00	0,52	**0,73**	**PS**	**PS**
9	Italy	1,04	0,53	0,52	0,90	0,39	0,05	**0,57**	**CC**	**CC**
10	Turkey	-0,12	0,23	0,35	0,31	0,12	0,09	**0,16**	**VA**	**CC**
11	Brazil	0,51	0,29	0,08	0,18	-0,18	-0,07	**0,13**	**RL**	**RL**
12	Mexico	0,13	-0,68	0,17	0,35	-0,57	-0,27	**-0,15**	**PS**	**RL**
13	Saudi Arabia	-1,77	0,22	-0,09	0,22	0,12	0,15	**-0,19**	**VA**	**VA**
14	India	0,47	-1,19	-0,01	-0,28	0,05	-0,33	**-0,21**	**PS**	**PS**
15	South Africa	0,56	0,02	0,51	0,42	0,06	0,10	**0,28**	**PS**	**PS**
16	Argentina	0,25	-0,02	-0,42	-0,90	-0,66	-0,49	**-0,37**	**RQ**	**RL**
17	Indonesia	-0,05	-0,64	-0,21	-0,28	-0,56	-0,71	**-0,41**	**CC**	**PS**
18	China	-1,65	-0,44	0,12	-0,20	-0,35	-0,53	**-0,51**	**VA**	**VA**
19	Russia	-0,95	0,40	-0,28	-0,46	-0,77	-1,12	**-0,53**	**CC**	**CC**

Source: Kaufmann, Kraay & Mastruzzi (2010)

Table 2
Results of the Panel Tests

Variable	No. Times Significant	Dependent Variable	Sign
GPC	5	GWI, VA, RL, RQ, RQ (lag)	negative (GWI,VA) and positive (RL, RQ, RQ-lag)
INF	5	GWI, PS,RL, RQ, VA (lag)	negative (GWI,PS, RL, VA(lag)) and positive (RQ)
HDI	5	PS,RQ, GE, CC, RQ (lag)	positive (PS, GE, CC, RQ(lag)) and negative (RQ)
PRI	5	GWI, PS,RL, GW1 (lag), PS(lag)	positive
INV	3	VA, RQ, CC (lag)	negative (VA, CC(lag)) and positive (RQ)
OE	3	VA, CC, GWI(lag)	negative (VA,CC) and positive (GWI(lag))
INV(lag)	2	VA(lag), RQ(lag)	negative
DBT	2	RL, GWI(lag)	negative
GPC (lag)	1	RQ	negative
PRI(lag)	1	GE(lag)	positive
OE(lag)	1	GWI(lag)	negative
GRW	1	VA	positive
DBT(lag)	1	GWI(lag)	positive

In short, we need better measures of intangible capital. We can say, however, that government balance (PRI and DBT), INF and HDI are good indicators of improvement in the perception of governance. These variables were more resilient to present significance and to keep their signs, observing all the tests.

4. Environmental Agreement Games

In the environmental agreement debate, first of all, we have to assume that countries can do better in terms of their own development if they

cooperate with each other on environmental issues and then there is an incentive to develop cooperation and institutions. Broadly speaking, it is possible to find equilibrium in the strategies of cooperation between countries, if the countries attribute a high value to sustainable development, which means that they use a low discount rate, or if the treaties that establish cooperation change the structure of incentives of the countries.

Barrett[18] assumes that countries can do better when the cooperation between them can be sustained, so they have incentives for developing institutions which can punish uncooperative (free riding) countries. The author analyses, then, the power of a self-enforcing international environmental agreement (IEA) to improve substantially upon non-cooperative results. In his setting, Barrett considered that IEA signatory countries maximize their net marginal benefits, equalizing each country's marginal cost with the collective marginal benefit of the IEA members, while the nonsignatory countries equalize each country's marginal cost with each country's marginal benefit.

The author observes different functional specifications to benefits and costs of the levels of abatement of an environmental pollutant, but in every case the IEAs cannot increase the global net benefits substantially when the number of countries is very large. A self-enforcing IEA only sustains a large number of countries when the difference between the global net benefits under full cooperative and non-cooperative outcomes is small; that is, only when the self-enforcing IEA makes very little effect.

Besides the adoption of collective marginal benefits to the signatory countries' maximization, Barrett uses strong but usual restrictive assumptions in his approach, such as: i) all countries are identical; ii) every country's net benefit function is known by all countries, and know to be known by all countries, and iii) the abatement levels are instantly and costlessly observable. All of these assumptions are relevant in establishing the functional specifications.

