

Markets and the Kyoto Protocol: Lessons from AIJ Pilots

Donald F. Larson and Gunnar Breustedt*

Abstract

Under the Kyoto Protocol, countries can meet treaty obligations by investing in projects that reduce or sequester greenhouse gases elsewhere. Prior to ratification, treaty participants agreed to launch country-based pilot projects, referred to collectively as Activities Implemented Jointly (AIJ), to test novel aspects of the project-related provisions. Relying on a ten-year history of projects, we investigate the determinants of AIJ investment. Our findings suggest that review-agency preferences related to national political objectives and possibly deeper cultural ties influenced project selection and limited the number of AIJ projects. Bilateral ties also appear to have affected investment decisions directly, possibly because of related transaction costs. We conclude that if approaches developed under the AIJ programs to approve projects are retained, the scale of investment under Kyoto's flexibility provisions and their cost-savings will be less than what is generally anticipated and the resulting pattern of investment less driven by abatement costs.

Keywords: greenhouse gas; joint implementation; Kyoto Protocol; count model; selection model.

JEL classifications: C34, D72, F35, F37, P16, Q58

1. Introduction

The strategy to limit greenhouse gas emissions laid out in the Kyoto Protocol relies on a set of novel market-based flexibility provisions intended to mobilize private foreign investment through market incentives. This is important since the scale of investment required to significantly reduce emissions precludes governments acting alone (Vrolijk, 2000). Further, the flexibility provisions are expected to greatly reduce treaty implementation costs by allowing countries to meet national treaty-bound emission limits by investing in projects in developing or transition economies that reduce global

*Donald F. Larson is with the Development Research Group at the World Bank. Gunnar Breustedt is with the Department of Agricultural Economics, University of Kiel.

emissions at lower cost.¹ Global markets are envisioned, since the flexibility provisions permit trade in surplus allowances and credits generated through project investments.

In practice, the degree to which any particular investment activity generates credits toward treaty obligations depends on counter-factual baselines and other unprecedented features of the Protocol. Moreover, although the treaty provides guiding principles for implementation, the process by which projects are initiated and credits ultimately used relies heavily on national policies. Consequently, the decision to invest in Kyoto projects depends significantly on the heterogeneous institutions established in host and investor countries and on emerging conventions and standards among countries.

To gain experience, participants in the United Nations Framework Convention on Climate Change (UNFCCC) agreed to set up national pilot programs and agreed to report results from the pilots in a standard way. The national pilots, collectively referred to as Activities Implemented Jointly (AIJ), provide the most significant source of available experience on projects intended to offset greenhouse gas emissions. In this paper, we make use of outcomes from the AIJ pilots to draw inferences about how project investments might be determined under the investment provisions of the ratified Kyoto Protocol. Of particular interest are the rules and procedures for reviewing, approving and monitoring projects that grew up under the national pilots.

An important feature of the AIJ program that continues under the Clean Development Mechanism of the Kyoto Protocol is that investor and host government approval is required in order for private bilateral project investments to go forward. Descriptive studies of the AIJ program suggest that these approval processes provided opportunities for additional, sometimes unrelated, national political objectives to influence project selection. This differs from the conceptual depiction of Kyoto-related institutions as impartial regulators of project quality and suggests that the institutional arrangements that gave rise to AIJ investments outcomes are not fully consistent with the competitive market outcomes that are anticipated from the flexibility provisions of the Kyoto agreement. In our paper, we test this characterization of the AIJ program. We find evidence that project investments under the national AIJ programs were not independent of the types of political and cultural considerations that motivate traditional models of development assistance and that this limited the number of implemented projects.

Although the AIJ program and the current Kyoto project mechanisms differ in significant ways, we argue that the AIJ experience has relevance for current climate change policies for two reasons. First, because the national pilots were undertaken to build experience relevant for treaty implementation, countries may be inclined to retain institutions built up during the pilots. If so, and if these institutions continue to work to constrain investment choice, efficiency gains from the proposed flexibility mechanisms will be reduced. Therefore, understanding better the determinants of investments under early pilots can potentially identify key policies that could minimize or mitigate

¹ Jacoby, Prinn and Schmalensee (1998) and McKibbin and Wilcoxon (2002) provide general discussions of the economics of regulating greenhouse gases.

investment hurdles under current programs. Second, the characterization of an investment process limited by an additional layering of bilateral selection is also at odds with the cost assumptions that underlie most quantitative estimates of benefits related to the Protocol's flexibility mechanisms. Potentially, most efforts to value the economic effects of the Protocol are based on a flawed view of how the implemented treaty might work. Our findings suggest the need to find alternative modeling approaches that take into account bilateral relationships.

The remainder of the paper is organized in the following way. Section 2 contains background information on the origins of the AIJ program; section 3 reviews studies concerning the motivations for investing in AIJ projects. A conceptual model of the investment decision process and a derived applied model are described in Section 4. In Section 5, we discuss the data that are used to estimate the model. Estimates of the applied model and related alternatives are presented in section 6. Section 7 concludes.

2. Origins of the AIJ Program

A series of debates in the scientific community over the potential risks and uncertainties associated with a continuing buildup of greenhouse gases, led to political concerns and in 1989, the UN initiated the process of negotiating an international treaty to protect the global climate by limiting greenhouse gas emissions. The framework for doing so was eventually established by the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in December 1997. The Protocol entered into force in February 2005.²

The cost of reducing emissions varies greatly among countries, though the effects of greenhouse gas emissions on climate change are uniform regardless of where the gases are emitted. Early drafts of the treaty soon settled on restricting the richest countries to historical emission levels as the primary mechanisms for limiting emissions, but debate continued on how to control abatement costs.³ In the course of negotiation, the Government of Norway suggested that a mechanism be introduced to allow partnerships between countries that would achieve emission reductions at lower cost (Carraro, 1999; Dixon and Mintzer, 1999). Broadly, the approach allowed those countries facing emission limits to receive credit for investments made elsewhere that reduce global emissions. The concept came to be known as joint implementation and was subsequently adopted into the treaty negotiating documents (articles 4.2 and 3.3 of the UNFCCC) that are now part of the Protocol.⁴

² As of May 2008, 181 countries had ratified the treaty, including 39 Annex I countries that represent about 64% of 1990 emissions.

³ Early policy discussions centered on whether permitted emission levels should be based on history or whether common ownership rights applied (Bertram, 1992). Proposed approaches included carbon taxes, national quantitative restrictions and tradable quotas. See Whalley and Wigle (1991) for an early quantitative assessment of policies under debate.

⁴ Under current usage, Joint Implementation (JI) refers to projects hosted in the developed countries and transitional economies listed in Annex I of the Kyoto Protocol. Projects hosted in non-Annex I countries fall under the Clean Development Mechanism (CDM).

The notion of solving pollution problems through international cooperation had precedent but key aspects of the climate proposal related to joint implementation were unique.⁵ The proposed measures included caps (assigned amounts) on emissions for the richest countries that could be supplemented when jointly implemented projects resulted in certified reductions. Both assigned amounts and newly created offset credits could be traded. The supplemental credits, measured in tons of carbon, were to be calculated by comparing actual project emissions against a hypothetical counterfactual known as a baseline.⁶ This framework, based on trade and the opportunity to supplement fixed emission allocations with project-based offsets, evolved into the “flexibility mechanisms” of the current Kyoto Protocol.

