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ADOPTION OF SOIL CONSERVATION TECHNOLOGIES IN EL SALVADOR: A CROSS-SECTION AND OVER-TIME ANALYSIS

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ABSTRACT

This paper examines the determinants of adoption of soil conservation technologies among farmers participating in the Environmental Program of El Salvador (PAES). A sample of PAES participants was surveyed in 2002, from which a sub-sample was re-surveyed in 2005 along with a control group of non-participating households. This is an ex-post evaluation of PAES and there is no baseline and no randomized control group. Therefore, quasi-experimental techniques were applied to select the treatment and comparison groups after the intervention occurred. Matching techniques were employed to construct a comparison group that resembles the treatment group based on observed characteristics while statistical controls were applied to measure differences on adoption of soil conservation for the treatment group at two points in time (2002 and 2005) and between the treatment and comparison groups at a given point in time (2005), allowing for before-after and with-without comparisons.

Two adoption models (Conservation Practices and Conservation Structures) were estimated using two separate samples (PAES beneficiaries 2002-2005 and beneficiaries-control group 2005). We then analyzed the factors associated with disadoption of the technologies in 2005 relative to 2002. Overall, the adoption of practices and structures is positively associated with schooling, off-farm earnings, crop diversification, technical assistance, participation in social organizations, frequency of extension visits and access to local markets. More importantly, PAES beneficiaries have increased significantly the area treated with conservation between 2002 and 2005. The results confirm that the project intervention (frequency of extension visits and years with project) is positively associated with adoption. Our findings also indicate that access to agricultural markets and rural infrastructure and institutions is crucial for adoption and diffusion of new technologies.

Two probit models are estimated to examine the disadoption of practices and structures using the 2002-2005 data for PAES beneficiaries. These models indicate that off-farm income, education, frequency of extension visits, years with PAES and participation in social organizations are significant contributors to reducing the probability of disadoption of conservation technologies. In turn, disadoption is significantly associated with farm size. Disadopters of practices tend to be younger than adopters and have more diversified and larger farms with more access to input and output markets. In turn, disadopters of structures tend to have larger and more steeply farms, are more involved in social organizations and have less access to input and output markets and local infrastructure.

INTRODUCTION

Natural resource degradation is pervasive in Central America and is mainly caused by poor land management. Without major changes in agricultural production strategies in the region, some analysts project that native forests will disappear by the middle of this century (Kaimowitz, 1996; Utting, 1997). Environmental degradation also threatens regional food security, as indicated by the persistent drop in per capita production of the main staple crops -corn and beans (Johnson and Baltodano, 2004; Barbier, 2000; Conroy *et al*., 1996).

To address this bleak scenario, local governments with the support of international agencies have undertaken a series of public investment programs focusing on poverty reduction and the promotion of conservation technologies. One such effort is the Environmental Program of El Salvador (PAES). This program, which concluded in 2004, had a US $35.89 million price tag making it the largest public agricultural investment ever made in this country. A major thrust of this project was to increase farm-household income through improved soil productivity, the adoption of conservation technologies and product diversification. PAES can be viewed as three separate projects, PAES1, PAES2 and PAES3, since each one was implemented in a different area by a different international consortium.

Three previous studies have analyzed the effects of adopting soil conservation technologies among farmers associated with PAES. Bravo-Ureta *et al*., (2006) and Cocchi (2004) show that the adoption of soil conservation practices among PAES beneficiaries has significantly improved farm income. On average, an additional *Manzana* cultivated under soil conservation practices could increase annual farm revenues by 8%. In addition, Solís, Bravo-Ureta and Quiroga (2005) report a significant positive association between the adoption of soil conservation technologies and technical efficiency in the farm.

