Measuring Gross Disproportion in Environmental Precaution to Establish Regulatory Expropriation and Quantum of Compensation in International Investment Arbitration

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ABSTRACT:

This article applies a new methodology for the assessment of environmental risk prevention expenditure to the adjudication process of international investment arbitration. The Disproportion Factor Model can be implemented by investment arbitration tribunals to evaluate the reasonableness of environmental regulations imposed by host states that have a damaging impact upon foreign investment activity, such as would be the subject for a claim of indirect or regulatory expropriation. In this setting the Disproportion Factor Model can help illustrate whether a host state measure is unreasonable and in that sense should engage the investor's entitlement to compensation under international law. It also acts as an objective guide to the setting of an appropriate quantum of compensation for the injured investor by reference to the environmental benefits that the regulation aimed to achieve relative to their costs, as evaluated by a rational decision-maker. The formula should be consequently viewed as a useful tool in judicial analysis by international investment tribunals.

I Introduction

Claims of indirect expropriation are among the most common brought by foreign investors in international arbitration. Unlike formal expropriations in which the host state takes title to a foreign investor's property outright, indirect expropriation embodies measures taken which have the effect, even if cumulatively, of depriving

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the investor of most or all of the commercial benefit that they expected from their investments. Indirect expropriation could take the form of a tax, licensing fee, or most notably for the purposes of this article an environmental regulation, such as that requiring that investors implement certain industrial safety precautions. In theory the extent to which such an obligation is unreasonable in the sense that the burden to the investor is disproportionate to the benefit to itself and society will dictate the extent of compensation that the host state must pay. Gauging the correct level of compensation for expropriation is a critical and often highly controversial exercise of investment tribunals constituted to assess liability and damages on the part of host states at the behest of injured foreign investors.[1] This article will offer innovative guidance in the approach to this process by investment arbitration tribunals by applying a formula, drawn from the field of risk prevention mathematics and rooted in cost-benefit analysis. This should offer much needed direction for adjudicators in the establishment of an objective, consistent and predictable approach to this important feature of dispute settlement in international investment law.

This article will begin by outlining the nature of claims that may be brought by foreign investors as a consequence of onerous environmental laws. It will then introduce the Disproportion Factor equation which can be used to calculate reasonable levels of expenditure. In part three this mathematical model will explain the point of indiscriminate decision and the permission point and how they can be used to define when the expenditure on environmental protection has become excessively disproportionate. A hypothetical example drawn from the nuclear energy industry will be described in the final section for the purposes of illustration.

[1] See e.g. I Marboe, *Calculation of Compensation and Damages in International Investment Law* (Oxford University Press, 2009) at 2

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II Regulatory Expropriation for Environmental Protection and Cost Benefit Analysis

Regulation in the forms of taxes, fees, licenses or other forms of governmental interference can diminish the profitability of the investment activity to the point that it has become effectively useless, from a commercial standpoint, and as such can be considered acts of expropriation even where they serve a legitimate social aim[2] Measures enacted for environmental purposes have been the subject of several expropriation claims by foreign investors, perhaps most notably in the *Metalclad* dispute brought by a US company against Mexico[3] and the *Methanex* dispute in which a Canadian company argued that a Californian state law prohibiting a certain chemical was a measure tantamount to expropriation.[4] Both of these disputes were brought under the investment provisions of the North American Free Trade Agreement ('NAFTA').

Recently the Swedish energy company Vattenfall threatened to file a claim in international arbitration against the German government under the Energy Charter Treaty ('ECT'), an international treaty which provides guarantees to investors regarding illegitimate governmental interference with commercial activities. This dispute relates to Germany's decision to withdraw from its nuclear energy program following the Japanese Fukushima Daiichi incident, effectively an environmental as well as a health and safety based policy. As of early 2013, Vattenfall claims that it

[2] R Dolzer and S Schreuer, *Principles of International Investment Law* (Oxford University Press, 2008) at 92-118

[3] Metalclad v Mexico, Award 30 August 2000, 5 ICSID Reports (2002) 209 (denial of a construction permit in relation to a hazardous waste landfill)

[4] Methanex v USA, Award 3 August 2005 44 ILM (2005) 1345 (ban of the gasoline additive methanol because of drinking water contamination)

will lose 700 million euros from investments made in nuclear power plants, which were made on the understanding that their life spans would be extended by Germany.[5]

The increasing environmental awareness of many governments and policy makers around the world suggests that measures enacted for these purposes will intensify.[6] In addition to the obvious potential for domestic litigation, over-zealous environmental regulatory activity could result in a greater number of claims brought by investors under international investment treaties and regional economic integration agreements, collectively termed international investment agreements ('IIA's), such as NAFTA and the ECT. While there are more than 3000 of these instruments in operation,[7] IIAs typically contain guarantees against expropriation without the payment of full compensation in addition to other protections such as a guarantee of Fair and Equitable Treatment, essentially encompassing due process in terms of the administration of regulations that impact foreign investors, and National Treatment, ensuring that foreign investors will not be discriminated against because of their foreign character. Such assurances against unfair regulatory interference by host governments are thought to encourage mutually beneficial foreign direct investment ('FDI'), especially in relation to states that have a history of disregard for foreign property or which are politically unstable.[8] Guarantees against indirect (as well as the now uncommon direct) expropriation in IIAs typically consist of states' obligations not to expropriate the assets of foreign investors unless this is done for a public purpose, in a non-discriminatory manner, in accordance with due process and

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[5] International Institute for Sustainable Development 'Investment Treaty News' Issue 2, vol 2 December 2011/January at 14

[6] J Marlles, 'Public Purpose, Private Losses: Regulatory Expropriation in International Investment Law' 16 Journal of Transnational Law and Policy 275 (2007)

[7] UNCTAD World Investment Report 2012 at 18 <http://unctad.org/en/PublicationsLibrary/wir2012overview_en.pdf> (accessed March 2013)

