

Horn, Henrik; Sanctuary, Mark

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Investment Treaties and the Replacement of Stranded Investment

Henrik Horn and Mark Sanctuary

INVESTMENT TREATIES AND THE REPLACEMENT OF STRANDED INVESTMENT*

Henrik Horn[†]

Research Institute of Industrial Economics (IFN), Stockholm
Centre for Economic Policy Research, London

Mark Sanctuary[‡]

IVL Swedish Environmental Research Institute, Stockholm
KTH Royal Institute of Technology, Stockholm

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[†]Address: Research Institute of Industrial Economics (IFN); Box 55665, SE-102 15 Stockholm, Sweden. Email: henrik.horn@ifn.se.

[‡]Address: IVL Swedish Environmental Research Institute, Box 21060, SE-100 31 Stockholm, Sweden. Email: mark.sanctuary@ivl.se.

Abstract

A common claim holds that investment treaties reduce the willingness of host countries to regulate foreign-owned, environmentally-stranded, investments. A counter-argument is that the treaties can yield incentives for environmentally-friendly replacement investment. This paper examines these claims in a stylized setting with a stranded investment and a potential replacement investment, both of which are protected by an investment agreement. The paper shows how treaty protection weakens incentives for environmental protection. The paper also shows how the extent of environmental damage depends on the implementation of core legal notions, such as investor legitimate expectations, the full compensation requirement, carve-outs from compensation obligations, and what qualifies as an investment.

JEL Codes: F21, F23, F53, K33

Keywords: Investment treaties, environmental degradation, regulatory chill, legitimate expectations, transition risk

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1 Introduction

There are more than 2 500 *international investment agreements* that are in force globally.¹ The treaties contain a range of substantive provisions that protect investor interests. They almost invariably include investor-state dispute settlement (ISDS) mechanisms that enable foreign investors to pursue disputes outside host country legal systems. It is alleged that the agreements' potentially far-reaching compensation obligations combined with the ISDS mechanisms can curtail host countries' willingness to pursue legitimate government policies. Such *regulatory chill* has been alleged to be a problem in particular with regard to host country climate policies.^{2,3} There is also an emerging debate regarding the impact of these agreement on biodiversity protection. [IPBES \(2019\)](#) estimates that of some 8 million existing animal and plant species, around 1 million species already risk extinction, many within decades. To prevent further species losses it will be necessary to regulate large stocks of environmentally-unfriendly investments. A potentially serious obstacle is that these stranded investments are often foreign-owned, and can therefore be protected by the 'investment treaties.

It is easy to agree with the concerns regarding the impact of investment treaties on environmental protection. These agreements have been intensively criticized on a wide range of aspects in both the policy debate, and in the academic literature. Due to their shortcomings, the agreements are often alleged to impose too stringent compensation requirements on host countries to foreign investment.

There is a counter-argument to the alleged adverse environmental effects of the agreements that is hard to dismiss, however. The required phase-out of environmentally stranded investments will lead to large income losses for employees, lost tax revenues, etc. Such regulations will not be politically viable unless the regulated investments are replaced. The estimated required investment flows are indeed very large. For instance, [Deutz et al. \(2020\)](#) estimate that between USD 598 billion and USD 825 billion a year will be needed in the form of public and private sector investments to close the biodiversity funding gap. It can thus be argued that strong investment protection will be necessary

¹ Investmentpolicy.unctad.org/international-investment-agreements.

² The Energy Charter Treaty in particular has been alleged to be detrimental in this regard. This is a trade and investment agreement for the energy sector with approximately 50 member states, including the EU, all individual EU member states except for Italy, the UK, and Japan. The agreement was recently renegotiated to to better align it with climate policy targets. But several EU member states are nevertheless leaving the agreement, citing its incompatibility with the 2016 Paris Agreement on the climate.

³ See [Rarrick \(2019\)](#) for an analysis of legal aspects of the environmental impact of investment treaties.

to achieve in particular the required private investments. The purpose of this paper is to examine the how to reconcile these views regarding the impact of investment treaties on the transition to production with less damaging environmental impact.

To examine this issue we consider a setting in which there is both a stranded investment that a host country wants to phase out with regulation, and a potential replacement investment. The investments are protected by an investment treaty that was in force before the stranded investment was made. The host country incentives to regulate the stranded investment depend on the probability that it will have to compensate the investor, and on its expectations regarding a replacement investment. Investor incentives for replacement investment in turn depend on expected future regulatory treatment by the host country. The more specific purpose of the paper is to examine how an investment agreement affects the transition to more environmentally-friendly production, when the incentives for regulation and for replacement investment, are interrelated in this manner.

We thus assume that at the outset of the interaction, a firm in country Source has already made an irreversible investment in country Host that causes environmental damage, denoted the “stranded” investment. The interaction starts with Host’s decision regarding whether to impose regulation to phase out production. In case of regulation, the investor can respond by undertaking a replacement investment, or by exiting the host country. When replacing the investment, the investor determines the environmental damage that the replacement investment causes. Finally, if a replacement investment has been made, Host determines whether or not to regulate the replacement investment. Host and the investor have conflicting interests: larger environmental damage increases investor profits but reduces Host welfare. Absent an investment agreement Host would regulate the stranded investment, and the investor would respond with either a sufficiently environmentally-friendly replacement investment that Host abstains from intervening, or by exiting the market.

The investment agreement between Host and Source can lead to a compensation requirement for Host if it regulates production, depending on the uncertain determination of the arbitration panel to be appointed in case of a dispute. To capture the “legitimate expectations” notion, which is a central feature of the implementation of investment agreements, it is assumed that the investor has a higher probability of receiving compensation in case of regulation of the stranded investment, which was made before the environmental impact of the investment became a policy concern, than over the replacement investment that is made after this concern has become known.

In this setting, the compensation requirement in the agreement has the expected direct

effect of dissuading Host from regulating both the stranded and the replacement investment. Yet there is also an indirect effect: the agreement can also provide incentives for the investor to make a more environmentally-friendly replacement investment. A central question, therefore, is whether or not the investment agreement leads to a better environmental outcome. We show that the investment agreement has a detrimental impact on the environment. This rather stark outcome arises from a central feature of investment agreements: strengthened incentives for foreign investment by reducing regulatory risk, which is also a weakening of Host's incentives to impose regulation.

The agreement can indeed in certain cases induce the investor to make a replacement investment that is less damaging to the environment than the stranded investment. However, the probability of compensation that the agreement implies induces the investor to choose a more environmentally-damaging design for the replacement investment than the investor would choose without the agreement. Absent an agreement, the threat of regulation of the replacement investment will force the investor to choose a sufficiently small environmental damage that Host will refrain from regulating it. But the protection the agreement gives to the replacement investment means Host will be less inclined to regulate the stranded investment. The investor takes advantage of this by *increasing the damage* from the replacement investment. This worsening of the damage from the replacement investment also serves to weaken Host's incentive to regulate the stranded investment.

These findings suggests a more general feature of investment treaties: whether they stimulate investments will depend on whether it is technologically feasible for investors to accommodate regulation risks through the design of their investments. When this is not feasible, investors might invest only if protected by a treaty. This is the archetypical depiction of the benefit of treaty protection against direct expropriation, where the host country seizes the income stream from the investment. In this case a treaty can stimulate investment since there is no scope for the investor to adapt their investment to avoid this type of direct expropriation.

However, when it is technologically feasible for an investor to adjust the investment, the investment can be undertaken even absent an agreement by adapting the investment to meet Host country's regulatory objective. The protection from an agreement is then irrelevant to the entry decision. But the protection enables the investor to opportunistically extract surplus from the host country through the design of the investment. For instance, this can be the outcome when an investor designs its investment so as to avoid an indirect (regulatory) expropriation, as in the present setting.