The general goal of this study is to empirically estimate the factors affecting the adoption of soil conservation technologies among hillside farmers in El Salvador. The specific objectives are to compare adoption rates between 2002 and 2005 for PAES beneficiaries, and to make such comparisons between beneficiaries and non-beneficiaries for 2005. The rest of this paper is organized as follows. The next section presents an overview of some key features of PAES, followed by a discussion of studies that analyze the adoption of soil conservation practices. Section 4 contains a synopsis of alternative impact evaluation techniques in order to set the basis for the methodology adopted in this study, followed by the description of the fieldwork , the dataset and the empirical techniques employed

to model technology adoption. Next, the empirical models of soil conservation are discussed, followed by the presentation of the econometric results. The paper ends with a summary and some concluding remarks.

I. THE ENVIRONMENTAL PROGRAM OF EL SALVADOR (PAES)

El Salvador is the smallest and most densely populated country in Latin America, with over 7 million people living in 21,000 square kilometers, an area about the size of the state of Massachusetts. As population increases, more pressure is put on the country's limited natural resources. Less than 5% of the total land area remains forested (Koop and Tole, 1997). Approximately 57% of the country's population live in rural areas and about 75% of the basic grains (corn and beans) are produced by poor *campesinos* who operate very small holdings.

The site chosen for PAES is the upper basin of the Lempa River, an area covering 25% of El Salvador's land area and 40% of its national population. The Lempa watershed and the reservoir created by the Cerrón Grande dam are badly degraded as a result of the removal of almost all tree cover; poor land management, and limit access to capital, technical support and financial credit (Mercado and Dulin, 2001). PAES had three main components: 1) protection of natural areas; 2) monitoring of water quality; and 3) soil conservation and agroforestry. This study focuses exclusively on the soil conservation and agroforestry component.

Thirteen project areas, totaling 34,000 hectares and 19,500 farming households, were identified for priority intervention (San Rafael de Cedros, Tejutepeque, Nejapa, Cinquera, Tenancinango, San José Guayabal, Guazapa, Segura, Sacacoyo, San Juan Opìco, Resbaladero, Texistepeque, and Nueva Concepción). The 13 areas were grouped into three intervention regions (PAES 1, 2 and 3) and operated by separate international consortiums or Project Operation Units (POU) (see Map 1).

Within each priority area, the target population consisted of farmers with incomes below the poverty line and producing mainly staples (corn and beans) in hillsides with slopes of at least 15%. The project was promoted at the community level through meetings with farmers held at local institutions and organizations such as Local Development Associations (*ADESCOS*), Churches, Town Halls, and NGOs. Farmers then prepared annual farm plans with the assistance of communal extensionists and contact farmers. The communal extensionists, in turn, trained and supported farmer groups of 10 beneficiaries. Farmers to be accepted as beneficiaries have to fulfill certain conditions, including: a) residing in the community, b) willing to receive training, c) willing to accept technical recommendations regarding soil conservation and output diversification, and d) to return to the community part of the incentives received

from PAES. The latter condition played an important role in motivating other community members to initiate their own farm plans (Henríquez, 2006).

The process of training and technical assistance was progressively transferred from the POU's extension agents to the contact farmers and communal extensionists. The technical assistance was developed with farm plans and supported by talks, workshops, contact farms and other means of group training. This model of facilitation where contact farmers teach their neighbors new and improved practices enables farmers to define their own problems and involves them in a participatory process that culminates in the development and implementation of solutions (Beynon *et al.*, 1998).

PAES also implemented a complex incentive program based on the creation of an Incentive Fund that became progressively administered by the communities. The incentives were temporary (no more than two years) and were either agricultural inputs (seeds, plants, agrochemicals, tools) or payments for services provided by farmers, such as construction of conservation structures for themselves or for other farmers. Beneficiaries received the incentives which were later returned to the Incentive Fund for redistribution within the community. PAES was not responsible for the recovery of the distributed funds, but only for implementing an effective incentive system. A cost-sharing mechanism was also established with each farmer based on an approved farm plan and on a commitment to establish a communal organization to monitor the goals of conservation and natural resource management. The level of incentives was related to the annual farm plan that the farmer had to prepare with the support of the contact farmer and the extensionist. In principle, the farm plan included three components offered by the project: soil conservation, agroforestry and diversification, while technology choices were made by the farmers based on their availability of labor and capital. Each farm plan contains the amount of incentives required to attain the annual goals of the farm. At a regional level, the demand for incentives contained in the farm plans was consolidated into the Annual Regional Plan of Incentives. The system of incentives represented around 50% of the program's budget and constituted the core of the relationship between farmers and extensionists (Herrador, 2005).