[8] The extent to which IIAs actually improve FDI flows is a subject of much controversy: see e.g. K Sauvant and L Sachs eds. *The Effect of Treaties on Foreign Direct Investment* (Oxford University Press, 2009)

accompanied by the payment of prompt, adequate and effective compensation.[9] IIAs, which were historically concluded between developed and developing countries, often elaborate that compensation must be paid without delay, be equivalent to the fair market value of the expropriated investment immediately before the taking and be in a fully realizable currency.[10] Such provisions were intended to mitigate the risk of Western investors sinking enormous costs in commercial projects in highly unstable developing countries, although such guarantees may be equally enforced against developed countries that had traditionally been capital exporters. As noted above, the obligation to pay compensation to injured investors is applicable notwithstanding the public purpose behind the value-diminishing regulation, such as whether the measure had an objective of environmental protection. As one investment tribunal emphasized:

> Expropriatory environmental measures -- no matter how laudable and beneficial to society as a whole – are ... similar to any other expropriatory measures that a state may take in order to implement its policies: where property is expropriated, even for environmental purposes, whether domestic or international, the state's obligation to pay compensation remains.[11]

Although the obligation to pay compensation for regulatory interference, such as those linked to environmental policies is well established, whether or not the measure constitutes an unreasonable interference worthy of compensation (as opposed to legitimate state action) as well as the manner in which the precise quantum of this compensation is calculated by arbitration tribunals is far from settled, in part due to

[9] E.g. Art 6 of the US Model BIT 1994 and Art 1110.1 of the North American Free Trade Agreement ('NAFTA'). This is the so-called Hull Formula.
[10] The so-called Hull Formula, see e.g. Art 7 of the US Model BIT and Art 1110.2 of NAFTA
[11] Award: *Compañía del Desarrollo de Santa Elena, S.A. v. Republic of Costa Rica,* ICSID case No. ARB/96/1, 15 ICSID

difficulties associated with valuing the assets that are taken.[12] The analysis of the quantum of compensation often pre-occupies arbitration panels during the merits stage of a dispute, even once an expropriation has been found to have occurred. Concepts such as fairness and adequacy of profit have little practical significance, requiring highly contextualized analysis of the value of an asset as well as the purpose of the measure taken.[13]

This process is complicated by the established principal that illegal expropriations, which are either discriminatory, do not serve a public purpose, or ignored due process, require a payment of damages to the foreign investor rather than simple compensation.[14] Thus, it would appear as though a regulatory measure that diminished the value of a foreign investor's asset undertaken ostensibly for an environmental purpose but which actually did not serve this aim, would require that the host state pay a greater quantum of compensation than if the measure was justified because of its beneficial impact upon society. Some degree of proportionality between the regulatory burden and the policy objective is thought to be essential to legitimize state action.[15] This inquiry lies at the heart of one of the central debates in international investment law and indeed public international law generally, namely the extent to which a host state may implement its sovereign right to regulate in the public interest where this conflicts with international obligations, including those that have an impact on private commercial actors located in their territory, which may or may not originate from abroad. Arbitration tribunals can attempt to bring objectivity to the delicate balancing required in this assessment by resort to general principles of

[12] M Sornarajah, *The International Law on Foreign Investment* (Cambridge University Press, 2010) at 208
[13] S Subedi, *International Investment Law: Reconciling Policy and Principle* (Hart Publishing, 2008) at 126
[14] Ibid at 74
[15] S Schill, *The Multilateralization of International Investment Law*, (Cambridge University Press, 2009) at 378

international law, such as the right to full reparation in the case of illegal takings[16] as well as accepted principles of accounting such as full market value, book value and other methods of asset valuation.

Some valuable insight into this aspect of international adjudication, tied too closely to abstract notions or reasonableness and proportionality, may be gained through an application of economic analysis. Law and economics scholars explore empirical methods for resolving the ambiguity inherent in the law's reliance on the ubiquitous concept of reasonableness as a means of injecting greater coherence and predictability to the exercise of judicial discretion. Indeed this type of methodology suggests that a correct approach to the judicial interpretation of the law can be achieved in reference to economic efficiency, meaning that benefits resulting from a certain legal rule were greater than costs.[17] The transparent use of a strict cost-benefit analysis as a tool in assessing the reasonableness of safety precautions to avert human injury was demonstrated most famously in Judge Learned Hand's equation from *United States v Carroll Towing Co*[18] wherein he stated that an injurer will be found negligent if the burden of the precaution against harm (B) is less or equal to than the resulting benefit, which is a product of the magnitude of the injury (I) multiplied by the likelihood of it occurring (P): $B \leq IP$. Similarly, the UK Court of Appeal established in *Edwards v. National Coal Board*[19] that health risks faced by employees should always be reduced unless the employer could demonstrate that there was "gross disproportion" between the costs and the benefits, meaning that the risk was insignificant in relation to the sacrifice. This assessment implied that some over-spend on safety is warranted, but not to the point of gratuitous waste. Further, in

[16] As seen in the Chorzow Factory Case (Merits) *Germany v Poland*, PCIJ Rep (1928) Series A No. 17 and Art 36 of the International Law Commission's Articles on State Responsibility
[17] R.A Posner, 'A Theory of Negligence' 1 J of Legal Studies 28 (1972)
[18] 159 F.2d 169 (2d Cir. 1947)
[19] [1949] All ER 743 (CA) per Lord Asquith

Grimshaw v Ford Motor Company[20] the California court rejected the defendant auto company's argument that the disproportion factor needed to mandate the safety precaution necessaru to prevent sudden engine fires in certain car models would be too great at 2.8 (meaning that the cost of the precaution would be 2.8 times greater than the magnitude of the injury that it would avoid), finding against Ford. The logic is clear – private citizens should not be expected to spend excessively when mitigating risks because to do so would act as a deterrent to socially productive commercial activity.