At subsequent negotiations in Berlin, delegates agreed that pilot projects could help inform the debate on practical issues surrounding joint implementation.⁷ The agreement, known as Decision 5 of the UNFCCC, provided broad guidelines for establishing a voluntary AIJ program that reflected then-current deliberations. It declared that all AIJ projects should benefit the climate in real and measurable ways, that each AIJ project should be agreed upon by host and investor governments, and that any financing from investor-governments must be additional to planned aid flows -- a condition termed “financial additionality”. Moreover, to prevent the stockpiling of projects under lax baselines, the decision explicitly precluded the accrual of credits under AIJ projects during the pilot phase.

The rules set out in the Decision influenced the expectations and motivations for AIJ projects in standard ways for all participating countries. In addition, participants forged a common reporting standard to record key characteristics of projects implemented under national AIJ programs.⁸ Both features help make comparisons among AIJ projects feasible. Even so, as discussed below, differences among the national programs emerged, giving rise to differing incentives and procedures.

3. Related Studies

In the next sections we develop an applied model of how project investments came about under the AIJ program. In order to provide context for the models, we briefly review results from numeric studies that measure the expected benefits of the Kyoto flexibility mechanisms. We also discuss the theoretical and practical motivations for carbon project investments and the country-specific

⁵ Examples of international cooperative action include the 1976 Convention Concerning the Protection of the Rhine River against Pollution by Chlorides and the 1985 Vienna Convention for the Protection of the Ozone Layer (Hanafi, 1998).

⁶ See Heister, Karani, Poore, Sinha and Selrod (1999) on early World Bank experiences with baselines.

⁷ A key concern was that imprecise baselines would allow countries that had pledged reductions to purchase watered-down credits cheaply from developing countries, attenuating the environmental benefits of the treaty. Delegates from developing countries worried that donor countries would redirecting aid flows to joint implementation projects (Grubb, Vrolijk and Brack, 1999). See also criticisms in Ghosh and Puri (1994), Parikh (1995) and Cullet and Kameri-Mbote (1998). Gulbrandsen and Andresen (2004) discuss non-governmental organizations.

⁸ Convention participants assigned an advisory committee, the Subsidiary Body for Scientific and Technological Advice (SBSTA) to establish reporting guidelines and to compile and publish the reports on an on-going basis.

processes by which AIJ project were approved and touch on the potential role transaction costs might play in influencing investment outcomes.

Numeric studies

Among related studies, the largest group comprises studies that estimate the potential benefits of the Kyoto Protocol's flexibility mechanisms. As Springer (2003) notes in his review, a common finding is that the costs of reaching greenhouse reduction goals are greatly reduced by rules that allowed spatial and temporal flexibility. By way of example, early model results by Bernstein, Montgomery and Rutherford (1999) suggest that flexible trading rules could reduce the price of carbon permits – which can be seen as the marginal cost of emission reductions – by a factor of seven in the European Union and by a factor of sixteen in Japan.⁹

Generally, the numeric studies focus on incentives created by differences in marginal abatement costs among regions and model the resulting demand for permits arising from project investments.¹⁰ Benefits related to Kyoto's flexibility mechanisms are calculated by comparing market-clearing outcomes under alternative policy scenarios that permit varying levels of trade. Model structure varies considerable; Springer (2003) categorizes reviewed models into five broad groups. The first is made up of integrated assessment models, where physical and human activities are jointly modeled. As Springer notes, there is overlap between this group and the remaining, since the economic components of the integrated models employ CGE or energy system models. Examples of integrated models are discussed in Manne and Richels (1999), Nordhaus (2001), and Jacoby et al. (2006). Another common approach relies on marginal abatement cost curves to examine the effects of trade. Examples include Jotzo and Michaelowa (2002), Löschel and Zhang (2002) and Stevens and Rose (2002). A less common approach focuses on macroeconomic tradeoffs between monetary policy and employment. See, for example, McKibbin, Shackelton and Wilcoxon (1999). An alternative approach is to employ technical engineering models of sectors or energy systems. These bottom-up models are sometimes integrated with other sectors via a CGE model. IPCC (2007) contains a review of several bottom-up sector models.

Despite differences in their structure, the models generally employ solution mechanisms that seek out market-clearing carbon prices or carbon tax rates. In most cases, price differences only prevail under scenarios in which trade in carbon is restricted by policy. In some cases, the solutions are dynamic and include the endogenous effects of carbon prices on capital stocks and available technologies (Löschel 2002; Sands 2004). However, model solutions generally do not take into account differences in profit or cost related to differences in bilateral transaction costs.

This is somewhat surprising since, at a conceptual level, considerable attention has been given to how transaction costs related to carbon markets might differ among countries and traded

⁹See Nordhaus and Boyer (2000), Springer (2003), Weyant (2004), Sands (2004) and Working Group III's contribution to the Fourth IPCC Assessment (IPCC 2007) for additional reviews of modeling approaches and results. Painuly (2001) reviews numerical models that address project-based investments in developing countries; Muller and Mestelman (1998) review related laboratory-based experiments.

¹⁰ Haites (2004) reviews model predictions of the potential size of CDM markets.

instruments.¹¹ And some researchers have explored ways of incorporating differences in transaction costs into numeric models.¹² However, to date, transaction costs that are incorporated into modeling efforts are tied to specific characteristics of the host – such as sovereign risk – or characteristics of the projects – such as scale or technology – and have no direct effect on bilateral investment outcomes in the model. Consequently, the models implicitly predict that all investors are equally likely to invest in any given host country. We return to this topic below.

Investment and agency approval

There is a separate and smaller literature that discusses early experiences from pilots. One area of study concerns the question of what motivated private sector investment in pilot projects and a small group of case-based studies examined the self-declared motivations of early project participants. This includes a discussion of private sector participation in the US AIJ program by Lile, Powell and Toman (1998), a study by Michaelowa, Dixon and Abron (1999) that looks at early AIJ participation, a study by Larson and Parks (1999) that surveys a broad group of early pilot participants about investment rationales, a review of selected AIJ projects by Schwarze (2000) and a broader review by Barrera and Schwarze (2004).

The studies identify a variety of factors motivating early participants. Some factors, most notably a desire to influence policy, are indirectly linked to market incentives. Nevertheless, the studies also find that many participants anticipated future regulations on greenhouse gas emissions and hoped to position themselves in ways that would prove useful as policies became clear. For some, this meant finding ways to reduce future regulatory costs, while others looked toward opportunities that might arise from new markets for carbon off-sets. Moreover, although early crediting was prohibited during the pilot phase, Schwarze (2000) notes that many of the AIJ projects have project lives extending well into the CDM and JI crediting periods and surmises that many AIJ investors expected to receive credits for offsets generated after the close of the pilot phase.¹³ Haites (2004) identifies 54 AIJ projects that are potentially eligible for CDM registration and estimates that the projects could generate reductions equivalent to 20 metric tons of carbon dioxide annually for the 2008-12 commitment period.