II. ANALYSES OF THE ADOPTION OF SOIL CONSERVATION TECHNOLOGIES

Faced with the danger that farmer-induced land degradation would undermine efforts to increase agricultural productivity, planners and policy-makers have promoted and invested heavily in soil and water conservation technologies. While different technologies and approaches have been applied worldwide, the focus has been on controlling runoff and preventing soil loss. Typically, cross-slope technologies such as live barriers, stonewalls, ditches, and terraces have been promoted. More recently, attention has shifted towards no-burn practices and the use of cover crops and conservation tillage systems (Hellin and Schrader, 2003; Lutz *et al*., 1994).

One criterion often used to evaluate the success of conservation programs is the proportion of farmers adopting the promoted land management technologies. Based on this criterion, many public initiatives in various developing (and developed) countries have not fulfilled the expectations (Pretty *et al*., 2006; Hellin and Schrader, 2003; Hellin and Haigh, 2002; Pretty and Shah, 1997; Westra and Olson, 1997; Thampapillai and Anderson, 1994; Shaxson *et al*., 1989). While farmers tend to adopt techniques that are expected to be profitable, profitability is not a sufficient condition, since demographic and farm characteristics as well as institutional barriers can constrain the adoption of innovations (Scherr, 2000; Saín and Barreto, 1996; Neil and Lee, 2001; Lapar and Pandey, 1999; Current *et al,* 1995*;* Reardon and Vosti, 1995; Lutz *et al,* 1994).

Most soil conservation programs begin with the notion that there are technologies that work, and it is just a matter of finding the "triggering mechanism" to induce adoption by farmers (Reij, 1998; Pretty and Shah, 1997). Ryan and Gross (1943) were the first to show that technological adoption varies from farmer to farmer and since then considerable effort has been devoted to study which attributes better explain this variability. Most of the literature on the use of conservation technologies consists of behavioral studies examining the influence of factors such as farmer and farm attributes (Lichtenberg, 2001). Detailed reviews can be found in Rogers (1995), Feder and Umali (1993), Feder, Just and Zilberman (1985), and Lindner (1987).

Farmer attributes that are commonly included in adoption studies are education, age and erosion perception. Farmer and household schooling is expected to foster adoption (Feder and Umali, 1993), despite studies showing non-significant or negative results (Rahm and Huffman, 1984; Marra and Ssali, 1990; Warriner

and Moul, 1992; Hansen *et al*., 1987; Hopkins *et al.,* 1999; Caviglia-Harris, 2002). Regarding age, older farmers are expected to be less likely to adopt conservation technologies (Norris and Batie, 1987). If labor and credit markets are imperfect, then older farmers lacking the labor needed to introduce and maintain conservation technologies may seem less prone to adopt them (Shiferaw and Holden, 1998). The perception of erosion as a problem has been indicated as a pre-condition for conservation investments (Earle, *et al*., 1979; Norris and Batie, 1987; Ervin and Ervin, 1982; Gould *et al*, 1989, Stonehouse, 1991; Hopkins *et al,* 1999; Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995; Shiferaw and Holden, 1998; Negatu and Parikh, 1999).