Similar, typically less mathematically explicit methods of assessing the legitimacy of environmental risk control have appeared in numerous pieces of legislation, case law as well as government feasibility studies.[21] This may reflect a trend towards greater sophistication in regulatory activity, perhaps itself the consequence of the mass availability of information upon which laws are based through the internet. Environmental impact statements are now required for governmental approval of many schemes, including the acceptance of certain foreign investment projects by host states or FDI funding bodies. Numerous international development banks mandate environmental cost-benefit analysis as a pre-condition for a FDI project's receipt of support. For example, the International Finance Corporation of the World Bank implements Performance Standards which require that investors seeking financial support for a development purpose must assess and manage the social and environmental costs of a project, compensating injured stakeholders where this is financially feasible (meaning that the cost to the investor

[20] (1981) 119 CA (3d) 757

[21] See C Sunstein, *Risk and Reason: Safety, Law and the Environment* (Cambridge University Press, 2002) noting for example cost benefit analysis in the Safe Drinking Water Act 42 U.S.C. par 300 and in Chemical Manufacturers Association v Environmental Protection Agency 217 F 3d 861 (DC Cir 2000).

does not outweigh the benefit of proceeding with the project).[22] The Multilateral Investment Guarantee Agency of the World Bank states in its Performance Standards of Land Acquisition and Involuntary Resettlement guidelines that investors must balance environmental costs and benefits when designing projects.[23] While these international organizations are eager to enhance capital flows into developing countries, they are mindful that this often entails social costs that must be evaluated.

Despite the ubiquity of the economic perspective in policy materials, there a surprising dearth of economic analysis in the field of international investment law, particularly in relation to the quasi-judicial process of international investment arbitration in investor-state dispute settlement. While there has been some empirical work devoted towards the perceived bias in international investment decisions,[25] as well as to the dominant sources of law cited by International Centre for Settlement of Investment Disputes (ICSID) arbitrators,[26] assessment of the arbitrators' reasoning in investment awards through quantifiable means, let alone cost-benefit-analysis, has thus far escaped academic scrutiny. Such analysis is warranted because of the importance of reasonableness in the assessment of regulatory actions taken by host states, in particular those which may be viewed as indirect expropriations by foreign investors, and which will consequently engage an entitlement to some measure of monetary compensation.

In the international investment arbitration context, cost-benefit or economic analysis can be found implicitly in the exercise of proportionality-based adjudicatory discretion. Scholars have observed that investment arbitrators who view themselves

[22] International Finance Corporation Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts, 1 January 2012 [14]
[23] Performance Standard 5 Land Acquisition and Involuntary Resettlement, 1 October 2007 [7]
[25] S Franck, 'The ICSID Effect? Considering Potential Variations in Arbitration Awards' 51 Virginia Journal of International Law (2011)
[26] O K Fauchald, 'The Legal Reasoning of ICSID Tribunals: An Empirical Analysis' 19 European Journal of International Law 301 (2008)

as agents of a wider community evaluating the larger public impact of their decisions and recognizing the influence of their awards as precedents (as opposed to a narrower, party-specific commercial approach) are prone to engage in proportionality-balancing between the rights and obligations of investors and host states.[27] This view can be seen, for example, in the *Tecmed v Mexico* decision:

> in addition to the negative financial impact of such actions or measures, the Arbitral Tribunal will consider, in order to determine if [the regulations] are to be characterized as expropriatory, whether such actions or measures are proportional to the public interest presumably protected thereby and to the protection legally granted to investments, taking into account that the significance of such impact has a key role upon deciding the proportionality. [28]

Assessing the proportionality between the financial harm suffered by the investor against the environmental gain to society was openly considered in the *Total v Argentina*[29] dispute. In deciding in favour of the investor and ordering compensation for expropriation, the tribunal examined an Argentine law which directed that levels of compensation for regulatory interference must take into account the extent of the burden placed upon the property owner:

> General modifications to regulations and procedures related to ... [e]nvironmental [p]rotection shall not entitle [the investor] to [c]laim any indemnification or compensation for damages, except ...when said modifications are arbitrary and cause compliance with the agreement [that are] extremely burdensome for [the investor]...[30]

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[27] E.g. A Stone Sweet, 'Investor-State Arbitration: Proportionality's New Frontier' 4.1 Law & Ethics of Human Rights 47 (2010)
[28] *Tecnicas Medioambientales Tecmed S.A. v United Mexican States (Mexico)* (Additional Facility) 43 I.L.M. 133 (2004) [122]
[29] *Total S.A. (Claimant) v Argentine Republic*, Award, ICSID Case No. ARB/04/1 (Decision on Liability) (21 Dec 2010)
[30] at 277

The phrase “extremely burdensome” is telling because it requires the national government and subsequently the arbitrator implementing the domestic law to assess not simply whether or not the environmental measure is financially injurious to the investor, but the extent to which that injury is out of proportion to the benefit it engenders, on the assumption that some degree of disproportion is acceptable.

The problem therefore becomes: how can arbitrators, appointed on an ad hoc basis and chosen by the parties, decide whether a particular expense incurred in the fulfilment of a regulatory obligation for the purposes of protecting the environment is out-of-proportion to the benefit it engenders? The answer will be tied to the costs suffered by the foreign investor, typically a firm engaging in some form of manufacturing or extraction, and the value received in terms of the prevention avoided. It will also engage an assessment of the investor’s risk aversion. Thus in order to evaluate the reasonableness of the regulatory safeguard imposed by the host state, it must be determined whether or not a private individual would choose that course of action in the absence of the law given the costs and benefits that are entailed. Crucially this assessment hinges on the understanding that the decision-maker, meaning the manager or owner of the firm in question that is considering whether or not to implement the precaution voluntarily, is choosing a course of action on the basis of rationality. A rationally informed decision by a private individual should be the benchmark by which reasonableness of regulatory precaution should be assessed, establishing whether or not the measure was an expropriation and if so, how much compensation is required.