Lange and Vogt[19] study the effect of equity (fairness) preferences (incentives) on international cooperation to deal with international environmental problems, like global warming. To try to find equilibrium with cooperation, the utility of the country is not based only on the absolute payoff, but also on the equal share payoff. The results show that the cooperation can cover a larger proportion of countries, but the authors also use stron

We have seen that the number of countries is a relevant aspect of a binding environmental agreement. Ray and Vohra[20] and Thoron, Sol and Willinger[21] were more specific about this problem, dealing with particular sizes of coalition.

Ray and Vohra investigate the formation of binding agreements for providing public goods using the Bargaining Game à la Rubinstein[22]. They focus on coalition formation as a potential source of inefficiency. Their main objective is to establish a complete characterization of the equilibrium coalition structure in a public goods model. While full cooperation is possible, it may not emerge in equilibrium. This means that asymmetric coalitions can exist and provide equilibrium, with the smaller coalition free-riding on the larger one.

They assume common knowledge, complete information, one pure public good (level of pollution control) and identical members. In Ray and Vohra's approach, then, even if the members are identical, efficiency (full cooperation) may not produce equilibrium. They develop what they called the "simplest symmetric structure for public goods provision".

There are n members. Each member produces a pure public good, pollution control, in which the benefits accrue equally to all regions, with z denoting the public benefit and c(z), the cost of providing that public good. The problem facing a coalition with s members is to produce z per member, maximizing the z of the coalition minus the c(z) of the coalition.

The coalitions form sequentially: some member makes its first offer to form a coalition of a specific size or to stand alone; then, some unincluded member makes a second offer of the same type to other unincluded members, and so on until all members are formed into coalitions or singletons. Then, unlike in Barrett, here the cost, c(z), also depends on the coalition, besides the benefits and when a member decides to stand alone, it benefits from the other coalitions' provisions and its cost is only related to its effort.

Ray and Vohra clarify their arguments by an example. They use a quadratic cost function, that is, $c(z) = \frac{1}{2} z^2$. A coalition of sizes s_i will enjoy a payoff per member of:

[18] Barrett, 1994.

[19] Lange & Vogt, 2003.

[20] Ray & Vohra, 2001

[21] Thoron, Sol & Willinger, 2009.

[22] Rubinstein, 1982.

$$\sum_{j=1}^{m} s_j^2 - \frac{1}{2} s_i^2 \qquad (1)$$

Since the authors consider identical members and the absence of intra-coalition transfers, an offer is essentially a proposal regarding the number of partners that a country seeks. We can see that, with only two countries, the first proposer must choose full cooperation since the payoff per member with this efficient equilibrium is 2, while the payoffs per member with the two standing alone is 1.5. However, with four members the equilibrium is one singleton and one coalition involving three countries.

We extrapolated the Ray and Vohra's analysis to observe the different equilibria when there are more members. One important outcome of the model is that a formation of only singletons is never an equilibrium. From 2 to 31 members, the full cooperation efficient result represents an equilibrium within six possibilities: n = 2, 3, 5, 8, 13, 20 and 31. The equilibrium is asymmetric in the remaining twenty-three inefficient possibilities, with some doubts to n equals to 12 or 30, because the full cooperation's average payoffs in these occasions are equal to the smaller coalitions' average payoffs.

Thoron, Sol and Willinger checked Ray and Vohra's game by running an experiment in which the subjects have the chance to sign binding agreements. Their paper gives us an opportunity to include empirical analyses in our search for understanding a binding agreement. Moreover, it is important to us because of our focus on the need for a bounded rationality approach.

Thoron, Sol and Willinger used the same maximization problem of Ray and Vohra, equation (1) above. The experiment involved 63 participants randomly assigned to a group of seven subjects. Their results show the behavioral aspects of the decisions to form coalitions. The coalitions formed in their experiment present strong differences from those indicated by Ray and Vohra that considered identical players.

In short, they show that: i) players seem to simplify the game choosing singletons or full cooperation; ii) players do not play Nash strategies (using a standard rationality to reach a higher possible payoff given the other players' strategies); iii) the outcome from Ray and Vohra of n = 7 (two coalitions, one with 2 players and the other with 5) occurred rarely, depending on the treatment (dictatorial or veto); and iv) the experimental outcome is, on average, even more inefficient than the theory predicts. They conclude that different types of behavior co-exist. This means that we face bounded rationality behavior.