Separate from the issue of what motivated firms to participate in pilot projects are examinations of the national processes by which proposed investments were approved. Michaelowa, Begg, Parkinson and Dixon (1999) investigate the application and approval process for AIJ projects in eleven investor countries.¹⁴ They report that most countries established panels drawing on staff

¹¹ See, for example, Woerdman (2001).

¹² Bréchet and Lussis (2006) employ transaction costs when modeling the effects of CDM markets on reducing greenhouse gas emissions in Belgium. Michaelowa and Jotzo (2005) use measures of transaction costs taken from AIJ and early World Bank projects to modify marginal abatement cost curves in a numerical model of Kyoto Protocol permit markets to assess the effects of transaction costs on market size.

¹³ Schwarze examines 96 AIJ projects and finds that all projects lasted well beyond 1999, the scheduled close of the program, and that the average duration of the projects is 31 years.

¹⁴ The countries are Australia, Belgium, Canada, France, Germany, Japan, the Netherlands, Norway, Sweden, Switzerland, and the United States.

from three to eight ministries with sometimes competing objectives. In addition, six of the eleven study countries explicitly imposed additional criteria to reflect domestic policy goals. They conclude that these design features of the approval process encouraged the incorporation of broad policy considerations into the project selection process. Similarly, Lile, Powell and Toman (1998) report that the evaluation process for projects submitted to the United States Initiative on Joint Implementation Evaluation Panel allowed seven departments and agencies to influence the project approval.

To summarize, the descriptive literature suggests that private sector participants were influenced in part by economic incentives motives derived directly from the potential for late-stage credits or indirectly as initial investments in the development of future markets. In addition, the research suggests that the design of the process by which projects were approved played a significant role in investment outcomes.

Multilateral and bilateral transaction costs

As discussed, transaction costs have been a subject of recent interest for numeric modelers and both administrative costs related to agency approval and transaction costs related to investment generally play a role in the applied model developed in section 4.

In general, transaction costs are associated with all types of economic exchange and are most often related to the costs of acquiring information, addressing risks, enforcing contracts and protecting rights and property. Public institutions are expected to play an important role in reducing private transaction costs (North, 1987). Practical experience suggests transaction costs are important for tradable emission programs, especially when related markets are nascent (Hahn and Hester, 1989). Hahn (1990), Stavins (1995), Gangadharan (2000), and Cason and Gangadharan (2003) provide additional examples. The same is true for foreign direct investment (FDI) markets (Chakrabarti, 2001; Bénassy-Quéré, Coupet and Mayer, 2007). And this has relevance to AIJ investments, which can be seen as a special type of FDI.

Later, as part of the discussion of data used for the applied model, we return to the specifics of what might determine transaction costs for AIJ projects. However, it is useful to note that even in the case of bilateral transactions, many of the determinants of transaction costs are not themselves bilateral in nature. Country-specific institutions and characteristics are expected to influence bilateral incentives and costs in general ways, while bilateral characteristics are expected to influence transactions among particular country pairings.

Of particular relevance for the bilateral component of bilateral investment is the role cultural ties might have on transaction costs.¹⁵ Strong cultural ties might be expected to lower search costs and other costs related to information as well as costs associated with counter-party risks. For example, common cultures can give rise to similar legal systems that lower the costs and risks of

¹⁵ See reviews by Kogut and Singh (1988), Choi (1999), Shenkar (2001) and Siegel, Licht and Schwartz (2007) on the link between culture and investment.

entering into long-term contractual agreements. Contemporaneously, strong cultural ties can provide popular and reciprocal political support for the strong bilateral political ties and bilateral aid flows.

In this regard, one striking feature of AIJ pilots is the degree to which investments took place along lines where bilateral relationships were already strong (Barrera and Schwarze 2004). To a degree, this can be attributed to the project selection process and the preferences of policy makers to see investments flow to favored countries. Even so, as with other forms of direct foreign investment, the same dynamics that give rise to strong bilateral ties between governments may also work to hold down private transaction costs. Such ties may be especially important for reducing transaction costs when alternative formal institutions are weak.¹⁶ We take up the implications of this for the conceptual and applied models in the next section.

4. A Model of Project Investment

In this section, we develop a conceptual model of the AIJ investment process, motivated by the descriptive literature from section 3. The key feature of the conceptual model is that it distinguishes between investment choices that are exclusively motivated by uncertain profits and those that are additionally constrained by an approving agency's preferences and related transaction costs. We also develop two related statistical models.

In the base model, we explain the number of joint projects using a set of variables thought to determine private investment in combination with a model intended to explain bilateral aid flows. The result is a mixed-regime count model that allows us to test whether bilateral relationships tied to bilateral aid limited the number of observed project investments.

We also consider an alternative dichotomous probit-with-selection model that focuses on whether or not bilateral investment relationships occurred. Information about the number of projects between a given investor-host combination is retained in this model to explain heterogeneity in the error terms, but it is not taken to indicate the strength of the bilateral partnership. The related point of interest is whether the agency-approval hurdle is cleared for any given potential partnership, rather than how frequently it is cleared. As we discuss later, another motivation for the alternative model has to do with differences in the scale and structure of AIJ projects in instances when project counts are high. The dichotomous model serves as a check that this feature of the data does not unduly influence conclusions drawn from the base model.

Conceptual Model

As a starting point, consider an irreversible investment in a joint implementation project where the profit flow, $\pi(t)$, associated with an investment I follows the stochastic process:

$$d\pi = \phi(s)\pi_0 dt + \sigma(s)\pi_0 dz \quad 1)$$

¹⁶ Michaelowa and Jotzo (2005) argue that weak institutions currently limit the overall market for project-investments under the Kyoto mechanisms.

where dz is an increment in a Wiener process; and where the growth parameter, ϕ , and the dispersion parameter, σ , depend on exogenous state variables, s . It is assumed that the investment is sufficiently long-lived to be represented by the infinite-horizon value function:

$$v(s_t) = E \int_t^\infty \pi_m e^{-\delta(m-t)} dm \quad 2)$$

where E is the expectations operator, δ is a discount rate and where 2) is conditional on the restriction given in 1). Dixit and Pindyck (1994, 144-45) show that associated with this investment evaluation problem is a critical level, $v^*(s)$, that exceeds the combined present value of the investment and any option value associated with postponing an irreversible investment. In passing, it is important to point out that factors that reduce uncertainty decrease the option value associated with delay and results in a larger number of desired investment projects.

Now suppose that an interested firm considers a fixed number of investment opportunities. By repeating, for each project, the valuation in 2), the firm can match an evaluation, v^i , with each project, I^i . After ranking the projects, the firm will consider that set of projects, $\Omega(s_t)$ where $v(s_t) \geq v^*(s_t)$. The firm may consider additional restrictions, given by vector c .¹⁷ With this in mind, the firm choice problem can then be written as:

$$\text{Max}_I P(I;c) \text{ s.t. } I \in \Omega(s_t) \quad 3)$$

where P represents the firm's decision process for evaluating risk and profit. Changes in the values of s that lower $v^*(s_t)$ will result in a larger number of desired investment projects.