II Risk-aversion and the Decision to Invest in Environmental Precaution

Concerns regarding disproportionate spending on risk prevention by governmental authorities in the United Kingdom prompted risk scientists, P. J. Thomas, R. D. Jones and W. J. O. Boyle, to develop a mathematical model that evaluates the extent to which the decision to invest on a particular environmental risk prevention scheme is rational and can accordingly be viewed as a sensible decision by the firm.[31] This model can provide normative guidance with respect to how much money a government, private company, or most importantly for the purposes of this analysis, a foreign investor, should be expected to spend on environmental safeguards, such as those that may be required pursuant to a law imposed by the country in which they operate. Thus the model can help international investment arbitrators ascertain whether a particular regulation should be viewed as unfair, excessive, or an undue interference with private property rights, which may be framed as a claim of indirect expropriation or other treaty violation.

A reasonable expenditure on an environmental safeguard may be calculated as the ratio of the actual expenditure to the maximum that is reasonable for a protection system guarding against expected environmental costs. The concept of costs attempts to monetize what might be viewed more conventionally as economic injuries including those suffered by both the company and the region or ecosystem in which it is located. Such costs could consist of structural damage to a factory or plant, ground contamination, expenses in evacuating and potentially relocating people, agricultural yield losses, business disruption as well as loss of reputation, and even loss of beauty or pleasure, to the extent that this can be quantified. Other factors relevant to assessing these costs include pre-existing and remaining environmental hazards, the period that the protection system will operate and the growth rate of the organization

[31] P. J. Thomas and R. D. Jones, 'Extending the *J*-value framework for safety analysis to include the environmental costs of a large accident' 88 Process Safety and Environmental Protection 297 (2010)

or the foreign investment. A regulation imposed by a host state which necessitates that a foreign investor spend more than this amount as derived dictates should be viewed as unreasonable by an international investment arbitration tribunal and therefore indicative of a regulatory expropriation. As suggested above, this conclusion is predicated in the intuitive assertion that governments should not expect private commercial enterprises to pursue policies that are based upon irrational decisions.

In addition to determining whether or not the regulation should be viewed as an unfair interference and therefore engage the obligation to compensate, the formula discloses a Disproportion Factor, which indicates the extent to which the expenditure on protection exceeds the expected loss. The expected loss, that is to say the potential loss multiplied by its probability of occurrence, is the amount that the company should be prepared to spend based purely on a standard cost-benefit analysis. However it may well be rational for the company to adopt a greater degree of aversion to risk and hence spend more than this minimum amount.

The Disproportion Factor model focuses on the role of risk-aversion in the decision-making process of company managers, which for the purposes of this article are taken to be foreign investors. Risk-aversion expresses the degree to which a decision-maker is unwilling to accept a bargain with an uncertain payoff rather than another bargain with a more certain, but possibly lower, expected payoff. For example, a risk-averse investor might choose to put his savings into a bank account with a low but guaranteed interest rate, whereas someone who has a lower level of risk-aversion may choose to put his money in investments that may have high expected returns, but which also carries the danger of losing value. Commercial enterprises tend to operate in a risk neutral manner, with a risk-aversion of zero, when

carrying out their normal business activities. However an investor may demonstrate a higher risk-aversion when anticipating the effects of a large scale environmental disaster because of their public image and political sensitivity.[32] Fears over negative reputational consequences such as those of the BP oil spill in the Gulf of Mexico in 2010 might influence investors in the petroleum industry to adopt a more cautious approach towards environmental safeguards. The extent to which foreign investors seek political risk insurance as a means of offsetting risks such as these will not be explored in this article, although it should be noted that such insurance typically covers expropriations by host states.

The assessment of decisions relating to environmental precaution is rooted in the logic of utility, meaning the total satisfaction received from consuming a good or service. Utility is a means of analysis that is used widely in public planning as a means of interpreting public preferences.[33] The application of utility theory to decision-making for the purpose of environmental protection is achieved by identifying four factors (*ABCD*) in a process often described as the ABCD model.[34] *A* represents the total assets of the organization that is deciding whether or not to implement an environmental safety precaution. For the purposes of this application of the model, the organization is a foreign investor and *A* will represent those assets that may be drawn upon to compensate for environmental damage in the country hosting the industrial plant. These may be the assets of a national subsidiary, but the total assets of the international company might be considered in some cases, such as BP's Macondo oil release, because the company has such a major interest in the nation concerned. *B* is the sum that the environmental protection system will cost that will

[32] Ibid at 300
[33] Ibid at 299
[34] PJ Thomas, RD Jones, WO Boyle, 'The Limits of Risk Aversion: Part 1: The Point of Indiscriminate Decision' 88 Process Safety and Environmental Protection 381 (2010)

reduce the probability of incurring the environmental costs from one larger figure to another smaller one, where the probability of the harm occurring is typically already small. Clearly the *B* figure is derived from engineering as well as financial assessment, which for the purposes of this analysis is presumed to be an accurate representation of the economic costs and risk. Thus the functionality of the formula is predicated on the assumption that real costs and risks can be fairly accurately measured. *B* can stand for "balancing" as it balances the expenditure in precaution against the reduction in risk of harm, the crucial proportionality exercise associated with assessing the legitimacy of a host state's laws. *C* is the total environmental harm costs associated with the lack of implementation of the precaution system being considered. Again this figure will be derived from an economic analysis of the adverse effects suffered, which are taken as fully capturing the magnitude of the damage both to the firm and to society.