Among farm characteristics, farm size, tenure, slope and credit have been widely analyzed. In land-scarce areas, availability of cultivable land is an important and valuable asset. Population pressure and land degradation have pushed the agricultural frontier to marginal lands previously unsuitable for cultivation. This population pressure could also trigger the removal of conservation structures, since these structures occupy an important part of the scarce productive land (Shiferaw and Holden, 1998). However, several studies report negative or non-significant effects of farm size on adoption (Caviglia-Harris, 2002; Knowler and Bradshaw, 2001; Agbamu, 1995; Hansen *et al*, 1987).

Conservation decisions are also closely linked with crop diversification. Empirical studies have shown that farmers usually allocate the bulk of production and conservation technologies to cash crops, either because the profitability is higher than for subsistence crops, or because there is credit or input provision in cash crop schemes (Reardon *et al*, 1995). Moreover, some crop mixes (such as a high share of perennials) or land use patterns (such as a high share of pasture and fallow) are substitutes for conservation investments (Clay *et al*, 1995).

Similarly, land tenure can contribute to adoption, since landowners tend to adopt more frequently than tenants, an argument that has justified numerous efforts to reduce tenure insecurity (Bonnard, 1995; Lutz *et al,* 1994; Shultz *et al*, 1997). An important effect of land tenure is to facilitate the access to institutional credit (Wachter, 1994). However, in several cases land tenure appears to have the opposite effect on adoption (de Herrera and Saín, 1999; Lee and Stewart, 1983).

Parcel slope, as an indicator of erosion potential, is a farm attribute frequently studied. Slope positively affects conservation investments in Winters *et al* (2002), Shiferaw and Holden (1998), Bonnard (1995), Ervin and Ervin (1989) and Norris and Batie (1987). Another variable that has received attention is access to institutional credit which commonly has a positive effect on adoption

(Caviglia-Harris, 2002; Saín and Barreto, 1996; Pender, 1992; Napier, 1991; and Hansen *et al*, 1987).

When market imperfections for all goods and services are not present, factor endowments should have no effect on a household's production and investment decisions (Pender and Kerr, 1996). However, imperfections in labor markets force households to equate their labor demand with labor supply, and thus higher relative labor endowments may boost conservation investments. Imperfections in credit and capital markets also imply that households with higher savings or productive assets are in a better position to invest in conservation. Distortions in land markets may also lead to differential investment behavior. Thus, when market imperfections are important, the theory of investment behavior suggests inclusion of household characteristics and asset endowments in explaining adoption decisions (Shiferaw and Holden, 1998).

In contrast with the substantial body of research dealing with technology adoption, very few studies have focused on the factors associated with farmers' decision to abandon or disadopt soil conservation technologies. Among the few studies that examine this issue, Neill and Lee (2001) evaluate the adoption and disadoption of sustainable agriculture in Northern Honduras. They conclude that the adoption of new production technologies will not be sustained unless these technologies are associated with more profitable crops.

In a recent paper, Feder *et al.* (2004) applied a difference-in-difference model to examine the impact of participation in farmer field schools on yields and on pesticide use based on panel data for beneficiaries and a control group in Indonesia for the period 1991-1999. The application of the difference-in-difference methodology was appropriate in the Feder *et al.* (2004) study given the availability of a control group over the period studied as well as a considerable time lag between the two points in time analyzed. In addition, Abdulai and Huffman (2005) suggest that in order to achieve an enduring adoption of a new technology over time, especially among farmers in developing countries, it is necessary to invest in human capital and improve local commodity markets.

III. Identification of PAES Impacts

In this section the strategy followed to identify the farm-level impacts associated with PAES is presented. Impact evaluation relies on the construction of a counterfactual situation to examine what would have happened to a group of beneficiaries had they not participated on a given project. The counterfactual outcome is never actually observed as people cannot simultaneously participate and not participate in a project. To generate counterfactual data it is necessary to establish a control or comparison group (those who do not participate or receive benefits) to compare it with the group under intervention. If there is data for a control group then "with and without" project comparisons are possible. Ideally, data for impact evaluation would be collected from the same set of households at least twice, before and after the intervention. Beneficiaries can also be compared before and after the intervention if baseline and follow-up data are available. Even if only post-intervention data are available, it is still possible to conduct a sound evaluation by choosing an appropriate evaluation design (Adam, 2006; Prennushi *et al*., 2000).