The setting also yields insights regarding the interpretation of vaguely drafted treaties. A central aspect of treaty interpretation is the amorphous legitimate expectations notion. Applied to the present setting, we stipulate that the probability of Host prevailing in a dispute should be higher for the replacement investment than for the stranded investment. On the face of it, this notion seems detrimental to environmental protection. However, upon closer scrutiny the impact is less clear. A high probability for Host to prevail in a dispute regarding the replacement investment can make the investor less prone to undertake the replacement investment, which would have a positive environmental impact in case of regulation of the stranded investment, and this would strengthen Host's incentive to regulate the stranded investment.

A second crucial issue is the implementation of a basic principle in international law regarding state responsibility to *fully compensate* for unlawful acts. It is typically taken to imply that investors should receive the full discounted flows of foregone future earnings on affected investments. However, when a replacement investment is triggered by regulation of a stranded investment, the actual harm to the investor from the regulation is not what is lost from not being allowed to operate the stranded investment, but the *difference* between the lost profit on the stranded investment, and the profit made on replacement investments that otherwise would not have been undertaken. Failure to take this latter feature into account tends to dissuade regulation of the stranded investment.

A third issue relates to calls for increasing Host country "policy space" through interpreting agreements differently, or by defining concepts used in the treaties and/or introducing exception clauses, etc. To capture these developments, the paper examines how a *carve-out* from compensation obligations for sufficiently severe environmental damage can lead to a more environmentally-friendly replacement investment.

A fourth issue is the meaning of the term "investment" in the agreements. One possible reading is that a replacement investment is a novel investment, and that it is therefore not covered by the agreement until it has been undertaken (assuming that the agreement does not include pre-investment protection). An alternative understanding is that the replacement investment is a modification of the stranded investment, and as such covered by the same protection as this investment. This distinction can have important implications, since the first interpretation can give the host country more scope to screen the replacement investment, than the second reading. Such screening can in the present setting make Host more prone to regulate the stranded investment, and can induce the investor to choose a more environment-friendly design for the replacement investment.

Finally, there is a small theory literature on investment agreements, including con-

tributions by Aisbett et al. (2010a), Aisbett et al. (2010b), Horn and Tangerås (2021), Janeba (2019), Konrad (2017), Ossa et al. (2023), Schjelderup and Stähler (2021), and Stähler (2023). The set-up in the present paper differs from these analyses in several ways, including:

- The paper allows for *interaction between a stranded and a replacement investment*.
- Most studies of investment treaties study implications for invested volumes, implicitly assuming that qualitative features of the investments remain unaffected by the agreements. This paper also includes a *qualitative* feature of a replacement investment, the extent of environmental damage from a replacement investment.
- The model allows for *different compensation obligations* depending on whether regulated investments were made before or after the particular environmental damage appeared as a policy concern, to capture the central notion of “legitimate expectations” in case law.
- The paper examines the potential role for *pre-investment protection* in the context of investment agreements.

2 A brief background on investment treaties

Investment treaties started to appear in the late 1950s, during a period when expropriations were becoming increasingly common in developing countries. They were initially bilateral agreements between developed and developing countries. Today a significant share of the bilateral agreements are between developing countries, and investment protection is also included in most major trade and investment agreements.

A clear distinction can be drawn between the treaties formed up to around 2015, and a smaller number of recent treaties. The focus of our paper is on the former, “traditional”, agreements. These treaties are characterized by vaguely formulated obligations, and almost always include ISDS mechanisms that apply without restrictions. In contrast, the much smaller group of recent agreements, such as the trade and investment agreements concluded by the EU, include a number of features that reduce the discretion of arbitration panels.

Traditional treaties typically have very similar basic structures, so similar that they are sometimes referred to as “boilerplate” agreements.⁴ Virtually all agreements require

⁴ See e.g. Dolzer et al. (2022) for an introduction to International Investment Law.

host countries to provide “fair and equitable treatment” (see below). They also require compensation in case of both direct and “regulatory” (indirect) expropriation. Direct expropriation occurs when a host country seizes an investor’s asset. A regulatory expropriation is an intervention by the host country that has largely the same effect for an investor as a direct expropriation, but without a formal seizure of the asset.

The agreements also often include clauses regarding “full protection and security”, prohibitions of performance requirements, freedom for top management to enter and remain in the host country, the right for investors to freely transfer earnings, etc. The agreements furthermore typically include stipulations regarding compulsory dispute settlement, and allow both investors and source country governments to initiate disputes. Most countries are signatories to conventions that require courts in the signatory states to recognize and enforce arbitral awards from any other signatory state. The enforcement mechanisms are consequently much stronger than those in international trade or environmental agreements.

Vague obligations give arbitration panels significant discretion. The obligations to provide full protection and security, and fair and equitable treatment, and to compensate in case of indirect expropriation, are extremely vague. These concepts are typically not defined in traditional agreements, thus leaving to arbitration panels to interpret these notions. Panels are not obliged to adhere to previous judgments and interpretations, but in practice often seek inspiration from earlier determinations. Panels thus have significant freedom when applying a traditional agreement to any particular dispute.

The freedom that panels have to interpret traditional agreements have made the outcome of panel determinations *uncertain*. For instance, [Schmidl \(2021\)](#) compares the reasoning regarding alleged violations of the fair and equitable treatment provision in the Energy Charter Treaty in 28 arbitration reports, involving Spain, Italy and Czechia. Despite the significant similarity of the factual circumstances in these cases, panels have used three different lines of reasoning, leading to different conclusions regarding the legality of the contested measures.

The “legitimate expectations” notion. When interpreting the vague obligations regarding e.g. fair and equitable treatment and indirect expropriation, arbitration panels typically rely on a notion of “legitimate expectations”. This concept is almost as elusive as the obligations it is meant to clarify, at least when viewed from an economic point of view. However, a common line of reasoning by panels is that investors can legitimately expect a

stable policy environment, unless they have received information regarding policy changes to come, before making their investments. Hence, investors should be compensated if Host undertakes policy changes that reduce their profits, if the changes were not announced before investments were made. On the other hand, investors have weaker protection for losses arising from policy changes that were announced before investments were made, or that the investors should reasonably be able to foresee.

Investor-friendly interpretations by arbitration panels. Traditional agreements have sometimes been interpreted to impose *far-reaching compensation obligations* by arbitration panels. An often cited example - and infamous in the view of critics of investment agreements - is an arbitration report from 2003 regarding the fair and equitable treatment provision, which states:

... The foreign investor expects the host State to act in a consistent manner, free from ambiguity and totally transparently in its relations with the foreign investor, so that it may know beforehand any and all rules and regulations that will govern its investments, as well as the goals of the relevant policies and administrative practices or directives... Any and all State actions conforming to such criteria should relate not only to the guidelines, directives or requirements issued, or the resolutions approved thereunder, but also to the goals underlying such regulations.⁵

Several subsequent panels adopted this line of reasoning. But panels have lately often taken considerable distance from this interpretation. What is clear however, is that some panels have interpreted investment treaties to impose very stringent compensation requirements on host countries.

Many environmental disputes. There have been several hundred investment disputes regarding fossil fuels.⁶ Among recent cases, Italy was requested to compensate the UK oil company Rockhopper with EUR 190 million for an offshore drilling ban, imposed for environmental reasons. US-incorporated Lone Pine Resources sought USD 104 million in compensation from Canada for the revocation of an exploration license in respect of a shale gas concession, but the request was denied by the arbitration panel.

⁵ *Técnicas Medioambientales TECMED S.A. vs. The United States*, Case N. ARB (AF)/002, International Centre for Settlement of Investment Disputes, May 29, 2003.