The *D* portion of the formula denotes the difference in the expected utilities of the organization's wealth with and without the protection system. The utility of the organization's assets may simply be linear, meaning that it may be regarded as identical to their monetary value. This corresponds to "risk neutrality", meaning that the organization's decision-makers will be concerned simply with maximising the organization's wealth. Increasing the value expressed for the organisation's risk-aversion will tend to make it less reluctant to invest in a protection system. It is important to recognize that risk-aversion is not a static value. It will change for the same individual decision-maker according to the costs and benefits associated with the particular decision with which he is faced. But even at high levels of risk-aversion the decision-maker will choose to pursue the safety investment only when the scheme is relatively close to financial break-even. For such borderline schemes, where the

cost is close to the benefit, the amount the organisation is prepared to spend on the protection system will tend to rise as the risk-aversion increases. This reflects the fear of bearing the financial and other burdens associated with a large environmental disaster. The ratio of the cost of the protection scheme that would be sanctioned at a given risk-aversion to the expected loss in its absence is identified as the Limiting Risk Multiplier, the maximum value of which is governed by the maximum feasible value of risk-aversion.

Appreciating the mental state of the decision-maker is crucial to understanding the value of this formula. Accordingly, it must be recognized that increasing the decision maker's risk-aversion will reduce the clarity, or rationality, of the process of choosing whether or not to undertake the safety precaution. As a result, the capacity for discrimination between the two options will gradually diminish, being lost altogether at what has been called the Point of Indiscriminate Decision. At this level of risk-aversion the decision maker will be able to distinguish neither advantage in installing the scheme nor disadvantage in installing its inverse, a hypothetical "danger system" that would actually lead to environmental harm. The Point of Indiscriminate Decision provides a natural upper limit for the value of risk-aversion. This bounds the Limiting Risk Multiplier in turn, and so sets an objective upper amount that it is rational to spend on an environmental protection system. This is the level of spend that should be expected by the environmental law of the relevant jurisdiction.

The formula yields further valuable insight into the decision-making process of the foreign investor. At any risk-aversion level greater than zero (meaning that the decision-maker will apply more caution that he would than if he were trying merely to maximise wealth), the utility of wealth increases at a decreasing rate to the point that additional wealth results in limited additional utility. Successive increments of utility

tend to decline sharply in proportion to the total wealth saved, meaning that a business will value initial savings greater than later ones of the same monetary value (saving 10,000 euros rather than 0 will matter more than saving 90,000 euros instead of 80,000 euros).[35] This effect becomes more pronounced the higher the level of risk-aversion, and, as a result, an improvement in utility level brought about by a money-saving strategy will become very difficult to distinguish at a very high level of risk-aversion.

Company decision-makers will obviously seek to maximize their company's expected utility. This means that they will generally want to implement the environmental protection scheme if the scheme's cost is outweighed by the increase in expected utility it brings about. This will occur when the expected before-and-after utility difference (the *D* variable) is negative – the expected utility after implementation will be greater than the expected utility in the absence of the protection scheme. This means that the environmental precaution is expected to increase the value of the company's assets. Reluctance to spend on environmental precaution is directly linked to the expected impact on the value of the company's assets. Again, this reveals the type of decision that should be viewed as conforming to national environmental laws.

Taking the company decision-maker's initial position as one of scepticism as to the usefulness of the environmental precaution, the reluctance to invest in the precaution can be defined by reference to the ratio between the expected before-and-after utility difference (*D* in the *ABCD* model) to the starting utility measured relative to one unit of money. "Reluctance to invest" is a mathematically defined variable that simply provides a convenient scale by which to judge the motivation to invest in a

[35] P Thomas and R Jones, 'JT Value Assessment of Schemes To Protect Against Accidents With High Human and Environmental Costs' 43:5 Measurement and Control 152 (June 2010)

protection system. A 100 per cent reluctance to invest in the precaution, the equivalent of an outright refusal or unwillingness to do so, will be associated with a protection system that is so expensive that it is expected to reduce the utility of the company's assets to zero. A negative reluctance to invest will suggest an openness to investment in a protection scheme. However, psychologists note that: [36]

> There are two problems of behavior which any theory of motivation must come to grips with. ... The first problem is to account for an individual's selection of one path of action among a set of possible alternatives. The second problem is to account for the amplitude or vigor of the action tendency once it is initiated, and for its tendency to persist for a time in a given direction.

The variable, reluctance to invest, reflects these two key features of decision making.. Thus an increase in risk-aversion may cause the reluctance to invest to go from positive to negative, but the "amplitude or vigor of the action tendency" will decrease at the same time. At some point, when the risk-aversion has reached a very high value, the "amplitude of the action tendency" will be so small that the ideal, rational decision maker will be unable to detect it and hence would feel no enthusiasm to implement the precaution. In such circumstances laws requiring the relevant precaution should be viewed as illegitimate or unreasonable.

Companies should and will become more willing to spend money to avoid disasters as they become more worried about the consequences of not doing so. If the use of the ABCD model suggests that a rational investor facing the decision to invest would be motivated to do so, both as regards the direction of the decision and the amplitude of the action tendency, then any environmental regulation requiring this

[36] J. W. Atkinson, 'Motivational Determinants of Risk-Taking Behaviour', 64:6 Psychological Review 359 (1957)

investment should be tolerated by the company even if the Disproportion Factor is greater than unity.

Where the expected payoff from installing protection is high, meaning that the environmental precaution is expected to save the investor money (equivalent to adding to the company's expected utility, measured at a risk-aversion of zero), increasing the company's risk-aversion above zero will not change the orientation of the decision maker towards the implementation of the precaution. However, it will decrease his motivation to do so because of the increasing difficulty noted earlier in distinguishing utility improvements as the level of risk-aversion becomes higher. The "amplitude or vigor of the action tendency" will be at a very low level. As suggested above, at some value of risk-aversion, the company decision makers will be unable to see the benefit of even an environmental precaution that can be expected to save their firm money. This mathematical result from utility theory may be explained intuitively as describing the situation where the decision makers become so enveloped in gloom that they do not believe that any action will make a difference – even a system of good value (cost relative to level of prevention) will not assuage their fears.