The choice of methodology to determine the counterfactual is at the core of evaluation design and depends largely on how and when the evaluation is planned. The earlier an evaluation is planned, the greater the methodological flexibility, particularly in the choice of quantitative techniques. Two broad categories of such methodologies can be identified: experimental designs (randomized); and quasi-experimental designs (nonrandomized) (Adam, 2006; Ezemenari *et al*., 1999). Experimental designs are generally considered the gold standard and the most robust of the evaluation methodologies. By randomly allocating the intervention among eligible beneficiaries, the assignment process itself creates comparable treatment and control groups that are statistically equivalent to one another. This is a very powerful approach because, in theory, the control groups generated through random assignment serve as a perfect counterfactual, free from the troublesome selection bias issues that plague most evaluations (Adam, 2006; Kerr and Chung, 2001; Baker, 2000).

For the purpose of this ex-post evaluation of PAES, no experimental design is possible, since there is no baseline and no randomized control group. Instead, quasi-experimental techniques were applied to select the treatment and comparison groups after the intervention occurred (Adam, 2006; Baker, 2000). Matching techniques were also employed to construct a comparison group that resembles the treatment group based on observed characteristics while statistical controls were applied to measure differences on adoption of soil conservation for the treatment group at two points in time (2002 and 2005) and between the

treatment and comparison groups at a given point in time (2005), allowing respectively for before-after and with-without comparisons. These techniques are explained in more detail below.

IV. DATA COLLECTION AND EMPIRICAL MODELS OF SOIL CONSERVATION

All the data used in this study were obtained from surveys applied to representative samples of farm households in El Salvador. The data set covers a wide range of variables including attributes of the households, land tenure status, inputs used and outputs produced, prices paid and received, technology adoption, soil conservation practices implemented, non-farm sources of income, and access to services such as formal education, credit, training, extension, and technical assistance. Originally, a sample of rural households participating in PAES was surveyed in 2002. These data were collected and analyzed by Bravo-Ureta *et al*., (2003), as part of a Technical Cooperation between the Office of International Affairs (OIA) at the University of Connecticut (UConn) and the Inter-American Development Bank (IDB). For the purpose of the current study, a sub-sample of the 2002 survey was re-surveyed in 2005, this time along with a control group of non-participating families.

A. The 2002 Data

The initial fieldwork comprised a sample of 530 farm households belonging to 102 communities within the regions of Resbaladero and Texistepeque (PAES1), San Juan Opico and Nueva Concepción (PAES2), and Tenancingo and Guazapa (PAES3). The beneficiary households, 175 from PAES1, 177 from PAES2 and 178 from PAES3, were randomly selected from records provided by the respective implementing firms. The sample was stratified by region to reflect the geographical distribution of the three projects. The interviews were conducted between June and August 2002, including pre-tests and training of the team that performed the field work. The local consulting firm SERTECNIA conducted the survey with a team comprised of four supervisors and six interviewers. The samples and questionnaires were designed in a cooperative effort among OIA-UConn, the projects' management units and specialists from the Inter-American Development Bank during a workshop held in San Salvador during April 2002.