⁶ See [Di Salvatore \(2021\)](#) for a comprehensive examination.

German industrial groups RWE and Uniper pursued disputes against the Netherlands regarding its recent ban on coal-based power generation, in which the companies unsuccessfully demanded more than EUR 3.5 billion in compensation.⁷ There is an ongoing dispute between the US firm Westmoreland and Canada concerning Alberta’s decision to regulate coal-fired power plants by 2030, in which the investor is requesting CAD 470 million in compensation.⁸ The Swiss firm Azienda Elettrica Ticinese has initiated arbitration proceedings against Germany regarding the regulation of coal-generated electricity.⁹ Australian Zeph Investment is seeking compensation for a climate-motivated ban on coal mining, claiming damages of AUD 41 billion. There have also been more than 90 invocations regarding renewable energy investments, most of which concern revoked support schemes. Many of these are ongoing.¹⁰

Carve-outs. There have been several developments during the last decade that have led to implicit or explicit carve-outs from substantive obligations in agreements. One such trend is a gradual shift toward more host country-friendly interpretations of traditional agreement. There have also been renegotiations of traditional agreements. For instance, the Energy Charter Treaty was recently renegotiated, partly with the aim to make it more compatible with climate objectives. Another major example is the renegotiation of NAFTA. The revised agreement no longer allows for ISDS between Canada and the other two countries, and there is drastically reduced scope for ISDS between the US and Mexico. There have also been unilateral termination of some agreements; for instance, several EU countries are in the process of leaving the Energy Charter Treaty.

Yet another development is that some new agreements already from the outset include considerable restrictions on the ambit of substantive provisions through e.g. definitions of central terms in the provisions and inclusion of exceptions clauses. These amendments limit the scope for arbitration panels to make far-reaching interpretations of the agreements. Recent agreements also sometimes include restrictions on the use of the ISDS mechanisms, for instance by requesting a “cooling off period” before arbitration can start, or by requiring that investors exhaust local remedies before turning to arbi-

⁷ See [Bohmer \(2021a\)](#), [Bohmer \(2021b\)](#), and [Putter \(2021\)](#) for descriptions of these disputes. The Uniper case was reportedly withdrawn as part of the agreement between the German government and Uniper regarding the recent government bailout of Uniper; see [Bohmer \(2022\)](#). The RWE dispute was discontinued due to its intra-EU character.

⁸ See e.g. [Brouwer \(2023\)](#).

⁹ See [Bohmer \(2023\)](#).

¹⁰ See [Mehranvar and Sachs \(2024\)](#) for an excellent account of the institutional background, and the core legal issues involved, in the renewable energy disputes against Spain.

tration. All these developments give host countries more freedom to regulate without having to compensate investors for resulting losses.

3 The setting

We study country Host’s incentives to regulate an existing “stranded” investment, and a subsequent replacement investment, by an investor in country Source. The description of the setting begins with a definition of Host’s welfare function, the investor’s profit function, and a joint welfare function. We then describe the sequence of the interaction between Host and the investor. Thereafter, we introduce the investment agreement.

Host welfare. The investment yields commercial benefits to Host in the form of e.g. consumer surplus, employment, technological spillovers, or learning-by-doing by the workforce. But the investment also imposes a cost on Host in the form of environmental damage. The magnitude of the damage is determined by the variable $\beta \geq 0$, with a larger β corresponding to a more adverse impact.¹¹ If the investment is operational, Host welfare level is $V(\beta)$. Host obtains neither commercial gains, nor suffers environmental damage, if the investment is not operational, yielding Host the welfare level 0. The commercial benefits that accrue to Host mean that Host prefers production if β is sufficiently small, $V(0) > 0$. But Host welfare strictly falls in the level of environmental damage, $V_\beta < 0$ and $V_{\beta\beta} \leq 0$ (subscripts on function operators denote partial derivatives). There is thus a $\beta_{V=0} > 0$ such that $V(\beta_{V=0}) \equiv 0$ (see Figure 1).

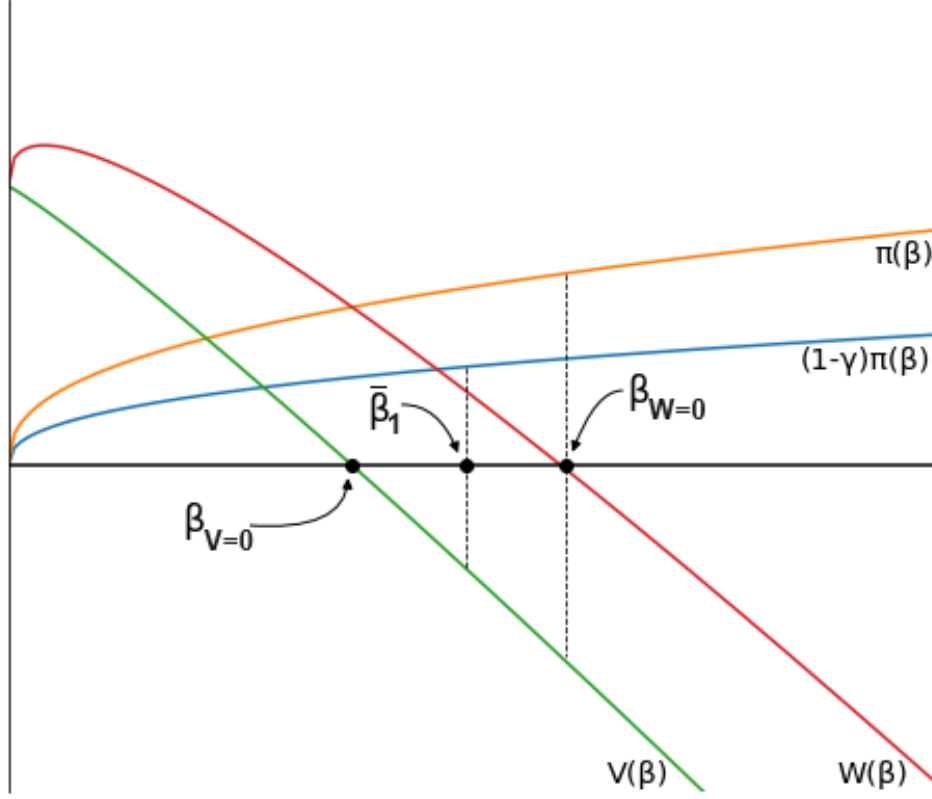
Investor profits. If there is production with environmental impact β , the foreign investor will reap operating profits $\Pi(\beta)$. Environmental protection is costly and Host’s operating profits therefore strictly increase in the environmental damage, $\Pi_\beta > 0$. There is an upper limit $\beta_{\Pi-\max}$ to how much the investor can benefit from the environmental damage: $\Pi(\beta) = \Pi_{\max}$ for $\beta \geq \beta_{\Pi-\max}$.

Joint welfare. To measure the welfare impact from an aggregate perspective, we occasionally use the joint welfare of the parties. If there is production, joint welfare is $W(\beta) \equiv V(\beta) + \Pi(\beta)$, and $W = 0$ if there is no production.¹² Joint welfare is particularly relevant in settings where there are investments between the two countries in both

¹¹ In Section 6.3 we discuss the case where Source is also affected by the environmental damage

¹² We consider trans-boundary environmental damage in Section 6.3.

Figure 1: Welfare and profits as functions of environmental damage



directions, so that each country is both a source and a host country. If countries are fully symmetric they have a common interest in a treaty outcome that maximizes joint welfare.

It is assumed that as the environmental damage gets worse, the adverse effect on Host welfare dominates the positive effect on profits from a joint welfare perspective: $W_\beta < 0$ for $\beta > \beta_{V=0}$. Since there is an upper limit to $\Pi(\beta)$, there is a $\beta_{W=0} > \beta_{V=0}$ such that $W(\beta_{W=0}) \equiv 0$ (see Figure 1).