Next, suppose the firm must also seek approval from an agency that has its own objective function, derived from a set of broad policy objectives, characterized by the vector, $z(t)$. Further, assume that, through a ranking process analogous to the firm's ranking process, the agency derives its own set of desired investments, $\Psi(z_t)$. If the agency only approves investments from its desired set, the choice problem now becomes:

$$\text{Max}_I P(I;c) \text{ s.t. } I \in \{\Omega(s_t) \cap \Psi(z_t)\} \quad 4)$$

That is, the set of feasible investments is reduced to the subset of investments that the firm desires and that the agency will approve. Designating the solution to 3) as P^* and the solution to 4) as P' , it follows that $P^*(s) \geq P'(s, z)$, since the reduction in feasible projects cannot improve the solution to the maximization problem. Said differently, the approval process can be non-binding, in which case the two outcomes are identical; however, when the approval process constitutes a binding constraint, the number of observed projects will decline, for a given value of s . Finally, in anticipation of the discussion below, it should be noted that s and z may contain common elements and that information about $\Psi(z)$ may be available to the firm and reflected in s .

¹⁷ For example, the firm may want to limit total investments by country because of portfolio risk considerations.

Applied model

Given the foregoing discussion, we represent the firm-ranking outcomes with the index, η^* and represent the unobserved ranking process as a linear function of the state variables that determine the set $\Omega(s)$. In our base model, the index is a count of desired projects between investor-host partners, where i represents the country in which the investing firm resides and h represents the country hosting the project. For each investor-host dyad, we model an investment equation giving the desired number of projects as a function of the state variables:

$$\eta_{ih}^* = n_0 + \sum_j n_j s_j \geq 0 \quad 5)$$

where the n are parameters associated with the j state variables. It should be kept in mind that while the projects are pair-wise outcome, the relevant state variables may be specific to the investor, to the host, or to a relationship between the host and investor.

In practice, observed AIJ projects are rare relative to the number of potential investor-host partnership, and when relationships are observed, the number of investment projects is generally low. Both characteristics are suggestive of the Poisson and negative binomial distributions, which are associated with many forms of count data. Consequently, count-model methods are well suited to estimating equation 5). However, when the investment decision is additionally constrained, a modification is required that results in a mixed regime model.

As a starting point for developing the agency constraint, we assume that the approving agency's preferences relate to broad national policy objectives and that the same objectives that influence the project-ranking process permeate other aspects of the bilateral relationships. One tangible indication of national preferences is the expenditure of public funds for bilateral aid. Fortunately, because the UNFCCC and the OECD use the same set of income classifications, the possible pair-wise combinations of OECD donors and aid recipients corresponds to the potential flow of investment (from investor to host) anticipated under the AIJ program. Consequently, using bilateral aid as a proxy for unobservable agency preferences is attractive conceptually and practically, and we make use of this in the applied model.

In particular, we assume that governments' ordering of preferences, as revealed in the provision of bilateral aid, correspond to the ranking agencies apply as they consider which projects to approve. Therefore, in a way analogous to the firm's preference function, we model the intensity of an agency's ranking of projects, α , proxied by bilateral aid, as a linear function of the k state variables that determine the preference set, $\Psi(z)$ and a vector of fixed parameters, a , so that:

$$\alpha_{ih} = a_0 + \sum_k a_k z_k \quad 6)$$

To combine the investment and agency preference components into a single model, let A represent a binary variable set to one when agency approval is granted. The number of observed projects can then be written as: $\eta_{ih} = \eta_{ih}^* A_{ih}$, where $\Pr ob[A = 0]$ can be modeled as a function of aid

levels α_{ih} or the corresponding aid determinants z_{ih} . In the parlance of count models, the agency preference component is considered an “inflation” equation that accounts for an observed excess of zeroes, implying that fewer projects are observed than predicted by the investment function alone.

Several variations of this class of models based on alternative assumptions about the underlying probability distributions have been used in earlier studies. In our application, we model the underlying desired number of projects using a negative binomial distribution and the probability of agency approval using the normal distribution. We also test our choice against commonly-used alternatives. This type of mixed count-and-probit model is discussed by Greene (1994) and by Long (1997).

An alternative dichotomous model

With modification, the model can be adjusted to focus on whether or not an investor-host partnership occurred. In the dichotomous case, the binary variable $N_{ih} = 1$ if $\eta_{ih}^* > 0$; otherwise $N_{ih} = 0$ is introduced, which gives the alternative specification:

$$N_{ih} = \begin{cases} 1 & \text{if } n_0 + \sum_j n_j s_j + \varepsilon_\eta > 0 \\ 0 & \text{otherwise} \end{cases} \quad \text{subject to} \quad A_{ih} = \begin{cases} 1 & \text{if } a_0 + \sum_k a_k z_k + \varepsilon_\alpha > 0 \\ 0 & \text{otherwise} \end{cases} \quad 7)$$

By assumption, the error-terms, $\varepsilon_{n(i,h)}$ and $\varepsilon_{\alpha(i,h)}$, are distributed normally and are potentially correlated. Written in this way, the alternative model takes the form of a probit-with-selection model as developed by van de Ven and van Pragg (1981).

Internalized agency preferences and transaction costs

To this point in the discussion, information concerning bilateral aid has been treated as separate from the information upon which firms base their investment decisions. However there are a couple of reasons to believe this is not the case.

For one, firms and NGOs investing in projects under the pilots had an incentive to seek out information about agency preferences in order to avoid the cost of submitting projects that had little chance of approval. In practice gaining insight to agency preferences may not have been difficult. The case studies suggest that the experimental nature and small scale of the AIJ programs encouraged a dialogue between investors and administrators. And in some instances, administrating agencies signaled their preferences by actively seeking out participants.¹⁸ Consequently, firms may have internalized the agency preferences signaled by bilateral aid.

While anticipating agency preferences would have helped firms avoid some of the administrative and regulatory costs associated with the pilot, other types of transaction costs may have played a role as well. As discussed, deep-seated cultural ties are expected to reduce transaction costs related to gaining information and enforcing contracts and have been shown to influence other

¹⁸ See, for example, Lile, Powell and Toman (1998).

types of direct foreign investment. Strong bilateral ties are also expected to influence aid flows as well, suggesting that information on bilateral aid carries information about otherwise unobservable bilateral effects on investment costs and risks. For both reasons, we expect bilateral aid to carry information relevant for the project investment equation.

Additional estimation concerns

The expectation that agency preferences are endogenous to the investment decision raises a potential estimation problem due to simultaneity bias were bilateral aid directly included as both a determinant of investment and a proxy for agency preferences. In the context of the base count model, the problem is easily avoided, since the proposed vector of bilateral aid determinants can be used as an alternative proxy for agency preferences.

In the case of the dichotomous model, another strategy is needed. This is because, in contrast to the count model where the two components of the mixed regime are estimated in combination, the probit-with-selection model requires the specification of a system of two equations with separate error terms. To address potential simultaneity bias in this form, we use a two-stage process in which instruments generate predicted values of bilateral aid that are subsequently used in the project investment function in lieu of observed values. Standard-errors are found by using a bootstrapping method in which both stages are estimated from repeated draws on the original sample.¹⁹

5. Data Description

AIJ Investments

A count of AIJ projects, which serves as our dependent measure of AIJ investment, is calculated from data on AIJ projects reported to the UNFCCC and compiled by the SBSTA. As of February 2002, the UNFCCC reported on 156 projects. Among these, 147 projects reached the point at which a letter of intent was signed with the host country. For this study, two projects, both investments in the Solomon Islands, were dropped because some of the corresponding data on institutions was unavailable. Consequently, the study is based on 145 projects begun between 1993 and 2000 among 12 investor countries and 41 host countries.