B. The 2005 Data

From the 353 beneficiaries surveyed in 2002 and participating in PAES1 and PAES3, 260 were randomly selected to be re-surveyed in 2005 using the Surveyselect procedure in SAS. We also surveyed 325 farm households who never received PAES benefits, from which 260 observations were randomly extracted to form a control group. The control group includes 163 Neighbors (residing in the same village as PAES participants) and 162 Non-Neighbors

(living in cantons outside the PAES area). The sample of 163 Neighbors was obtained from a list assembled by asking randomly 130 PAES beneficiaries the names of three neighbor farmers who never received benefits from PAES. From this list, one or two out of the three names, depending on village size and determined ahead of time, were randomly chosen, totaling the required 163 farmers. In turn, 162 Non-Neighbors were selected randomly from listings of cantons and villages within the five departments of El Salvador where the PAES was implemented but not served by the project. The listings were provided by the General Direction of Statistics and Census of El Salvador (DIGESTYC). The interviews were also conducted by SERTECNIA between May and June 2005, including pre-tests and training. The questionnaire applied to the non-beneficiaries is based on the one used for the beneficiaries with appropriate adjustments.

A "matching" technique was used to construct a control group from the oversample of non-beneficiaries. To select the 260 members of the control group from the total of 325 observations, participation scores were generated by regressing participation (1 for participant; 0 for non-participant) on a set of demographic and farm variables that are likely to influence the participation selection process.[1] A total of 595 observations (260 beneficiaries + 325 non-beneficiaries) were pooled together to estimate the following logistic regression:

(1) **Participate** = *f* (off-farm income, tenure, slope, distance house-field, age of head of household (HH), gender of HH, family size, average education of household)

From this logistic regression, the predicted probabilities of participation for beneficiaries and non-beneficiaries were used to sort and match both groups. The average expected probability of participation for the control group selected is 45.9%, which is very similar to the 48.7% obtained for beneficiaries (see Appendix 1 for listings of participation scores).

PAES has promoted at least 15 different soil conservation and agroforestry technologies. For our purpose, it is convenient to classify them into: 1) soil conservation practices (crop residue mulching, minimum and zero tillage, crop rotation, green manure, and contour tillage); 2) soil conservation structures (terraces, ditches, live barriers; stone walls); and 3) agroforestry practices (intercropping, trees in contour, shades, trees dispersed in lots, and secondary forest management).

[1] Further details on this procedure can be found Baker (2000); Jalan and Ravallion (1998); and Rosenbaum and Rubin, (1985).

Usually, choice models (i.e., probit and logit) are used to examine the factors determining probabilities of adoption for a specific technology. Given the wide array of technologies disseminated by PAES, we construct two general indicators of adoption: 1) Area treated with soil conservation practices; and 2) Area treated with soil conservation structures and agroforestry combined. In addition to the adoption variables, binary indicators of disadoption for practices and structures are also constructed. The disadoption of practices is calculated as a binary variable which equals one if in 2005 the area treated with conservation practices is smaller than in 2002, and zero otherwise (Neil and Lee, 2001). The same approach is followed for structures.

The distinction between structures and practices is important because traditionally most resource management projects have focused on structures designed to stop water runoff, such as terraces and ditches. These structures are labor-intensive and expensive to construct, require costly maintenance and the benefits usually accrue in the long run. Consequently, soil conservation programs do not have a very good track record regarding sustainable impact (Hellin and Haigh, 2002; Bunch, 2001; Herweg and Ludi, 1999; Erenstein, 1999; Wiggins, 1981; Blaikie and Brookfield, 1987). To improve performance, programs have recently shifted towards technologies that provide soil cover and recover organic matter, such as green manure, cover crops and improved fallows. Moreover, these practices are relatively inexpensive and demand little to no extra labor (Bunch, 2001; Scherr, 2000; Erenstein, 1999).

The adoption and disadoption models can be written in general form as:

(2) **Adoption** = *f* (land, labor, off-farm income, age of head of household (HH), gender of HH, education of HH, slope, social organization, frequency of extension visits, diversification, erosion, share of animal products on farm income, share of cash crops on farm income, tenure, years with PAES, time, PAES1).