The sequence of events. At the outset of the interaction, the Source firm has made an irreversible investment with environmental damage β_0 . Absent an investment agreement, the interaction then occurs in three stages:

- Host decides whether to regulate the stranded investment without compensation, or to allow production.
- If the stranded investment is regulated, the firm decides whether to replace the investment with an environmental damage β_1 , or to exit Host.

- In case of a replacement investment, Host decides whether to regulate the replacement investment without compensation, or to allow production.

Hence, if there is no regulation of the stranded asset, production proceeds with the environmental damage β_0 , and the interaction ends. The resulting welfare levels are then $V(\beta_0)$ and $\Pi(\beta_0)$.

If there is regulation of the stranded asset, and no replacement investment, welfare and profits will be zero. If there is a replacement investment, the investor will choose the associated environmental damage β_1 . If the replacement investment is not regulated, production proceeds with environmental damage β_1 , yielding welfare levels $V(\beta_1)$ and $\Pi(\beta_1)$. If the replacement investment is also regulated, both welfare levels will be zero and there will be no further investment. This assumption is a simplification to avoid having to consider an indefinite sequence of replacement investments and ensuing regulations, which would seem empirically rather implausible, even as an out-of-equilibrium consideration (see discussion in Section 6.2).

This setting captures a central feature of the environmental problem: when a host country decides to regulate the stranded investment, it has to take into account whether it will be replaced with a more environmentally-friendly investment. This will in turn depend on Host’s expected treatment of the replacement investment. The investment agreement considered affects both these regulatory decisions, as well as the decision regarding whether to replace the stranded investment (if regulated).

The agreement. Host and Source are parties to an investment agreement that entered into force before the stranded investment was made, at a time when the resulting environmental damage was not seen as an important policy issue. The agreement can request Host to compensate the investor in case of regulation. Any regulation will be challenged by the investor.¹³ The outcome of an investment dispute is not known with certainty. It is assumed that the investor has a higher probability of prevailing in a dispute over the “stranded” investment than for the replacement investment. This captures the legitimate expectations notion: the investor is more likely to prevail in a dispute regarding the stranded investment, which was undertaken before the environmental damage became a policy issue, than in a dispute concerning the replacement investment, which is undertaken after this policy objective has become known. Formally, the probability that the regulation of a stranded investment is found to not be compensable is $0 \leq \phi \leq 1$, and

¹³ For simplicity we do not include the investor’s decision to litigate. See Horn and Tangerås (2023) and Horn (2023) for analyses that include litigation decisions.

the probability that Host will prevail in a dispute regarding a replacement investment is $0 \leq \gamma \leq 1$, and reflecting the legitimate expectations notion, $\phi \leq \gamma$.

With regard to the magnitude of the compensation, it is a well-established paradigm in international law that states should provide “full compensation” when committing unlawful acts. A standard interpretation of this notion is that the compensation should be equal to the value of the discounted flow of income from the investment that is foregone due to the illegal measure. We assume that this equals $\Pi(\beta_0)$ or $\Pi(\beta_1)$ depending on whether the illegal measure concerns the stranded or the replacement investment, since this seems aligned with observed arbitration panel behavior. We point to a fundamental reason why this might be an incorrect implementation of a full compensation notion in Section 5.2.

4 The outcome

The outcome of the interaction is solved for backwards in standard fashion. This section thus first considers Host’s decision regarding whether to regulate a replacement investment. It then examines the investor’s incentive to make such an investment, given the regulatory treatment it expects. Third, the section considers Host’s decision with regard to whether to regulate the stranded investment, in light of the implications regarding replacement investment.

4.1 Host’s decision on regulation of a replacement investment

Host’s incentive to regulate the replacement investment increases in the environmental damage from the replacement investment. Assume that the investor has made a replacement investment with the environmental impact β_1 . If Host regulates, there will be no production, and hence no commercial benefits from the investment, nor any environmental damage. Host welfare is 0 in these respects. But there will be a dispute that Host will lose with probability $1 - \gamma$, in which case Host will have to pay compensation $\Pi(\beta_1)$. If Host instead permits production it gets welfare $V(\beta_1)$. The benefit for Host from a regulation of the replacement investment will thus be

$$Z^1(\beta_1, \gamma) \equiv -(1 - \gamma)\Pi(\beta_1) - V(\beta_1), \quad (1)$$

and Host will be indifferent between no regulation and regulation if $\beta_1 = \bar{\beta}_1$, given by¹⁴

$$Z^1(\bar{\beta}_1) \equiv 0. \quad (2)$$

Intuitively, a larger β_1 means a larger profit foregone by the investor in case of regulation, since $\Pi_\beta > 0$ for $\beta < \beta_{\Pi-\max}$. This tends to make regulation less attractive for Host, since Host will be requested to compensate with probability $1 - \gamma$. But a larger β_1 , also means lower Host welfare should Host abstain from regulation. This tends to make regulation a more attractive option for Host. It is in principle ambiguous how the level of β_1 affects the choice between no regulation and regulation. But the assumption that $W_\beta < 0$ implies that

$$Z_\beta^1 = -(1 - \gamma)\Pi_\beta - V_\beta > -V_\beta - \Pi_\beta = -W_\beta > 0.$$

That is, with increasing β_1 the adverse environmental effect will increasingly tend to dominate the expected compensation cost, making it increasingly attractive for Host to regulate the replacement investment.¹⁵

Lemma 1 *Host regulates the replacement investment iff $\beta_1 > \bar{\beta}_1$.*

4.2 The investor's decision on whether to make a replacement investment

The investor has three options if the stranded investment is regulated:

- Make no replacement investment and exit Host.
- Make a replacement investment with sufficiently small environmental damage that Host will refrain from regulating it, that is, to choose $\beta_1 = \bar{\beta}_1$.
- Choose a replacement investment with a higher environmental damage that triggers a regulation by Host. This will lead to a dispute that the investor will lose with probability γ .

¹⁴ Bars denote critical levels with regard to a choice between regulating and allowing production.

¹⁵ In the type of situation depicted in Figure 1, there will always exist a $\bar{\beta}_1 > 0$. However, it is possible to conceive of situations where such a level of β_1 does not exist. This might occur when profits are too small relative to the negative welfare of the host country. But to keep the paper focused on our main points, we will assume away this possibility.

Formally, all three options are viable choices for the investor. However, the last option seems implausible. Investors would probably not deliberately design a replacement investment that would trigger regulation with certainty in the hope of getting large compensations should they win the resulting the disputes. To ensure this will not be the outcome, we assume that the expected profit from the maximally harmful investment is smaller than the profit from choosing a environmental damage level that makes Host just indifferent between regulating and not regulating the replacement investment:

$$\Pi(\bar{\beta}_1) > (1 - \gamma)\Pi_{\max}. \quad (3)$$

This inequality is more likely to be fulfilled, the larger is the probability that Host will prevail in a dispute regarding regulation of the replacement investment (the larger is γ).¹⁶ It is also more likely to be fulfilled when Host is not very sensitive to the environmental damage ($\bar{\beta}_1$ is large). The assumption also implies that $\Pi(\bar{\beta}_1) > 0$, making the option of exiting Host unattractive. Hence:

Lemma 2 *After regulation of the stranded investment the investor makes a replacement investment with $\beta_1 = \bar{\beta}_1$.*

4.3 Host's decision on whether to regulate the stranded investment

When deciding whether to regulate the stranded investment, Host balances the direct effects of regulation in terms of less environmental damage from the existing investment, loss of commercial benefits from the existing investment, and the possible compensation payment to the investor with probability $1 - \phi$. But Host also has to take into account the implications of its treatment of the stranded investment for subsequent replacement investment.