For protection schemes that are clearly of poor value, meaning that the monetary cost to the company now outweighs the financial benefits in terms of probability and magnitude of environmental harm as assessed, a similar phenomenon will occur as risk-aversion increases. Now the disbenefit, seen very sharply at a risk-aversion of zero (when only the money matters), will lose clarity as the risk-aversion level of the decision maker increases. Again, at some high level of risk-aversion, the company decision makers will be unable to distinguish the disbenefit of abolishing an environmental precaution that can be expected to save their firm money. Intuitively the decision makers may be imagined to be enveloped in the same despair described

above, and will feel that, since no action on their part is going to make much if any difference, it does not matter what action they chose. It is clear that no rational investor should allow his risk-aversion to reach the level where he was unable to distinguish between the merits of a scheme that increased protection and one that diminishes protection for the environment.

III Point of Indiscriminate Decision, Permission Point and Excessively Disproportionate Expenditure

The ABCD analysis indicates that there is a level of risk-aversion at which the investor will have to make a decision (because doing nothing is still a decision) but will be unable to discriminate amongst any of the options available to him because to him there is no measurable difference. This is described as the Point of Indiscriminate Decision and it means that the decision taken at this level of risk-aversion is not related to any rational process. At this point the decision to implement the protection measure or not will be essentially random. This condition can be observed in individuals who enter a state of panic – perceptions are distorted and rational control over decisions is lost. No decision-maker should raise his risk-aversion to the point of indiscriminate decision or beyond because this will mean that he is not assessing options rationally but rather exhibiting a random, thoughtless response. Determining the maximum rational risk-aversion sets an upper bound on the Disproportion Factor, and so sets an objective upper limit on the amount that it is rational to spend on an environmental protection system. Thus any domestic laws calling for precautions in excess of this level should be viewed as manifestations of indirect expropriation.

Given a protection scheme of given cost, the rational decision maker will mull over the decision on whether or not to implement by varying his risk-aversion to find the value at which he experiences the minimum reluctance to invest. This value is known as the "permission point". If his minimum reluctance is now negative and the permission point is less than the point of indiscriminate decision, then the protection scheme should be implemented. This will include cases where the Disproportion Factor is greater than unity. If, however, the cost of the protection scheme is higher than the maximum rational cost, which is the product of the Disproportion Factor and the expected loss, then the cost is excessively disproportionate. The excess may be quantified precisely as the cost minus the maximum rational cost. Thus a level of compensation for the expropriation can be established.

IV The Disproportion Factor Model and Investment Arbitration: A Hypothetical Example

The operation of the Disproportion Factor Model in the sphere of international investment arbitration is best illustrated through an example. An electricity company from the fictional state of Ruristan, Protopower, has just finished building a nuclear reactor in Germany to supply electricity to the local population. Ruristan and Germany concluded an IIA that is the same as the text in the 2008 German Model BIT. Given widespread fears regarding nuclear energy in the aftermath of the Japanese tsunami, the German government subsequently conducts an environmental impact statement and imposes a requirement on Protopower that it should build a tertiary containment structure costing 200 million euros to reduce the frequency of a large release of radioactive contaminant from a conservatively assessed current figure

of one in a 100 thousand years to one in a 100 million years. The plant lifetime is 60 years, and the estimated environmental cost of such a release, should it happen, is 20 billion euros. Assessing the financial impact of the regulation and the potential risk that the associated environmental precaution could prevent, Protopower takes into account the fact that its German subsidiary has total assets of 21 billion euros that it can draw on to provide compensation if necessary, and the growth rate of that subsidiary has averaged 4 per cent per annum for the past 10 years.

The maximum sensible spend to achieve this reduction in accident probability is given by the equation drawn from the work of Thomas and Jones[37] for the risk-neutral case. The basis of this calculation is to equate the additional expenditure on the safety system with the reduction in the expected cost of an accident. The maximum sensible spend to implement this safety scheme (δZ) is given by the product of the Limiting Risk Multiplier (M_R) and the maximum cost of the scheme in the risk-neutral case (δZ_0):

$$\delta Z = M_R \delta Z_0 \quad [38]$$

For the risk-neutral case, the maximum that should be spent on the scheme is equal to the reduction in expected accident costs.[39] This is given by:

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[37] Thomas and Jones, above note 31 (Equation 30)

[38] Ibid (Equation 32)

[39] If the company's initial assets are *A* (euros) and it has a growth rate of r_{org} (per year) then, if no accident occurs, its final assets after a plant lifetime of *T* (years) will be $Ae^{r_{org}T}$. Should one or more accidents occur, the company's final assets will be reduced by the expected cost of the accidents, $M_{C1A}K_C(\lambda)$, which has been decomposed into the expected cost assuming no growth, K_C, and a multiplier which accounts for the growth of the remaining assets, M_{C1A}. Equation 18 of Thomas and Jones, *ibid.*, gives

$$K_C(\lambda) = C\frac{\lambda T}{1-e^{-\lambda T}}$$

$$\delta Z_0 = \frac{1-e^{-r_{org}T}}{r_{org}T} C(\lambda_1 - \lambda_2)T$$

where r_{org} is the growth rate of the company (4 per cent per year), T is the lifetime of the safety measure (60 years), C is the cost of an accident (2×10^{10} euros) and λ_1 and λ_2 are the accident frequencies without and with the safety scheme (10^{-5} per year and 10^{-8} per year, respectively). Substituting the figures for the Protopower scheme gives a maximum risk-neutral spend of $\delta Z_0 = 4.61\times10^6$ euros.