A list of investor countries and their host partners is given in table 1. The 145 projects are spread among 64 investor-host partnerships. The total number of implemented projects and partnerships is small relative to the potential for investment. To see why this is so, consider that when the AIJ program was established, 193 countries participated in the UNFCCC.²⁰ Implicit in

¹⁹ In particular, a regression of bilateral aid on all exogenous variables and their cross products was used to generate predictions that were subsequently used in the investment equation. The two-stage estimation process was repeated 500 times with random draws from the original sample to generate the standard errors reported in table 3.

²⁰ The 194 parties to the Convention during the study period include all member countries of the United Nations plus the Cook Islands, the Holy See, and Niue, a former territory of New Zealand and one non-country member, the European Union.

Decision 5 is the expectation that investments would originate from the 24 wealthier Annex II countries.²¹ Excluding the Holy See, this makes for 4,032 potential pair-wise combinations. We are constrained by data to consider a subset of countries, although the subset is large. We include 22 investor countries and 134 potential host countries in our study and therefore 2,948 dyads in our sample. ²² Consequently, there are 2,884 investor-host combinations for which no AIJ project is observed between 1993 and 2000. Defined in this way, actual partnerships comprise about 2% of potential partnerships.

Generally, each partnership consists of one or two projects. The notable exceptions are the fifty Swedish AIJ projects spread among Estonia, Latvia and Lithuania. Many of the projects are replications of a common approach and distinguished primarily by differences among second-tier counterparts.²³ These projects motivate the alternative dichotomous model.

Variables affecting investment choice

As discussed, abatement costs are expected to vary among countries and this variation is expected to influence which countries host carbon projects. To proxy unobserved abatement costs, we use a measure of the greenhouse gas intensity of a host country's economy with the notion that low-cost reductions can be more easily found where emission intensity is high. Also important is emission intensity for the investor country. Demand for emission reductions overall may be high when domestic emission intensity is high, but the cost of domestic abatement relative to host-country abatement costs will be high when domestic emission intensity is low. To capture these relationships we include measures of host-country and investor-country emission intensity as well as an interactive term. The greenhouse gas intensity measure is calculated by the World Bank (2006) and is the ratio of greenhouse gas emissions measured in kilograms per dollar constant GDP, where the national GDPs have been deflated using the 2000 purchasing power parity conversion factor.²⁴

Credits generated by carbon-market projects have value because they can be used to meet treaty or related regulatory obligations. Consequently, firms investing in carbon projects will take into consideration the specific host-country and investor-country institutions that govern their creation and use. At the same time, because carbon-market projects involve fixed up-front investments, they also face the more conventional types of risks faced by other forms of direct foreign investment. We therefore consider two classes of state variables related to transaction costs.

²¹ The name Annex II arises from the country-list annexes of the Framework Convention. Annex I contains the list of 36 countries, mostly OECD countries and transitional economies, that initially pledged to limit emissions. Annex II is the subset of wealthier Annex I countries. Prior to ratification, the list of countries capping emission changed and that eventual list of 39 countries is listed in Annex B of the Protocol.

²² A list of countries included in this study is available by request.

²³ For example, many of the projects between Sweden and Estonia involved up-grading public heating systems. The projects were organized under a common national framework, with projects differentiated when local government counterparts differed.

²⁴ The measure is imprecise, but information on the potential cost of abatement was not well developed during the pilots. Since then, coming up with better estimates of abatement costs has been a key objective of recent assessment reports by the Intergovernmental Panel on Climate Change.

The first includes general factors that influence the level of profit and the associated risk for all types of investments flowing into host countries. As discussed, these variables describe a general investment climate and include variables related to policies, expected profitability and a variety of risks. Factors that make up the general investment climate – that is, those factors that are not specific to bilateral pairings or the offset-project market -- are summarized by the ability of countries to attract international investors and we use total foreign direct investment (FDI) as our indicator of the general investment climate. Our measure is calculated by averaging the net inflows of foreign direct investment as a share of GDP reported by the World Bank (2006) over the study period, 1992-2001. Because this measure is an aggregate, it can be observed independently of bilateral investment flows. As discussed, general investment incentives may also have a bilateral component related to strong bilateral ties. In the expanded model, a continuous measure of real bilateral aid is included to capture this.

The second class of state variables relates to institutions that are more specific to emission trading. All things equal, it is likely that AIJ investing firms preferred to gain experience in host countries where local institutions could lower costs, reduce risk or otherwise give additional value to carbon credit streams flowing from joint implementation projects. Likewise, because investor-country regulations were expected to influence how earned credits could be used, it is also likely that domestic investor-country institutions were important to observed investment outcomes. At the same time, because the AIJ pilots preceded the eventual treaty, investors had to anticipate how future institutions might evolve. In the applied model, we assume that related commitments by governments, extant during the study period, provide an indication of the capacity of host and investor countries to put implementing institutions in place; we use these to proxy investor judgments. We construct commitment indicator variables for investor and host countries based on their participation in five international agreements: the Convention on Biological Diversity, the Montreal Protocol on Substances That Deplete the Ozone Layer, the United Nations Convention on Climate Change and the United Nations Convention on the Law of the Sea. To measure whether environmental issues are a policy priority, we also consider whether a country had an environmental strategy and a biodiversity action plan in place during the study period (World Bank, 2002). To identify countries with relatively strong institutions, we count the cumulative number of years between 1992 and 2001 that the environmental commitments were in place. Host and investor countries were separately ranked according to this cumulative measure and countries falling into the top of three respective quantiles were designated as highly committed to policies consistent with Kyoto objectives.

As discussed in section 4, uncertainty over investment outcomes generates incentive to delay otherwise desirable investment. This is especially true of long-lived carbon investment projects that depend especially on government institutions. Consequently, we include in the investment equation measures related to the capacity of host governments to sustain and carry-out processes leading to eventual carbon offset certification. In particular, we include a measure of government efficiency that relates to the quality of services provided by host governments and the political independence of

their bureaucracies. We also include a measure of political stability that relates (inversely) to the likelihood that the government will be destabilized or toppled by external or internal violence. The measures used in the study are described in Kaufmann, Kraay and Mastruzzi (2005).²⁵ Finally, we also include a dummy variable set to one for Norway, the Netherlands, Sweden and Switzerland, where subsidies were provided to domestic project participants (Michaelowa, Dixon and Abron, 1999). All things equal, the subsidies are expected to have lowered the investment threshold criteria for firms in the four countries.

And finally, we also include a continuous measure of bilateral aid to capture endogenous policy effects and the effects of bilateral ties on transaction costs. The measure is an average value of real bilateral aid for the period 1992 to 2001 for each investor-host dyad, based on from pair-wise data on Net Official Development Assistance (ODA) to recipient countries from OECD country members, as reported to the Development Assistance Committee (OECD 2006).