If Host does not regulate the stranded investment, there will not be any replacement investments. If Host regulates, it will lead to a replacement investment with $\beta_1 = \bar{\beta}_1$. Regulation of the stranded investment will thus yield Host the expected welfare $-(1 - \phi)\Pi(\beta_0) + V(\bar{\beta}_1)$, whereas allowing production yields $V(\beta_0)$. Let Z^0 be the gain to Host from regulating the stranded investment, compared to allowing production:

¹⁶ The term “more likely” refers not only to a change in a probability, but also to a larger parameter space.

$$Z^0(\beta_0, \bar{\beta}_1, \phi) \equiv -(1 - \phi)\Pi(\beta_0) + V(\bar{\beta}_1) - V(\beta_0). \quad (4)$$

If $Z^0(\beta_0, \bar{\beta}_1, \phi) > 0$, Host will prefer regulation of the stranded investment. Z^0 increases in β_0 by the assumption $W_{\beta_0} > 0$.

The level $\bar{\beta}_0$ of β_0 at which Host is indifferent between regulating and not regulating the stranded investment is then given by

$$Z^0(\bar{\beta}_0, \bar{\beta}_1, \phi) \equiv 0. \quad (5)$$

To see that such a value exists, note that evaluating Z^0 at $\beta_0 = \bar{\beta}_1$ gives

$$Z^0(\bar{\beta}_1, \bar{\beta}_1, \phi) = -(1 - \phi)\Pi(\bar{\beta}_1) \leq 0, \quad (6)$$

implying $\bar{\beta}_1 < \bar{\beta}_0$, that is, that Host would be better off choosing no regulation. It follows that $\bar{\beta}_1 < \bar{\beta}_0$. Conversely, as β_0 grows large, the right-hand side of (4) will increasingly be dominated by the term $-V(\beta_0) > 0$, since $\Pi(\beta_0)$ approaches the upper limit Π_{\max} for $\beta_0 \geq \beta_{\Pi-\max}$, making the expression positive. Consequently, by the continuity of the functions involved, there must exist a $\bar{\beta}_0$ that fulfils (5), with the following property:

Lemma 3 $\bar{\beta}_1 < \bar{\beta}_0$.

A comparison of (1) and (4) points to two factors that tend to make $\bar{\beta}_1 < \bar{\beta}_0$. First, the legitimate expectations notion implies that $\phi < \gamma$. This tends to make Host less prone to regulate the stranded investment than the replacement investment. Second, the level of $\bar{\beta}_1$ reflects that regulation of the stranded investment will lead to a replacement investment for which $V(\bar{\beta}_1) < 0$. However, regulation of the replacement investment will not lead to any further investment, and will as a result yield welfare 0 for Host. Hence, for Host to be indifferent with regard to the stranded investment requires more severe environmental damage than what is required with regard to the replacement investment.¹⁷

We can now summarize the outcome of the interaction as a function of the level of environmental damage of the stranded investment. To induce investment in less environmentally damaging production, existing investment needs to be regulated. However, regulation of the existing investment will lead to a dispute, and thus to an expected compensation payment. For regulation to be worthwhile for Host, the environmental the damage $\bar{\beta}_1$ from a replacement investment must be sufficiently smaller than the damage

¹⁷ See discussion in Section 6.2 regarding a multi-period version of the model.

from the existing investment β_0 . Host therefore only regulates the stranded investment for $\beta_0 > \bar{\beta}_0$. In sum:

Proposition 4 *The outcome of the interaction under the agreement is as follows:*

- (i) *Host refrains from regulating the stranded investment for $\beta_0 \leq \bar{\beta}_0$.*
- (ii) *Host regulates, and triggers a replacement investment with $\beta_1 = \bar{\beta}_1$, for $\bar{\beta}_0 < \beta_0$.*

4.4 Does the protection of the replacement investment benefit the environment?

As discussed above, it is sometimes argued that high levels of protection in investment agreements are desirable, since this will stimulate new investments with less environmental impact, and thereby ease the transition to production with less damaging environmental impact. To determine the impact of the agreement on environmental protection in this setting, we compare the outcome derived above with the outcome absent an agreement.

Absent the agreement, Host would regulate the replacement investment whenever $\beta_1 > \beta_{V=0}$. The investor would therefore choose to set environmental damage at Host's preferred level of $\bar{\beta}_1 = \beta_{V=0}$ to avoid regulation of the replacement investment. There are then two potential outcomes. If $\Pi(\beta_{V=0}) < 0$ it will not be profitable for the investor to make a replacement investment that will avoid regulation, so the investor exits Host. Such a case is illustrated in Figure 2. If instead $\Pi(\beta_{V=0}) \geq 0$ the investor makes a replacement investment with $\beta_1 = \beta_{V=0}$. In the first stage of the interaction Host therefore regulates the stranded investment if $\beta_0 > \beta_{V=0}$.

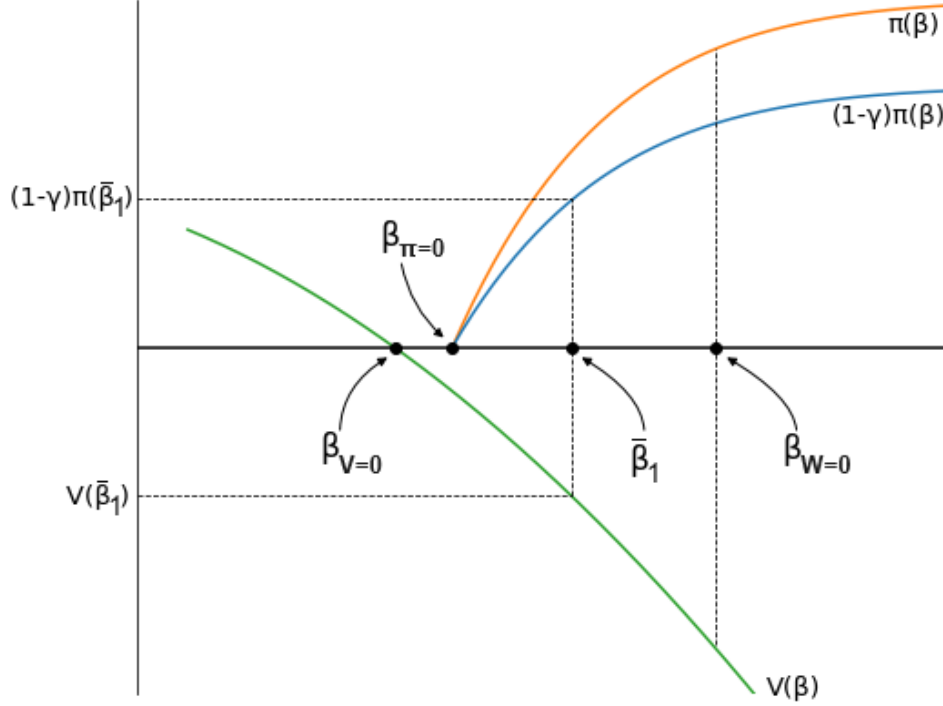
Under the agreement, Host does not regulate the stranded investment for $\beta_0 \in (\beta_{V=0}, \bar{\beta}_0)$. For higher levels of environmental damage Host regulates the stranded investment according to Proposition 4 irrespective of the agreement. The agreement will thus in this sense impose regulatory chill. For $\beta_0 > \bar{\beta}_1$ there will be regulation both with and without the agreement, since $\beta_{V=0} < \bar{\beta}_1$. But with the agreement there will be a replacement investment with $\beta_1 = \bar{\beta}_1$. Hence:

Proposition 5 *Relative to a situation without an agreement:*

- (i) *The agreement causes a replacement investment if $\Pi(\beta_{V=0}) < 0$ and $\beta_0 > \bar{\beta}_0$.*
- (ii) *The agreement worsens the environmental damage if $\beta_0 > \beta_{V=0}$.*

Intuitively, when $\Pi(\beta_{V=0}) < 0$ it will not be profitable for the investor to make a replacement investment absent the agreement. However, with the protection of the agreement,

Figure 2: A case where the agreement causes a replacement investment



it is possible for the investor to choose profitable, more environmentally damaging investment design that avoids regulation. This difference is relevant in cases where Host regulates the stranded investment under the agreement and thereby triggers the possibility for a replacement investment, that is, when $\beta_0 > \bar{\beta}_0$. Hence part (i). Part (ii) follows from the fact that the outcome with regard to the environmental damage under the agreement is always $\bar{\beta}_1$ or worse, whereas it is always $\beta_{V=0}$ without the agreement.