Thoron, Sol and Wiilinger make us suppose that the countries can play a simpler game with only extreme agreements: singletons or full cooperation. The conclusions and questions based on Thoron, Sol and Willinger's experiment also lead us to ask how the GATT was established, since its formation was supposed to counter these difficulties. We can only conclude that flexibility, institutional weakness, cheapness and bias to trade concerns were the basis for developing the GATT. However, environmental policies can be much more intrusive than trade. A relevant environmental agreement, that may be lasting, should observe local public goods besides global ones. It is clear that environmental agreement demands at least environmental standards.

The idea of having standards for environmental problems leads us to the Safe Minimum Standards approach (SMS), defined by Crowards[23] as a supplement to the cost-benefit analysis which places greater emphasis on the protection of the environment wherever the thresholds of irreversible damage are threatened. However, this approach has not met with wide acceptance among environmental economists because, paradoxically, of its strong appeal: uncertainty. Moreover, the SMS is viewed as a command-and-control policy. Let us look for the factors at the core of a typical problem for SMS. To illustrate these, we employ an extensive game, shown in Figure 1.

Society (S) must first choose between building a project that could lead to the extinction of some species. After this first choice, we have two different states of nature (Ω): disease (D) or no disease (ND). This disease may be cured by the species in the future. This is uncertain. After the occurrence of the disease, society has to decide whether to invest in R&D or not. If it had chosen to build the project, R&D is not related to the species (R^p). Society has to search for a different source of cure in another species, in technological improvement, etc. If it had chosen not to build the project, the cure will be achieved through R&D on the species (R^N). After this R&D, again we have two different states of nature (Ω): the cure (C) or not (NC) of the disease.

[23] Crowards, 1998.

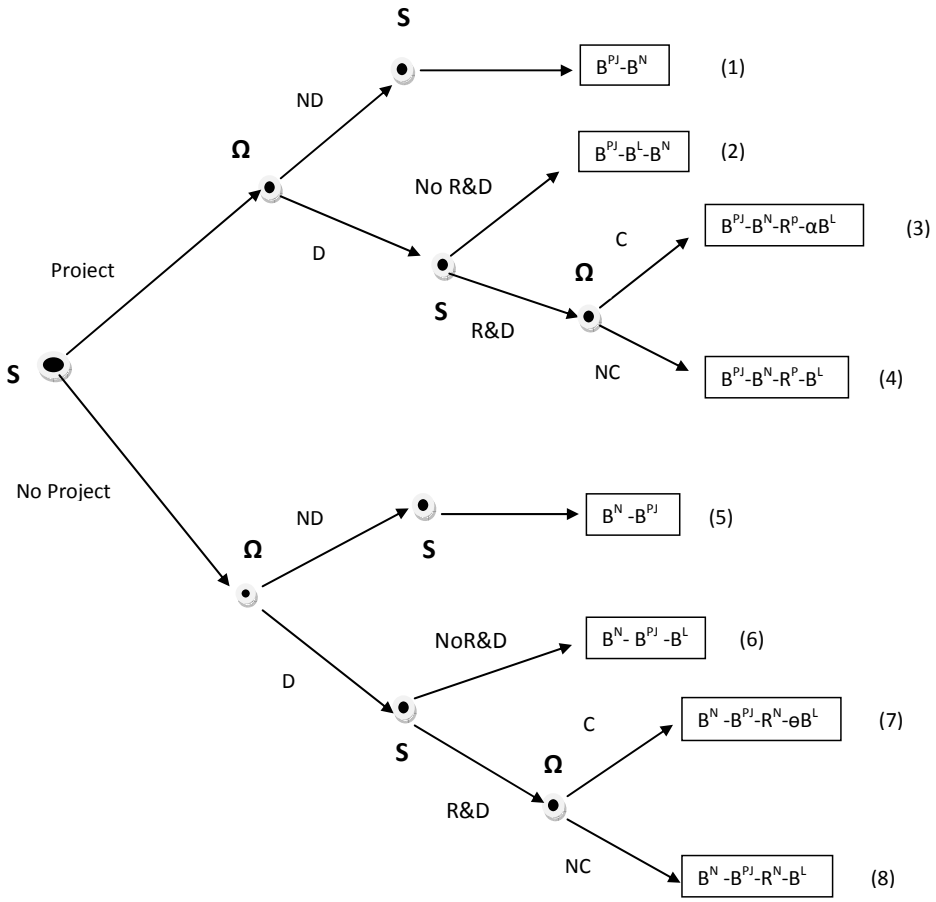

Figure 1 - Safe Minimum Standards approach (SMS)

Society faces alternative possible futures, with many uncertainties: disease versus no-disease, different R&Ds, cure versus no-cure and different level of casualties that depend on the R&D.