In the limiting case of zero growth, this risk-neutral spend is simply expressed as $\delta Z_0 \cong C(\lambda_1 - \lambda_2)T$, where C is the accident cost, λ_1 and λ_2 are the accident frequencies before and after the safety measure, and T is the lifetime of the safety measure.[40] With a growth rate of 4 per cent per annum and the accident costs and

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where C is the cost (euros) of a single accident and λ is the frequency (per year) of an accident. Equation D4 of Thomas and Jones, *ibid.*, gives

$$M_{C1A} = \frac{e^{r_{org}T} - 1}{r_{org}T}.$$

Denoting $U(W)$ as the utility of wealth W, then the expected utility of the company after T years without the safety scheme will be

$$E(u_{1T}) = p_{\lambda_1} U(Ae^{r_{org}T}) + (1 - p_{\lambda_1}) U(Ae^{r_{org}T} - M_{C1A} K_C(\lambda_1))$$

where the probability of there being no accident in the interval T is $p_\lambda = e^{-\lambda T}$. If the company spends an amount δZ_0 on the safety scheme to reduce the accident frequency from λ_1 to λ_2, then although the assets will be reduced by this amount, the expected cost of the accident will also be reduced. The expected utility after implementation of the scheme is then

$$E(u_{2T}) = p_{\lambda_2} U((A - \delta Z_0)e^{r_{org}T}) + (1 - p_{\lambda_2}) U((A - \delta Z_0)e^{r_{org}T} - M_{C1A} K_C(\lambda_2)).$$

The maximum that should be spent on the safety system occurs when the expected utility does not change after implementing the scheme, *viz.* $E(u_{2T}) = E(u_{1T})$. Noting that $U(W) = W$ for the risk-neutral case, the maximum rational cost is

$$\delta Z_0 = \frac{1-e^{-r_{org}T}}{r_{org}T}\left[K_C(\lambda_2)\left(e^{-\lambda_2 T} - 1\right) - K_C(\lambda_1)\left(e^{-\lambda_1 T} - 1\right)\right] = \frac{1-e^{-r_{org}T}}{r_{org}T} C(\lambda_1 - \lambda_2)T$$

(from equation 30 of Thomas and Jones, *ibid.*, substituting the definition of $K_C(\lambda)$ in the final step).

[40] Ibid (Equation 31).

frequencies as above, the full calculation gives a maximum risk-neutral spend of 4.61 million euros.

The Limiting Risk Multiplier is calculated as follows[41]. The numerical approach[42] iterates over values of the risk multiplier, $m_r \geq 1$. As the risk multiplier increases, the risk-aversion (ε) of the Permission Point also increases until it reaches its limiting value of $\varepsilon_{pp} = \varepsilon_{\max}$ at the Point of Indiscriminate Decision – this then corresponds to the maximum value of the risk multiplier, $m_{r\max} = m_r(\varepsilon_{\max})$. This

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[41] Thomas, Jones and Boyle, above note 34, (Appendix A2)

[42] In the ABCD model, the reluctance to invest, R_{120A}, is defined as the difference in expected utility of the company before, $E(u_1)$, and after, $E(u_2)$, the scheme is introduced, normalized to the expected utility of the starting assets, $E(u_0)$,

$$R_{120A} = \frac{E(u_1) - E(u_2)}{E(u_0)}.$$

The utility function is taken to be that of Atkinson (A. B. Atkinson, 'On the measurement of inequality' J. Econ. Theory, 2, 244, (1970)),

$$U(W) = \frac{W^{1-\varepsilon} - 1}{1-\varepsilon} \text{ for } \varepsilon \neq 1$$

$$U(W) = \log(W) \text{ for } \varepsilon = 1$$

where W is the wealth of the organisation and ε is the elasticity of marginal utility or "risk-aversion." The reluctance to invest can be expressed as

$$R_{120A}(\varepsilon) = \frac{A^{1-\varepsilon}}{A^{1-\varepsilon} - 1}\left\{(1-c)^{1-\varepsilon} - (1-b-c)^{1-\varepsilon} + p_{\lambda_1}\left[1-(1-c)^{1-\varepsilon}\right] - p_{\lambda_2}\left[(1-b)^{1-\varepsilon} - (1-b-c)^{1-\varepsilon}\right]\right\}$$

where A, p_{λ_1} and $p_{\lambda 2}$ are defined above, and the lower case letters denote costs normalised to the assets: $b = B/A$ and $c = C/A$.

In the risk-neutral case ($\varepsilon = 0$), the normalised cost of the scheme (b_0) will be exactly balanced by the expected normalised cost of the accident when $R_{120A} = 0$. Substituting these values into the equation for R_{120A} gives $b_0 = (p_{\lambda_2} - p_{\lambda_1})c$. The risk multiplier, $m_r(\varepsilon)$, is defined as the ratio of the cost of any given scheme (b) to this risk-neutral cost, $m_r(\varepsilon) = b/b_0$. In practice, it is convenient to express the reluctance to invest in terms of m_r rather than b.

The minimum reluctance to invest (the Permission Point) occurs at a risk-aversion of ε_{pp}. For any given set of parameters, this minimum can be found numerically by iterating over the risk-aversion, $\varepsilon \geq 0$, to compute R_{120A} at each point. At large values of risk-aversion, the reluctance to invest approaches an asymptote of $R_{120A} = 0$. The Point of Indiscriminate Decision occurs when the function approaches this asymptote such that $|R_{120A}| = 10^{-6}$, corresponding to the maximum risk-aversion for a rational decision maker, $\varepsilon_{\max}$. Again, this point can be found numerically.

maximum risk multiplier is a close approximation to the Limiting Risk Multiplier. [43] For the Protopower safety scheme, the Limiting Risk Multiplier is calculated to be 3.56. Hence the maximum that Protopower should be prepared to spend on the tertiary containment structure is $\delta Z = M_R \delta Z_0 = 3.56 \times 4.61 \times 10^6 = 16.4$ million euros. Protopower concludes therefore that it does not wish to implement the measure at a cost of 200 million euros.