The argument regarding the stimulating effect on the replacement investment is hence partly correct in this setting. Under the case identified in part (i) of the proposition, the agreement *causes* a replacement investment that yields less environmental damage than the stranded investment. However, the argument fails to take into account two negative aspects of protection of the stranded investment. First, the environmental damage of the replacement investment $\bar{\beta}_1$ is larger with the agreement, since there would then be no production absent the agreement:

Observation 1 *The investment agreement can cause a replacement investment. The replacement investment will impose less environmental damage than the stranded investment. But there will be more environmental damage than if Host were not bound by the agreement.*

Second, as can be seen from (4) and the assumptions regarding V , the more negative is $V(\bar{\beta}_1)$, the larger is $\bar{\beta}_0$. This implies that the protection of the replacement investment will not only have the direct effect of regulatory chill on Host's regulation of this investment but also affect the regulation of the stranded investment:

Observation 2 *The regulatory chill effect of protection of the replacement investment will exacerbate the regulatory chill with regard to the stranded investment.*

The findings above suggest a more general feature of the investment incentives that investment treaties provide: *the impact of the agreement depends on whether investors can affect the probability of regulation by adapting the design of their investments to be in line with Host's policy objectives.* If this is not feasible for investors, protection of replacement investments can cause investors to make an investment that they would not make absent the agreement. This case can arise when the risk for host country intervention is unrelated to product design. For instance, when investment agreements protect against direct expropriation. These interventions are motivated by host countries' desire to get hold of the profit stream from the investments, and are thus hard for investors to protect against. In contrast, when interventions seek to achieve regulatory objectives, and it is technically and economically feasible for the investor to design investments so as to avoid regulation *also absent an agreement*, the agreement will not stimulate investment (at least not to the same extent). The investor can then instead use the protection that the agreement yields to extract surplus from the host country through an opportunistic design of the investment.

5 Treaty interpretation and the regulation of stranded investment

As noted above, investment agreements are vaguely drafted, so arbitration panels have significant discretion in determining the actual implications of the agreements. The findings above lead to several observations regarding how interpretations that are common in case law affect the outcomes.

5.1 The legitimate expectations notion

A central notion in case law, and in some agreements, is an investor's "legitimate expectations", as noted above. We have interpreted this to imply that the stranded investment

has stronger protection than the replacement investment, since it was made before environmental damage became a policy issue, and the replacement investment is made thereafter. To highlight the consequences if the legitimate expectations notion in more detail, we will first examine the consequences of increasing the wedge between ϕ and γ that the legitimate expectations interpretation imposes, by separately increasing γ and reducing ϕ . We will then consider an extreme version of this notion.

A stricter legitimate expectations interpretation from a marginal reduction in ϕ will weaken Host's incentives to regulate the stranded investment:

$$\frac{d\bar{\beta}_0}{d\phi} = \frac{-Z_\phi^0}{Z_{\beta_0}^0} = -\frac{\Pi(\beta_0)}{Z_{\beta_0}^0} < 0.$$

If the stricter legitimate expectations interpretation is instead caused by an increase in the probability γ (that Host will win a dispute regarding the replacement investment) will have the direct effect of strengthening Host's incentives to regulate the replacement investment,

$$\frac{d\bar{\beta}_1}{d\gamma} = \frac{-Z_\gamma^1}{Z_\beta^1} < 0,$$

given the definition of $\bar{\beta}_1$, $Z_\beta^1 > 0$ by assumption, and $Z_\gamma^1 = \Pi > 0$. But this will have an indirect effect on $\bar{\beta}_0$, since it is a function of $\bar{\beta}_1$ defined by $Z^0(\bar{\beta}_0, \bar{\beta}_1(\gamma), \phi) \equiv 0$. In particular, since an increase in γ will strengthen Host's incentive to regulate the replacement investment, the investor will choose a more environmental-friendly design for its investment to avoid regulation; that is, $\bar{\beta}_1$ will fall. This will in turn make strengthen Host's incentive to regulate the stranded investment:

$$\frac{d\bar{\beta}_0}{d\gamma} = \frac{-Z_{\bar{\beta}_1}^0}{Z_{\beta_0}^0} \frac{d\bar{\beta}_1}{d\gamma} < 0,$$

given the definition of $\bar{\beta}_0$, $Z_\beta^0 > 0$ by assumption, and $Z_{\bar{\beta}_1}^0 = V_\beta < 0$.

The legitimate expectations notion is hence a mixed blessing for environmental protection:

Observation 3 *The lower the legitimate expectations interpretation pushes the probability for Host to prevail in a dispute over the stranded investment, the less prone Host will be to regulate this investment. But the higher it pushes the probability that Host will prevail in a dispute over the replacement investment, the more prone will the host country be to regulate both this investment and the stranded investment.*

The impact of the legitimate expectations interpretation will thus be highly sensitive to what is taken as the benchmark for the comparison.

5.2 The full compensation principle

Investment agreements often state that compensation should be “full”, reflecting a general principle in international law regarding state responsibility for unlawful acts. This principle is often interpreted by arbitration panels as requiring that compensation should equal the discounted future cash flow that the affected investment would have generated, had it not been for the host country’s intervention. The agreement considered here captures this principle with the assumption that the requested compensation is $\Pi(\beta)$ in case the investor wins a dispute regarding an investment of type β . However, in the present setting there will be a replacement investment after regulation of the stranded investment that will generate profits for the investor. The externality from the regulation of the stranded investment is thus not the loss of profit from this investment, but the *difference* in the profits generated by the two investments, $\Pi(\bar{\beta}_1) - \Pi(\beta_0)$. This failure to adjust compensation for profits from replacement investments should imply that the logic behind the full compensation principle in international law is not correctly reflected.

The failure to adjust compensation for profits from replacement investments will also affect the efficiency of the outcome from a joint welfare perspective. Absent replacement investments, the full compensation principle that is assumed here would have the virtue of inducing Host to fully internalize the effect of its regulatory decision (Aisbett et al. (2010a), Horn and Tangerås (2021)). But in the present setting, the agreement fails to incentivize Host with respect to this difference.