If society chooses the project and no-disease occurs, society will enjoy the outcome (1), which shows the present-valued project benefits (B^{PJ}) minus the present-valued benefits from the species that come from viewing, hunting, etc. (B^N). If the disease occurs after the project, society has to decide whether to invest or not in R&D to find a cure without the support of the species. If it decides not to invest in the cure, human beings will experience outcome (2), that is outcome (1) minus the present-value of the casualties from the disease (B^L). If society, instead, decides to search for a cure, it faces two possible states of nature: (C) and (NC). In (3), the cure is found, in which case society has a higher outcome than in 2, because in (3) there occurs only a proportion of B^L (αB^L), where $\alpha \in (0,1)$. If no cure is observed, we have the worst scenario for the project, outcome (4), that is less than (2) because it is reduced by the spending on R&D without the species (R^P).

If, on the other hand, society decides that the project is too dangerous for its future and avoids it, we have again, firstly, the two state of natures: disease or not disease. If no-disease occurs, society will enjoy B^N minus B^{PJ} (outcome (5)). If, instead, disease occurs, society has to decide whether to invest or not in R&D with the support of the species. If it decides not to invest, it will experience outcome (6), that represents B^N minus B^{PJ} minus B^L. If it invests in R&D, and the cure is found, society enjoys outcome (7) that is equal to outcome (5) minus the investment in R&D in the species (R^N) minus a proportion of B^L (θB^L), where also $\theta \in (0,1)$, but it may be different from α. If, instead, we have NC, the decision to have no project, as the outcome (8), this is equal to outcome (6) minus R^N.

Through backward induction, society should invest in R&D if the disease occurs, trying to reach outcomes (3) or (7), since any casualty justifies the investment in R&D over time, but, observing the possibility of the project, society has three questions to answer, trying to see which one is bigger:

1) B^{PJ} or B^N;

2) α or ɵ; and
3) R^P or R^N.

These three factors, isolated or combined, can change the decisions. Then, they are at the core of the problem. Besides that, the probabilities for each state of nature are extremely relevant for the strategies

Bishop and Scott[24] recommend going beyond the probabilities analysis, because not all possible future states of the world may be known, and, even for known states of the world, a mind-boggling list of questions confronts the analyst who would calculate the payoffs for preservation and extinction alternatives.

In short, in conclusion to this section, we see that a binding environmental agreement involves leadership, flexibility, free riding, intertemporal preferences, behavioral deficiencies and uncertainty. Thus, we champion a least human-restrictive principle to such an agreement. To last and to have real power, an environmental agreement shall consider the capacities, needs and deficiencies of human beings to establish and keep an environmental agreement. In that sense, an environmental agreement should recognize the relevance of bounded rationality approach, which observes human limitations and cognitive biases.

In the next section, we focus on bounded rationality approach, especially Evolutionary Game Theory to the G-20 environmental agreement. This game works with the idea of a learning process.

5. An Evolutionary Approach for G-20 Environmental Agreement

The abatement of levels of emissions that damage the environment is constantly viewed as a strictly dominant strategy in the folk Prisoner's Dilemma game, in which every country prefers to pollute, or as one of the two Nash Equilibria of the Chicken Game, in which, if a country decides to abate, the best strategy of the other country is to pollute. Notwithstanding, generally, we observe that the negotiations towards an environmental agreement involve countries with private information about their values (types), sensitivity to the details of the negotiation environment, with limited foresight, limited iterated reasoning, doubts about the other countries' capacity and a good chance to commit mistakes during their learning process. In that sense, negotiation with environmental agreements should be observed by adding bounded rationality to analytical game theory. Bounded rationality considers restrictions, anomalies, and limits on the decision-making process.