Variables affecting agency preferences

The applied model considers whether the same factors that determine bilateral aid flows also determine agency rankings of AIJ projects in the applied model -- that is, both aid and agency approval are a function of a set of common state variables, z . However, despite much research, finding a parsimonious set of determinants for bilateral aid is challenging.²⁶ For our purposes, we use a selective but representative set of variables meant to capture the following host country characteristics: need, size, hegemony, democratic institutions, civil order and bureaucratic integrity. Other studies using these or similar variables include Frey and Schneider (1986), Wall (1995), Alesina and Weder (2002), and Collier and Dollar (2002). In particular, we use the following statistical measures.

We take as our indicator of need, average per capita income for the period, measured in 1995 \$US. Because large countries are expected to have strategic importance, average host-country population is included. Motivated by the presumption that donor countries want to influence the policies of neighbors and important trade partners, we include two fixed effects: one based on proximity and a second to indicate that the host and investor country have entered into bilateral or regional trade agreements.²⁷ Because most donors have voiced support for democratic principles, we include an indicator of the openness and accountability of host governments to their citizens, referred to in the tables as “voice and accountability”. Poorly performing bureaucracies and corruption are expected to diminish the efficacy of aid and discourage donor support. To capture this we include measures to indicate host countries with bureaucracies of above-average quality

²⁵ Because indicators were not available for all study years, averages for 1996, 1998, 2000 and 2002 were used.

²⁶ Following Dudley and Montmarquette (1976), most studies suggest that aid flows are best explained by donor-country demand for specific outcomes that foreign aid helps to achieve, and by recipient country characteristics that determine aid effectiveness. In practice, applied studies ascribe a wide range of benign and predatory objectives to donor countries. See, for example, Pronk (2001) and Petras and Veltmeyer (2002).

²⁷ A dummy variable was set to one for investor-host dyads when both countries were members of the Commonwealth, ASEAN or NAFTA and for dyads containing an EU investor-country and a host country participating in the Phare program.

(government effectiveness) and where public and private sectors levels of corruption are below average (control of corruption). Political instability due to external or internal violence and armed conflict is expected to diminish the effectiveness of aid and we include this measure in our selection equation. At the same time, donors may also take a lack of civil order as an additional measure of need so that relationship between aid and civil order is ambiguous. The measures on income and population are averages for 1992-2001 (World Bank, 2006). The trade agreement and proximity variables are constructed. The institutional measures are described in Kaufmann, Kraay and Mastruzzi (2005).

As discussed earlier, the specification of the alternative model includes a dichotomous measure of bilateral aid not required in the count model. The measure is based on our continuous measure of bilateral aid and indicates whether aid was given during the study period.

6. Empirical Results

A simple prediction of the conceptual model is that, because donor-country agencies prefer projects that reinforce the national policy objectives that are also pursued through bilateral aid, AIJ projects will be observed together with bilateral aid flows. At the same time, because firms invest for separate reasons, not all countries receiving aid are expected to host projects. Among the 2,948 potential investor-host relationships in our sample, this simple prediction holds over study period averages (table 2). And, in all but five of the 147 AIJ projects, bilateral aid was given during the year that the project was launched.²⁸ So, in general, the pattern of investment observed under the AIJ program is consistent with the conceptual model in that investment is not observed separately from bilateral aid. In passing, it is also worth noting that table 2 is based on dichotomous measures of whether or not bilateral aid and bilateral investment occur, which corresponds to the dependent variables in the probit-with-selection model.

As discussed, the applied models provide a framework in which to explore the underlying determinants of project investment and to evaluate whether bilateral relationships tied to bilateral aid limited the number of observed project investments. Because AIJ investment and bilateral aid are observed contemporaneously, the first round of estimates takes into account potential simultaneity problems. In a second round of estimates, we examine the issue of contemporaneous correlations more closely and show that key outcomes from the baseline analysis do not depend on our simultaneity treatment.

Baseline model specification

Baseline estimation results for the count model and the dichotomous alternative of the model are given in table 3. Overall, the models perform well. Statistical tests are consistent with the chosen specification and the parameters that are statistically significant take on expected signs.

²⁸ The exceptions are given in the supplemental annex.

Project investment

Turning first to the AIJ investment equation in the count model, the three investor attributes are significant and take on reasonable signs. The results suggest that investment was more likely if host country environmental policies were strong and when the investor government offered subsidies to investors. The parameter on carbon intensity is significant and positive.

Looking at host-country characteristics, the parameter carbon intensity is also positive. It is not significant in itself, but is significant in combination with the cross product of host and investor carbon intensity. The imprecision of the estimate may be due to the crudeness of our measure, as already discussed. In addition, as a reviewer of an earlier draft pointed out, early projects may have been intra-marginal; that is some investors may have been attracted to “low-hanging-fruit,” even if abatement costs in the country were expected to be high on average.

Among the remaining host-country characteristics, the investment climate indicator, which is based on the ability of the host country to attract direct foreign investment, is positive and significant. The parameter associated with host country environmental policies is positive, but small relative to its standard error. The parameters on government effectiveness and political stability were positive and statistically significant at reasonable confidence levels.

Turning to the bilateral characteristics, the cross-product measure of carbon intensity is negative (indicating declining marginal effects) and significant. Importantly, the bilateral aid parameter is positive and significant, which we take as evidence that bilateral relationships, working either through agency preferences or transaction costs, positively affect investment decisions. We return to this topic later in this section.

Results from the alternative dichotomous form of the investment equation are given in the upper right-hand panel of table 3. Because the range of outcomes is limited to zero and one, the parameters are scaled differently from the count model. Setting this aside, the results are largely consistent with results from the count model, although there are some differences in the statistical significance of some of the parameters associated with host characteristics. The parameter on carbon intensity, which was not statistically significant in the count model, is significant in the dichotomous model, and the parameters on the investment climate and government effectiveness, which were significant in the count model, are not in the dichotomous model.

Agency preferences

Parameters associated with the agency preference component of the count model are reported in the lower left-hand-side panel of table 3. When interpreting the signs of the parameters, it should be kept in mind that agency preferences represent the “inflation” component of the mixed count model. The inflation component explains an excess of zeroes relative to the associated negative binomial component. An increase in a variable expected to positively influence agency preferences reduces the constraint on investment outcomes, generating fewer zeros and thus increases the probability of investment between the investor-host pair. For this reason, the signs on the parameters are somewhat counter-intuitive.

Turning first to bilateral characteristics, the geographic proximity parameter is negative and statistically significant. The trade agreement parameter is positive in contrast to expectations, but is not statistically distinguishable from zero. Among the host country characteristics, only size emerges as a significant parameter. Together with the earlier result, the count model suggests that approving agencies promote projects in neighboring countries and countries that are populous.

Results from the agency preference component of the dichotomous model are reported in the lower right-hand panel of table 3. Recall that in this form, a probit-equation indicating the probability of a bilateral aid flow is used as the selection component of a dichotomous indicator of investment. This has the practical consequence of reducing the importance given to the Swedish AIJ experience. It also results in a functional form for the agency preference that more closely resembles the regressions reported in other studies of bilateral aid.