The consequences of this can be seen in stark fashion if we consider an extreme, “strict”, version of the legitimate expectations notion. In this version any arbitration panel would rule that the regulation of the stranded investment must be compensated, $\phi = 0$, and any panel would allow Host to regulate the replacement investment, $\gamma = 1$. Host’s cut-off level for regulation of the replacement investment then becomes $\bar{\beta}_1 = \beta_{V=0}$, reflecting that when Host has free rein to regulate the replacement investment, there is no scope for the investor to make an opportunistic choice of environmental impact that harms Host. Furthermore, with $V(\beta_{V=0}) = 0$, Host will regulate the stranded investment for the definition of $\beta_0 > \bar{\beta}_0$, where the latter is given by

$$V(\bar{\beta}_0) + \Pi(\bar{\beta}_0) = 0, \tag{7}$$

Hence, Host will regulate whenever $\beta_0 > \beta_{W=0}$. In contrast, the jointly efficient outcome requires that the level of environmental damage from a replacement investment is

$$\beta^J \equiv \arg \max_{\beta} V(\beta_1) + \Pi(\beta_1), \quad (8)$$

and it is jointly efficient to regulate the stranded investment whenever $\beta_0 \neq \beta^J$. The assumption that $W_{\beta} < 0$ for $\beta > \beta_{V=0}$ implies that $\beta^J < \beta_{V=0} < \beta_{W=0}$. We thus have the following:

Observation 4 *The strict legitimate expectations interpretation induces Host to fully internalize the investor's direct loss of profits due to regulation of the stranded investment. But Host will not internalize the profits from a replacement investment that is generated as a result of the regulation, and will as a result tend to under-regulate from a joint welfare perspective.*

While the full compensation principle seems to require that awarded compensation is adjusted for profits from replacement investments, we believe that arbitration panels will often be unable to do so in practice. Suppose for instance that an investor will wait until after the conclusion of a dispute to make a decision on whether to make a replacement investment. The panel would then have to condition its requested compensation on whether or not there is a replacement investment, and furthermore on the magnitude of the expected discounted sum of future profits from this investment. Such conditional awards based on investments that have not yet been undertaken seem too speculative even by the standards of investment treaty case law.

A peculiar implication of the disregard of the profits from the replacement investment is that the investor can actually *benefit* from regulation of the stranded investment, since if the investor wins the dispute regarding this regulation, and thereby gets full compensation for the loss from the stranded investment, the investor will on top of this make some profit on the replacement investment. This is excluded in the present setting however, by the assumption in (3).

5.3 Carve-outs

The investment protection regime is gradually moving toward allowing host countries more freedom to protect the environment and the climate without having to compensate investors. These changes take different legal forms, but can in the present setting

naturally be seen as a carve-out from compensation obligations for sufficiently severe environmental damage. A simple representation of a carve-out is the following scheme:

$$\phi' = \begin{cases} \phi & \text{if } \beta_0 \leq \hat{\beta} \\ 1 & \text{if } \beta_0 > \hat{\beta} \end{cases} \quad \text{and} \quad \gamma' = \begin{cases} \gamma & \text{if } \beta_1 \leq \hat{\beta} \\ 1 & \text{if } \beta_1 > \hat{\beta} \end{cases}, \quad (9)$$

which allows Host to regulate without compensation if the environmental damage is sufficiently severe, $\beta > \hat{\beta}$. To capture the legitimate expectations notion we continue to assume that $\phi < \gamma < 1$. As will be seen, the impact of this carve-out will depend on how large the carve-out is, that is, how small $\hat{\beta}$ is.

(1) $\bar{\beta}_1 \leq \hat{\beta}$. The carve-out will not affect the regulation of the replacement investment, nor the choice of environmental damage $\beta_1 = \bar{\beta}_1$, as long as $\bar{\beta}_1 \leq \hat{\beta}$. However, it will induce Host to regulate the stranded investment for $\hat{\beta} < \beta_0 \leq \bar{\beta}_0$, since Host can then regulate without compensation, whereas it would have abstained from regulation absent the carve-out. Hence, a carve-out $\bar{\beta}_1 \leq \hat{\beta}$ will increase the range of β_0 for which there is regulation of the stranded investment, but the level of environmental damage from the replacement investment will not be affected by the carve-out, nor the range of β_1 for which there will be regulation of the replacement investment.

(2) $\beta_{V=0} \leq \hat{\beta} < \bar{\beta}_1$. The carve-out allows Host to regulate the replacement investment without compensation for $\hat{\beta} < \beta_1$ and will do so since $\beta_{V=0} < \beta_1$. It will therefore be better for the investor to set $\beta_1 = \hat{\beta}$, since the carve-out will then not apply, and Host will abstain from regulation since $\beta_1 < \bar{\beta}_1$ is too low to make regulation of the replacement investment worthwhile if this leads to possible compensation payments. There are then two possible cases with regard the stranded investment:

(i) If $\beta_0 < \hat{\beta}$, the carve-out is not applicable with regard to the stranded investment. However, since $\hat{\beta} < \bar{\beta}_1$ in the case, the carve-out will induce the investor to set $\beta_1 = \hat{\beta}$. Host will therefore regulate the stranded investment when

$$-(1 - \phi)\Pi(\beta_0) + V(\hat{\beta}) > V(\beta_0) \quad (10)$$

The carve-out will therefore increase the range of β_0 for which there will be regulation of the stranded investment, not by relieving Host of a compensation requirement for the stranded investment, but by making the replacement investment more attractive.

(ii) If instead $\beta_0 > \hat{\beta}$, Host can regulate the stranded investment without compensation.

This will give Host welfare $V(\hat{\beta})$ from the replacement investment. Since $V(\beta_0) < V(\hat{\beta})$ in this case, Host will regulate the stranded investment. Thus here there is a direct effect on the regulation of the stranded investment from a reduced compensation requirement for this investment.

(3) $\hat{\beta} < \beta_{V=0}$. If the investor sets $\beta_1 > \hat{\beta}$ Host can regulate the replacement investment without compensation, and will do so if $\beta_1 > \beta_{V=0}$. Hence, the investor can maximally set $\beta_1 = \beta_{V=0}$, while still avoiding regulation of the replacement investment. Host will then regulate the stranded investment whenever

$$-(1 - \phi)\Pi(\beta_0) + V(\beta_{V=0}) > V(\beta_0), \quad (11)$$

which will induce the investor to set $\beta_1 = \beta_{V=0}$. The carve-out thus affects both regulatory decision rules, and the investor's choice of environmental damage from the replacement investment.

It follows from the above that a carve-out from a compensation obligation can improve the environment in several ways, due to the interaction between the host country incentives to regulate the stranded investment and replacement investments, and the incentives for the firm in Source to reinvest:

Observation 5 *A carve-out from compensation requirements for regulation of severe environmental damage can reduce the resulting damage through one or several mechanisms:*

- *by making Host more prone to regulate a replacement investment;*
- *by inducing the investor to reduce the damage from a replacement investment;*
- *by making Host more prone to regulate the stranded investment.*

5.4 The investment notion

A number of countries have recently introduced investment screening with the stated aim of improving national security (see e.g. UNCTAD, 2023). These measure can come in conflict with undertakings in investment agreements, depending on the drafting of the agreements, although national security objectives are often seen as dominating other interests in international law. But as pointed out by Wagner (2023), the relations between investment screening and international investment law still remain largely obscure.

The freedom that parties to investment agreements have to determine the conditions for entry into their markets partly depends on whether their agreements apply to the

investment stage. Actual investment agreements fall into two broad categories in this regard. Under some agreements host countries retain the right to deny investors entry; for instance, this is typical of agreements with European partners. Other agreements, such as those with Canada, Japan and the US as partners, provide protection also prior to the investment stage. Such pre-investment protection is typically not be a free-standing obligation, but an extension of some other provision. Most common is that National Treatment and Most-Favored Nation provisions apply also to the entry phase, implying that the partner countries cannot have more favorable conditions for entry for domestic investors, or for investors from third countries.

The setting we have employed above points to a separate legal issue with regard to investment screening: *when should replacement investments be protected against investment screening by investment agreements, and when they should be seen as an investment de novo?* We are unsure how a typical arbitration panel would view a complaint regarding such a screening device applied to a replacement investment, but it will depend on the interpretation of the “investments” that are protected under investment agreements. This can become an important issue, since investment screening appears to be increasingly used to promote national commercial or regulatory interests.