Wishing to continue operating in Germany, Protopower instigates the environmental precaution as required under the law and against its better judgment, demanding compensation from the government for the cost by asserting that the measure was a form of regulatory expropriation. The German government refuses to pay, stating that the law was a reasonable exercise of regulatory discretion for the purposes of protecting the environment from radiation. Pursuant to Art 10 of the Germany-Ruristan bilateral investment treaty, Protopower brings a claim in international arbitration against Germany at ICSID. Their claim is based on Germany's alleged violation of Art 4(2) of the treaty, guaranteeing that there will be no expropriation of foreign investors' assets without full compensation. The question falling to the arbitration tribunal is first, whether or not the regulation dictating that the safety precaution on the nuclear power plant investment should be viewed as unreasonable and therefore a measure tantamount to expropriation. If the measure is not viewed as an act of expropriation, then no compensation is payable to Protopower by the German government. Secondly, in the event that the answer to the first question is that the regulation is not reasonable and therefore does constitute a form of indirect expropriation, the tribunal must determine the level at which compensation

[43] ibid

should be set to compensate the investor for the loss of value of their assets, namely the nuclear plant.

Given that the required spend exceeds the maximum that rational decision maker should be willing to spend, the environmental regulation should be viewed by an investment tribunal as grossly disproportionate and therefore an act of expropriation. Secondly, the amount of compensation due to the investor would consist of the extent to which the regulation was unreasonable, meaning that it imposed costs that did not lead to justifiable outputs in terms of environmental protection. By the Disproportion Factor Model, the maximum amount that is would have been reasonable to ask Protopower to spend on extra protection would have been 16 million euros. Therefore Protopower should be entitled to 200 million euros − 16 million euros = 184 million euros in compensation.

V Conclusion

Applying utility theory together with the auxiliary concepts of the Point of Indiscriminate Decision and the Permission Point, the Disproportion Factor model offers a mathematical justification for the concept of gross disproportion with respect to protection systems to guard against environmental loss. This method is important because the concept of regulatory expropriation in international investment law, is informed by this often highly discretionary consideration, an assessment of which falls to international arbitration tribunals as the specified for a for the resolution of disputes brought under IIAs. The Disproportion Factor model, which can be applied without the need for a sophisticated understanding of the underlying mathematical calculations, can provide useful guidance to investment arbitrators in the

determination of whether regulations imposed by host states against foreign investors should be viewed as indirect expropriations. It therefore clarifies whether there is an obligation on the part of the host state to pay compensation, or whether their regulatory actions should be viewed as legitimate exercises of governmental authority necessary to ensure environmental safety. Perhaps even more valuable is the Disproportion Factor's contribution to the gauging of an appropriate quantum of compensation. Rather than simply issuing a binary result of reasonable or unreasonable, the method yields a measurement of the degree of unreasonableness of a particular regulation relative to its costs and benefits, which can be readily adapted to disclose a total level of monetary compensation. The logic of the formula is that foreign investors, as with any private citizens, should not be forced to engage in behaviour that they would choose not to, were they fully informed of the costs to themselves and to society of their actions, and able to make the decision rationally. The ABCD model simulates the actions of a rational decision maker, and thus acts as an idealised proxy for the decision maker in the organisation in question. It is presumed that no person should be forced by law to act in an irrational way.

Whether a regulation that required a Disproportion Factor non-compliant spend might also be viewed as a breach of other international investment law protections, such as the Fair and Equitable Treatment standard seen in many IIAs in addition to indirect expropriation has not been examined here. The threshold for fair and equitable treatment violations is usually seen as a high one. For example, the tribunal in *Saluka v Czech Republic* stated that fair and equitable treatment requires that the host state "will not act in a way that is manifestly inconsistent, non-transparent (i.e. unrelated to some rational policy) or discriminatory (based on

unjustifiable distinctions)."[45] Furthermore, the Disproportion Factor model as considered here does not address harms to human health which may ensue from failures to instigate certain industrial safety precautions and which may often be a key component of environmentally-focused regulations. In order to capture human harms as well, the figure derived from the Disproportion Factor analysis must be incorporated with another formula, the J-Value assessment, giving the more comprehensive J_T-value (or Total Judgment Value) which has not been discussed in this article. [46]

Finally, the functionality of formula as an interpretive aid to adjudication is contingent upon accurate quantification of environmental costs and benefits, which is by no means certain. Nor can the frequencies of occurrence before and after a protection system has been installed be captured with absolute accuracy. While it may be somewhat less difficult to establish the financial costs to an investor's assets in terms of physical damage as well as the organization's role in an environmental disaster, the monetization of environmental harm may necessitate highly unscientific judgements, such as the value to society of cleaner air and a more aesthetically pleasing landscape. Nevertheless it can be expected that figures for environmental damage and frequency of occurrence may be found that may be agreed between the two parties even if their true values retain a degree of uncertainty.

Still, the value of the Disproportion Factor as a means of grounding the often highly ambiguous concept of reasonableness in the context of indirect expropriation in international investment law should not be understated. The formula's method of

[45] *Saluka v Czech Republic*, Partial Award, 17 March 2006

[46] P Thomas and R Jones, 'JT-Value Assessment of Schemes To Protect Against Accidents With High Human and Environmental Costs 43:5 Measurement and Control 152 (2010). The J-Value has been applied to decision-making by the World Trade Organization 1Dispute Settlement Body: D Collins, 'Health Protection at the World Trade Organization - The J-Value as a Universal Standard for Reasonableness of Regulatory Precautions' 43:5 Journal of World Trade 1071-1091 (2009)

objectively balancing between the costs and benefits of a particular course of action is a highly valuable tool in arbitral decision-making as it provides helpful direction regarding the extent of environmental precautions that governments should expect private citizens to take on the basis of informed rationality. This will in turn assist investors in appreciating the level of risk inherent in particular FDI projects as well as provide host states with a more full understanding of the level of investor expectation engendered by their commitments made in IIAs. Taken together this should reduce the uncertainty associated with engaging in foreign investment, surely enhancing global FDI flows.