Turning to the selection equation and the determinants of bilateral aid, the parameters are statistically significant for the most part and in line with findings from previous studies.²⁹ The two bilateral indicators – geographic proximity and participation in bilateral or regional trade agreements – are both statistically significant determinants. The estimated coefficient on income suggests that need plays a role in determining bilateral aid, with the probability of aid increasing as per capita income falls. The size of a country's population seems to matter as well, with larger countries more likely to receive bilateral aid. Among the institutional measures, institutions that tend to expand political participation are positively and significantly related to expanded aid flows. The parameter associated with government efficacy is positive, but not significantly so. While political stability contributed positively to the likelihood of bilateral investment, the results suggest that less stable governments were more likely to receive aid, which may indicate that donors sometimes use aid to promote stability in aid recipients. The results also suggest that failure to control corruption was not an impediment to receiving bilateral aid.³⁰

Model specification tests

The lower part of the table contains results from tests about the chosen model specifications. The first is an alternative form of the significance test for the bilateral aid parameter. In both versions of the model, outcomes are consistent with earlier result, implying that investors in the AIJ program took into account information on bilateral aid when making investment decisions.

The next test applies only to the count model and has to do with whether or not the Poisson distribution is preferred to the negative binomial distribution used to specify the investment function. The test is based on the over-dispersion parameter recovered from the underlying likelihood function and reported in table 3. A restriction setting this parameter to zero (as would be the case for a Poisson distribution) is rejected, providing evidence in favor of the negative binomial specification used in the base model.

²⁹ In this form of the model, a positive coefficient indicates a higher preference and is associated with a greater probability of bilateral aid and a higher probability of observing an investment relationship between the investor and host.

³⁰ This is consistent with other studies. See especially Alesina and Weder (2002).

The last test linked to the count model addresses the central hypothesis of the paper. The test compares the fit of the mixed regime model to an unconstrained investment model that depends on the investment determinants alone. The test is due to Vuong (1989) and is described in Greene (1994). For our sample, the unconstrained investment model is rejected with a high level of confidence in favor of the base model in which investment decisions are constrained by agency preference. Said differently, the test provides evidence that the agency selection determinants explain why fewer investments occurred under the AIJ program than predicted by the negative binomial investment function alone.

In contrast to the count model, it is not possible to directly test whether agency preferences are binding in the dichotomous model. This is because the selection structure is used to construct the likelihood function associated with the statistical model. However, within the context of the selection model, it is possible to test whether the investment and the agency preference equation are independent. Results reported in table 3 suggest that they are not, which is consistent with the conceptual model. The estimated correlation parameter is high at -0.692 and statistically significant. A related Wald test, also reported in the table, implies the same.

Revisiting the contemporaneous correlation assumption

Results presented in the previous section depend on statistical models constructed under the assumption that bilateral aid and project investment decisions under the AIJ pilots are contemporaneously correlated and the assumption is tested in this section. There are two reasons to do so. The first is technical: in the absence of simultaneity, more parsimonious specifications of both models can be estimated that might produce different outcomes for the parametric tests reported in table 3. A second reason is that evidence for or against the contemporaneous correlation assumption influences how we should interpret the policy implication of the results.

As discussed, there are two motivations for including bilateral aid as a determinant of project investment: an endogenous-policy hypothesis and a transaction-cost hypothesis. The first is that investors may have learned about agency country preferences, which are in turn related to bilateral aid. From a policy perspective, changing agency preferences is straightforward – at least conceptually – since the approving agencies can be issued new guidelines. The second reason for including bilateral aid as a determinant is that the strong bilateral ties that motivate bilateral aid flows also help reduce private transaction costs. The transaction-cost hypothesis suggests that information or contract enforcement hurdles exist that strong bilateral ties mitigate. From a policy perspective, changing agency guidelines will not resolve these types of investment hurdles. Instead, policy makers will want to focus on building up institutions that facilitate information flows and contract enforcement.

To a degree, tests for contemporaneous errors (simultaneity) can help distinguish between the two hypotheses. The transaction-cost hypothesis implies contemporaneous errors since unobserved bilateral effects (related to culture and history) are expected to be present in both the investment and aid equations. Consequently, test results that rule out a contemporaneous error

problem are inconsistent with the transaction-cost hypothesis. In contrast, the endogenous policy assumption that investors anticipate agency behavior does not necessarily imply simultaneity, since the effects can be one-way since agency preferences are arguably unaffected by investor preferences. That is, while agency preferences influence investor outcomes, the reverse is not necessarily true. In turn, this implies a recursive system and an absence of non-contemporaneous errors. Of course, this need not be the case and, in fact, feed-back from investors to approving agencies may have influenced investment outcomes. In this form, the endogenous-policy hypothesis also implies contemporaneous errors. To summarize, evidence in favor of contemporaneous errors, together with evidence that bilateral aid is a determinant of private investment, is consistent with both hypotheses, while evidence ruling out a contemporaneous error problem is consistent only with the endogenous-policy hypothesis.

The procedure used to test for contemporaneous correlation is a variation of Hausman's test. In the case of the count model, bilateral aid, rather than its determinants, are used in the agency preference (inflation) component of the model, while residuals from a regression of bilateral aid on the vector of aid-determinants and their cross-products is added to the investment component of the model. For the dichotomous model, the predicted values of bilateral aid used in the investment equation are replaced by actual values and their associated residuals.³¹ In the absence of contemporaneous correlations, the residuals are expected to contribute no additional information and the parameter associated with the residuals should be indistinguishable from zero.

As with many parametric tests, results from the simultaneity tests depend crucially on how the parameters standard-errors are calculated. As shown in the first row of table 4, Wald-tests, based on robust standard errors from the full sample, suggest that contemporaneous correlation is present, which would appear to rule out the recursive model. However, when the tests are repeated based on bootstrap standard errors, which Wong (1996) suggests as a more reliable approach, the results are less robust and levels of significance fall slightly below ten percent, providing weak evidence in favor of the recursive model. (See the second row of table 4.)

Even so, key conclusions from the previous estimation results remain under the alternative assumption that contemporaneous correlations are absent in the data. Tests conducted under the assumption of contemporaneous correlation and reported in the lower section of table 3 are repeated using recursive versions of both models. Test outcomes, reported in table 5, are unchanged. Results from both models suggest that agency preferences – as proxied by bilateral aid – influenced project investment in a positive and statistically significant way. In the recursive version of the count model, an alternative specification based on the Poisson distribution is rejected in favor of the negative binomial specification and the Vuong test indicates that agency preference limited investment outcomes. In the recursive dichotomous model, test results suggest that the investment equation and the agency preference (selection) equations are correlated.

³¹ The full set of estimates parameters are included in tables 3 and 4 of the supplemental annex.

Epilogue

During the course of writing this paper, experience has begun to accumulate about project investment under the Clean Development Mechanism. One surprising feature is that many of the early projects are “unilateral” in the sense that the projects appear to be financed domestically (Michaelowa, 2007). However, for projects involving direct foreign investment, a pattern similar to the AIJ experience has emerged. By May 2007, 316 projects involving bilateral or multilateral direct foreign investment had been registered under CDM. As with the AIJ experience, bilateral investment relationships were rare and associated with established bilateral ties. In no case did an investment occur between investor-host pairings in which bilateral aid relationships had not already been established during the AIJ period.³²

7. Conclusions

Case studies of national AIJ pilot programs describe approval processes that allowed general national policy objectives to influence project investment outcomes. Our findings are consistent with this characterization and suggest more specifically that AIJ investments were partly determined by the same factors that determine bilateral aid. Quantitative evidence supporting this conclusion is robust and holds up under a series of alternative specifications.