To illustrate the benefit that Host would have from discretion over the mode of entry into its market, assume that Host can set an upper limit on the permissible environmental damage from the replacement investment, before the replacement investment is made. Host would then choose a level such that the investor is (almost) indifferent between entering or not entering. Since Host will then set the maximal permissible damage either at its most preferred level among levels for which the investor makes a replacement investment, or sufficiently high that there will not be any entry. This will increase the attractiveness for Host to regulate the stranded investment.

Observation 6 *Investment screening strengthens both Host’s incentive to regulate the stranded investment, and the investor’s incentive to choose a more environment-friendly design for the replacement investment.*

For Host, the freedom to effectively determine the environmental damage from the replacement investment is better than a carve-out with regard to the treatment of the replacement investment, unless the carve-out is large enough to allow Host to regulate without compensation for all $\beta_1 > 0$. On the other hand, the carve-out gives Host increased policy space also with regard the stranded investment, in contrast to pre-investment screening.

6 Alternative model specifications

The paper has employed an extremely stylized model to illustrate some possible mechanisms that might be at play in the context of investment treaties. Special as the model, the findings do seem robust to some natural generalizations.

6.1 More general probability functions for panel outcomes

We have for simplicity assumed that the probabilities ϕ and γ for the outcomes of disputes are parametrically given. It would be more plausible empirically to assume that the probability Host prevails in a dispute increases in the severity of the regulatory problem. With $\phi = F(\beta_0)$ and $\gamma = G(\beta_1)$, these functions would be weakly increasing in their respective arguments, to capture the sensitivity of the dispute outcomes to the severity of the regulatory problem: $F_\beta > 0$ and $G_\beta > 0$. Furthermore, the legitimate expectations notion would be reflected in the assumption $F(\beta) < G(\beta)$.

This generalization would not change the picture qualitatively, as far as we can see. The expression corresponding to (1) would thus be

$$Z^1(\beta_1, \gamma) \equiv -(1 - G(\beta_1))\Pi(\beta_1) - V(\beta_1).$$

Since this would add the term $G_\beta \Pi(\beta_1) > 0$ to the expression for Z_β^1 , it would make it more likely that $Z_\beta^1 > 0$, as was assumed above. It would have the same effect for Z^0 , since with

$$Z^0(\beta_0, \bar{\beta}_1, \phi) \equiv -(1 - F(\beta_0))\Pi(\beta_0) + V(\bar{\beta}_1) - V(\beta_0),$$

there would be an additional term $F_\beta \Pi(\beta_0) > 0$ in the expression for Z_β^0 , which make it more likely that $Z_\beta^0 > 0$.

6.2 Infinite horizon interaction

We have assumed that if Host regulates the replacement investment, there will not be any further replacement investments. This seems intuitively plausible, and it allowed us to capture in a simple fashion the notion that the threat that Host will lose a dispute regarding regulation of replacement investment reduces its incentive to regulate, and thereby allows the investor to opportunistically choose a more environmentally damaging investment than what Host would prefer. But this assumption is of course a considerable short-cut in an analysis that emphasizes dynamic features of the interaction between

a host country and an investor. More appropriate from a formal point of view would probably be to assume interaction over an indefinite horizon. However, we conjecture that our model can be seen as a truncation of an infinite horizon game.

As long as regulation of replacement investment is associated with some strictly positive probability that Host will have to pay compensation, Host will not regulate the replacement investment unless this leads to sufficiently reduced environmental impact from the next replacement investment. Hence, there must be a reduction in the level of environmental damage over time for there to be a sequence of regulation of the replacement investment. This will gradually reduce the profits of the investor. It seems natural to assume that with e.g. a lower bound on the level of β for which the investor makes a positive profit, or fixed investment costs, or litigation costs, there will be a point where it is no longer profitable for the investor to make a replacement investment. We could then make such a lower bound or cost sufficiently binding that the investor will not make more than one replacement investment, as is assumed here.

6.3 An international externality

The analysis above assumes that the environmental damage from the foreign investment only affects Host. In the context of biodiversity loss, this could be losses that affect e.g. the productivity of local agriculture. But environmental damage can of course have adverse consequences also for other countries. For instance, biodiversity loss in a host country can adversely affect source countries in several ways. There can be a negative pecuniary externality from e.g. higher import prices for source countries such as when the biodiversity damage reduces productivity in a host country export industry. Or biodiversity loss in the host country might affect the availability of products in source countries, such as when pharmaceutical products are based on plants in host countries that are damaged by forestry industry, or by clearing of land for agriculture.

There can also be more direct effects on a source country, as when there is cross-border pollution, or migration of invasive species. Either case could be incorporated into our formal setting by assuming that the environmental impact gives rise to a cost in Source. This would imply that regulation of the stranded investment tends to benefit Source, by reducing environmental damage, which has to be set against the cost in terms of expected loss of profits. When the environmental problem is mutual in this way, Host's decision with regard to the regulation of the stranded investment will be further distorted by neglect of the impact on Source's environment, which will yield a tendency towards too

little regulation.

The above framework could also represent adverse climate impact from the stranded investment. The biodiversity and climate problems are in practice often interrelated in various ways. For instance, many productive activities contribute both to biodiversity degradation and to climate change. Also, both biodiversity and climate regulation give rise to commercial costs that have to be set against environmental benefits.

But there are also differences between the two types of when considered from the point of view of investment treaties. First, for almost all countries, there are hardly any measurable benefits from their own climate policies, since there are almost no local effects from policies targeting global greenhouse gas emissions. But as argued above, biodiversity protection can create important benefits in host countries. Second, the climate impacts from regulatory measures are easy to compare, since emissions can typically be measured with a high degree of accuracy. There is much less consensus on how to measure and compare the benefits from biodiversity protection. The latter often involve saving the life of a few individuals of some endangered species, with unclear economic value, at the cost of well-defined commercial losses for investors. Hence, it is likely to be easier to identify cases where policies that are alleged to be pursued to protect the climate, in actuality have protectionist motives, than in the case of biodiversity policies.

7 Concluding remark

There is a global need to phase-out very large volumes of existing investments that are harmful to the environment broadly, and more specifically to biodiversity. It is often alleged that this process will be constrained by the protection that investment treaties give to a significant fraction of the stranded investments. A counter-argument holds however, that the phase-out of stranded investment will cause large economic losses in terms of e.g. reduced incomes for investors and workers, as well as lost tax revenues. It is therefore unlikely to occur unless investment treaties protect the required substantial replacement investments.

To shed some light on the compatibility of these claims, the paper develops a very simple model that incorporates both a stranded and a replacement investment. It shows how an investment treaty might affect the interaction between a host country's incentives to regulate stranded investment, and replacement investment. The paper also points to a number of implications for the interplay between regulation of the stranded investment and replacement investment, and for the interpretation of investment treaties.

Overall, the paper casts some doubts on the claimed beneficial effect of investment treaties on replacement investment. Within the examined setting, the agreement can indeed in certain cases induce the investor to make a replacement investment with better environmental profile than the initial stranded investment. However, this replacement investment will be more environmentally damaging than what would result if the host country were not bound by the agreement. The protection from the agreement allows the investor to choose a more environmentally damaging design than the investor would choose without the agreement.

This finding suggests more generally that the impact of investment treaties for investment incentives will depend on the extent to which is technically and economically feasible for investors to accommodate regulation risks through the design of their investments. When this is not feasible, protection can be needed for investment to take place. But when it is possible, the protection instead enables investors to opportunistically extract surplus at the expense of host country's environment through the design of their investments.

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