The importance of using bounded rationality when analyzing environmental policies is very well presented by Venkatavhalam[25], who shows why the predictions of environmental policies can produce different results if one considers bounded rationality. For instance, an anomaly presented by bounded rationality theory is the endowment effect - the disutility of loss of a commodity that is an endowment is greater than the utility of acquiring the same commodity ex-ante. This effect can generate differences in the "willingness to pay" relative to the "willingness to accept compensation". Another important anomaly is the tendency to relate the discount rate to the time horizon. Individuals can reverse their preferences depending on the time horizon.

In our search to observe how G-20 should establish an environmental agreement, we consider, now, a branch of bounded rationality approach: Evolutionary Game Theory (EGT). As Samuelson[26] points out, EGT begins by dropping the assumption that the players are rational. Instead of being coldly calculating agents who take equilibrium strategy from a theoretical analysis of the game, the players in EGT use trial and error. They experiment with strategies, observe their payoffs, and try other strategies, looking for a strategy that works well.

EGT observes the dynamic adjustments to finding an equilibrium. This dynamic adjustment can be given by the Replicator Dynamics (RD). According to RD, the fraction of the population adopting a particular strategy will increase if it performs better in terms of the fitness function than the population average. RD describes the process of evolution of the existing strategies, and observes the stability of evolution. The most common version in continuous time of RD is given by the following expression:

$$\dot{s}(x) = s(x)[u(x) - \bar{u}] \qquad (2)$$

Where $s(x)$ is the proportion of the population playing x, $u(x)$ is the expected payoff of playing x, and $\bar{u}$, the average payoff in the population.

Now, consider Friedman and Fung's[27] game, which is an extremely relevant example of how to deal with the evolutionary game in eco-

[24] Bishop & Scott, 1999.

[25] Venkatachalam, 2008.

[26] Samuelson, 1996.

[27] Friedman & Fung, 1996.

nomics. Montet and Serra[28] point out that Friedman and Fung's analyses is the most interesting and empirically relevant application of evolutionary games in economics.

Drawing heavily on Friedman and Fung's analyses (FF), we can use their basic analysis to observe how there should be a G-20 environmental agreement that takes into consideration the environmental and development aspects of different countries, using an evolutionary approach. The goal is to observe how a G-20 environmental agreement could provide a pathway to reducing the environmental impact of economic growth observing the needs, limitations and capacities of the countries.

What we have in mind is two kinds of i firm: A firms, in which their production tries to follow the environmental law requirements (they are environmental friendly firms) and alternative B firms, that try to provide cheap outputs using loopholes in the environmental law or failures of environmental governance (failures of surveillance, corruption, judicial system's ineffectiveness, etc.). As in the FF model, the profitability of the firms depends on their distribution across procedures and on the general economic conditions.

We assume that A firms can reduce costs when there are more prevalent mainly because they have lower costs related to coping with the outlaw competition from B firms. A firms have a constant unit cost $c_A - bs > 0$ and B firms have a constant unit cost $c_B > 0$. The parameter $b \in [0.c_A)$ observes the prevalence externalities, while A firms' costs decreases at rate b as their prevalence (s) increases. Suppose that the sN of the firms in a country employ A environmental behavior and the remaining $(1-s)N$ use the B behavior for some fraction $s \in [0,1]$.

Assume that demand is linear and consumers regard the outputs of A and B firms as close but imperfect substitutes. Specifically, let P_A and P_B, be the prices of A and B firms' output, defined by:

$$P_A = \alpha_A - \delta X_A - \gamma X_B \quad (3)$$

$$P_B = \alpha_B - \delta X_B - \gamma X_A \quad (4)$$

$$X_A = \sum_{i \in A} x_i \quad (5)$$

$$X_B = \sum_{i \in B} x_i \quad (6)$$

As in the FF game, the short-run equilibrium is Nash-Cournot for the sN environmental friendly A firms and the $(1-s)N$ B firms. Each kind of firm chooses $x_i \geq 0$ to maximize its profit:

$$(\alpha_i - \delta(x_i + \hat{X}_i) - \gamma X_{-i})x_i - c_i x_i \quad (7)$$

Where $\hat{X}_i = X_i - x_i$ is the combined output of all i firms. The simultaneous solution to the first-order conditions defines a unique symmetric equilibrium with output levels. The short-run equilibrium profit is:

$$\pi_i = (x_i)^2 \delta \quad (8)$$

The FF model considers three effects to analyze: skimming, network and glut effects. We think that we can agglutinate the first two effects into what we call the prevalence effect and keep the glut effect. The prevalence effect is the effect of increasing s and the glut effect is because in the game $\gamma < \delta$ then an increase in s of A firms will lower the price of A's output relative to B's reducing A's profit. Also, we can argue that a lower γ means that the outputs from A and B are less substitutable goods.