One implication is that CDM and JI investments might be similarly constrained if the institutional arrangements built up to approve projects under the national pilots are maintained as the Kyoto Protocol is implemented. As discussed, this depiction of how investments were determined under the AIJ programs is inconsistent with often-used descriptions of how markets might work under an implemented Kyoto Protocol. Nevertheless, if policy preferences and the agency approval process alone constrain project investment, then the question of whether broader policy objectives should play a role in determining project location is a normative one and policy makers can set agency approval rules accordingly.

Alternatively, a more nuanced interpretation of the conceptual link between aid and investment suggests that deep-seated bilateral ties are relied upon to reduce otherwise insurmountable private transaction costs. Tests results are not fully consistent with this interpretation, but do not rule it out in a convincing way. For policy, the distinction matters since private bilateral transaction costs can remain even if regulatory transaction costs are fully reduced. Moreover, in contrast to the case of regulatory transaction costs, policy instruments to address private transaction costs are less direct and require the build-up institutions that address underlying problems related to the cost of information and contract enforcement. Experience suggests that private agents such as brokers or rating agencies emerge to fill gaps related to risk and asymmetric information. However, public agencies may find additional scope for enhancing information flows and reducing performance risk.

³² See table 5 of the supplemental annex.

In either case, a key finding of the study is that the cost-reducing benefits of the project-based components of Kyoto's flexibility mechanisms may be less than empirical studies predict. This is because the numeric models that provide the best guidance on how alternative policies might affect the implementation costs do not take into account either regulatory or private bilateral transaction costs that were important during the AIJ pilots and that may be important currently. From a methodological point of view, the results suggest that taking bilateral relationships into account might allow numeric models to better predict cost savings and the geographic distribution of project investment under the Kyoto Protocol investment mechanisms.

Even so, the findings suggest that national investor-country policy goals did not exclusively drive the AIJ investment process, leaving room for host countries to influence outcomes by taking up specific policies. By implication, countries that take policies that support investment generally and build the specific institutions needed to facilitate Kyoto-related markets will likely see greater investment flows under the Protocol's Joint Implementation and Clean Development Mechanism provisions.

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Tables

Table 1: AIJ projects included in the sample, 1992-2001 by host and investor countries.

Investor countries	Projects	Host countries
Australia	10	Chile, Fiji, Indonesia (3), Mauritius (2), Solomon Islands (2), Vietnam
Belgium	1	Croatia
Canada	2	Jordan, Zimbabwe
France	5	Czech Republic, Hungary, Jordan, Mauritania, Zimbabwe
Germany	6	Czech Republic, Jordan, Latvia, Russia (2), Zimbabwe
Italy	2	Jordan, Morocco
Japan	5	China (3), Thailand, Vietnam
Netherlands	16	Bhutan, Bulgaria, Costa Rica, Czech Republic, Hungary (2), Latvia (2), Poland (2), Romania, Russia (2), Slovak Republic (2), South Africa
Norway	6	Burkina Faso, China, India, Mexico, Poland, Slovak Republic
Sweden	51	Estonia (21), Latvia (21), Lithuania (9)
Switzerland	2	Romania, Slovak Republic
United States	41	Argentina (2), Belize (2), Bolivia (3), Chile (4), Costa Rica (7), Czech Republic, Ecuador, Equatorial Guinea, El Salvador, Guatemala (3), Honduras (2), Indonesia, Mali, Mexico (4), Nicaragua, Panama, Russia (4), Sri Lanka, Uganda

Table 2: Bilateral aid and AIJ partnerships

AIJ projects	Bilateral aid, investor to host	
	no	yes
no	337	2,546
yes	0	65

Table 3: Estimation results

	Count model		Dichotomous model	
	Coefficient	Std. Err	Coefficient	Std. Err
Investment equation				
Investor attributes				
Carbon intensity	6.049 ^a	1.354	1.634 ^a	0.415
Environmental policies	0.845 ^a	0.328	0.351 ^a	0.113
Subsidies offered	2.964 ^a	0.581	0.539 ^a	0.148
Host attributes				
Carbon intensity	0.456	0.328	0.139 ^a	0.053
General investment climate	0.065 ^a	0.027	0.020	0.030
Environmental policies	0.373	0.425	0.140	0.118
Government effectiveness	1.176 ^b	0.521	0.032	0.112
Political stability	0.572 ^c	0.339	0.408 ^a	0.116
Bilateral characteristics				
Carbon cross-product	-1.466 ^b	0.619	-0.330 ^b	0.150
Bilateral aid	0.011 ^a	0.003	0.014 ^b	0.006
Constant	-6.111 ^a	1.237	-3.003 ^a	0.366
Agency preferences				
Bilateral characteristics				
Proximity	-1.918 ^a	0.424	0.560 ^a	0.131
Trade agreements	0.350	0.416	0.415 ^a	0.134
Host attributes				
Income	0.052	0.148	-0.112 ^a	0.036
Population	-0.212 ^b	0.097	0.219 ^a	0.028
Government effectiveness	0.360	0.595	0.126	0.130
Political stability	-0.190	0.358	-0.146 ^b	0.072
Voice and accountability	0.088	0.196	0.129 ^a	0.053
Corruption controls	0.027	0.487	-0.192	0.120
Constant	4.080 ^b	2.027	-1.448 ^a	0.512
Over-dispersion parameter (log)	1.677 ^a	0.513		
Correlation between equations			-0.692 ^a	0.162
Tests				
Investment independent of bilateral aid		$\chi^2(1)=16.86^a$		$\chi^2(1)=5.69^b$
Poisson versus negative binominal		$\chi^2(1)=115.24^a$		
Investment unaffected by agency preferences		Vuong z=3.29 ^a		
Investment and agency preference equations independent				$\chi^2(1)=7.52^a$

Note: Results for the count model are based on a robust variance estimator. Standard errors for the two-stage dichotomous model are based on a bootstrapping procedure using 500 replications. ^a, ^b and ^c indicate significance at the 1, 5 and 10 percent level respectively.

Table 4: Results from Hausman tests for cotemporaneous correlation

	Count model	Dichotomous model
Standard errors used in test		
Sample (Robust)	5.17 ^b	12.50 ^a
Bootstrap (500 replications)	2.29 ^e	2.55 ^d

Note: Wald test has a χ^2 distribution with one degree of freedom. ^a, ^b, ^d and ^e indicate significance at the 1, 5, 11 and 13 percent level respectively.

Table 5: Tests of key hypothesis under “recursive policy” assumption

	Count model	Dichotomous model
Investment independent of bilateral aid	$\chi^2(1)=9.75^a$	$\chi^2(1)=12.50^a$
Poisson versus negative binominal	$\chi^2(1)=133.96^a$	
Investment unaffected by agency preferences	Vuong $z=2.08^b$	
Investment and agency preference equations independent		$\chi^2(1)=32.58^a$

Note: Results for the count model are based on a robust variance estimator. In the dichotomous model potential heterogeneity in the investment error term is accounted for by including information on the project count for each investor-host dyad. ^a and ^b indicate significance at the 1 and 5 percent level respectively.