In short, the FF game observes the dynamics of s, i.e. the impact of every parameter on the RD of s, when the profitability of every kind of firms changes. The evolutionary equilibrium can be with only A firms, only B firms or a interior unstable equilibrium when s at a point where the A and B firms have equal profit.

Asymmetries in size (N), cost, demand or glut effects can destabilize the equilibria. The profits for A firms are upward sloping and steeper than the profit for B firms when the prevalence effect dominates the glut effect.

Then, having the FF model in mind, the problem for a G-20 environmental agreement, when its goal is to achieve an evolutionary equilibrium with only A firms, consists of:

1) Increasing s or;

2) Increasing c_B relatively to $c_A - bs$ through, for example, higher surveillance and better governance;

3) Reducing the glut effect to the point that consumers observe two different outputs, rejecting B outputs, but avoiding that the prevalence effect

[28] Montet & Serra, 2003.

being dominated by the glut effect.

When considering trade, the FF game adds a parameter t to represent trade barriers, the excess unit cost for selling in the export market rather than in the domestic market. Then, Friedman and Fung show the impact on the dynamics of s when countries face different levels of free trade (only in outputs or outputs as well inputs).

Concerning a G-20 environmental agreement, it could be included an environmental barrier for trade in the parameter t. Then, it could result in a WTO panel. The WTO, rightly, uses to believe that trade barriers are poor environmental policies, that environmental problems are best addressed at source and that there is no inherent conflict between trade and the environment. Then, the G-20 members will need to observe consistency if they regard trade measures as a useful mechanism for fostering a certain environmental behavior among each other and among non-members.

In the 2009 G-20 Communiqué, the group gives some clues as to how the G-20 thinks it can help in providing a pathway towards reducing the environmental impact of economic growth. Basically, the group focus is on public finance and coordination among members. The G-20 involves powerful countries from different regions with diverse eco-systems and levels of development, and it has neither too many members as to make reaching a reasonable agreement impossible and to cause inacceptable delays nor so few members as not have any influence on the different policies and institutions.

6. Conclusions

We investigate a possible binding agreement among the G-20 countries to establish principles or safe minimum standards with regard to environmental problems. The G-20 allows us to foresee that this group of countries could lead other countries to adopt international environmental standards.

In our approach, we have in mind local and global environmental problems. In that sense, we highlighted the need for improvements in national governance. We measured the G-20 intangible capital against economic and development variables, and found consistent relevance only for government balance, which means that people perceive improvements in this capital when debt is under control. But, we missed a better measure to intangible capital, which could consider the different levels of regulation and show real data, not perception ones.

Many analyses, when analyzing an environmental agreement, try to find a stable equilibrium that has full cooperation or includes a good proportion of the members. Thoron, Sol and Wiilinger (2010)'s experiment showed that, when discussing an agreement, diverse types of behavior co-exist among the players and the Safe Minimum Standards approach highlighted the need to deal with strong uncertainties when discussing environment. These problems lead us to ask how the GATT was established, since its formation was supposed to counter similar difficulties. We can only conclude that a binding environmental agreement should have flexibility and leadership to cope with free riding, intertemporal preferences, behavioral deficiencies and uncertainties.

The GATT uses the least-trade restrictive principle to monitor the relationship between trade and environmental policies, we, observing what an environmental agreement needs, argue that such agreement should use a least human-restrictive principle. This agreement should provide viable and enduring alternatives to development and improve the enforcement of law and to last and to have real power, an environmental compromise shall consider the capacities, need and deficiencies of human beings. In that sense, an environmental agreement should recognize the relevance of bounded rationality approach, which observes human limitations and cognitive biases.

In the last section, through making minor changes to Friedman and Fung (1996)'s game, we were able to present the main factors of a G-20 environmental agreement when it wants to establish an evolutionary equilibrium with only environmental friendly firms. It should increase the cost of unfriendly firms' outputs through higher surveillance, for example, or facilitate the rejection of such outputs by consumers.

The G-20's diversity provides leadership and permits a learning process that can favor a more broadly accepted environmental analysis, which should consider least human-restrictive principle, either through adopting trade measures or not.

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