(3) **Disadoption** = *f* (land, labor, off-farm income, age of head of household (HH), gender of HH, education of HH, slope, social organization, visit, diversification, erosion, share of animal products on farm income, share of cash crops on farm income, tenure, years with PAES, time, PAES1)

The models in equations (2) and (3) include explanatory variables representing household, household-head, farm, project, and location characteristics based on the literature on technology adoption. All variables are defined in Table 1.

A community-level survey was applied in the 176 cantons included in the 2005 fieldwork to gather information on local access to infrastructure, transportation,

and input and output markets that might affect technology adoption/disadoption. A principal components analysis was then performed to summarize that information and to create two new variables: Market Access, and Local Infrastructure. Market Access was created as a function of distance to the city, presence of local production cooperatives, presence of an output market, and access to transportation. In turn, Local Infrastructure was constructed based on access to electricity, and the availability of primary and secondary schools. This analysis was performed using the Princomp procedure in SAS. For both variables, Market Access and Local Infrastructure, a higher value denotes a better level of market access or infrastructure availability, respectively. Appendix 1 reports values of Market Access and Local Infrastructure for each observation.

The adoption models are estimated using the Generalized Least Square Procedure (GLS) in order to correct for heteroscedasticity and the disadoption equations are estimated using the Probit procedure. Table 1 displays variable definitions as well as their means. This table also includes the statistics for the tests of mean differences for the different subsets included in the analysis. The data are disaggregated by survey year (2002 and 2005) and groups under analysis (i.e., PAES beneficiaries, neighbors, no-neighbors, and adopters and disadopters of conservation practices and structures). The tests of means reveal that the PAES beneficiaries have increased significantly the adoption of land conservation practices and structures between 2002 and 2005. Moreover, the data clearly show that beneficiaries have significantly higher rates of adoption than neighbors and non-neighbors in 2005.

V. ECONOMETRIC RESULTS

A. Adoption of Soil Conservation Practices and Structures

The two adoption models (Soil Conservation Practices and Soil Conservation Structures) are estimated for two separate samples (PAES beneficiaries 2002-2005, and beneficiaries-control group 2005). Table 2 presents the Generalized Least Squares (GLS) estimates of adoption of conservation technologies among PAES beneficiaries, while Table 3 compares the determinants of adoption between beneficiaries and the control group.

The Chow Test was applied to detect structural changes between samples of beneficiaries and control group. The calculated F-tests reject the null hypothesis that the beneficiaries and the control group have the same parameters at the 5% level of significance in all estimated models (Gujarati, 2002). The test reveals significant parameter differences regarding the determinants of adoption of soil conservation technologies between beneficiaries and the control group. The same is found for beneficiaries between 2002 and 2005. Thus, we treat the data as separate subsamples (Models 2002 and 2005 in Table 2 and Models Beneficiaries and Control in Table 3) instead of assuming similar structure across groups (Model Pooled in both tables).

Approximately 35% of the parameters in all models shown in Tables 2 and 3 are statistically significant with R-Squares ranging from 17.9% to 50.5%. Overall, the adoption of practices and structures are positively and significantly associated with labor, schooling, slope, crop diversification, social participation, and frequency of extension visits. In addition, land presents a decreasing positive effect on adoption with a positive linear term and a negative quadratic coefficient.

PAES beneficiaries have intensified conservation significantly between 2002 and 2005, as revealed by the positive coefficients for the dummy year in the pooled models presented in Table 2. This result is consistent with the tests of means for 2002-2005 reported in Table 1.

Land tenure usually fosters adoption of conservation technologies because landowners are supposed to care more about their resources than renters (Lutz *et al.,* 1994; Shultz *et al*., 1997). However, our results indicate that tenure does not significantly affect the adoption of conservation practices and structures. This finding may be explained by different land use patterns among landowners and renters. For example, landowners may devote more land to livestock and forestry

whereas renters might focus more on annual cash crops. In fact, the 2002-2005 data reveals statistically significant differences between the shares of cash crops in farm income for landlords (78%) and for renters (84%). A similar finding is reported by Pagiola and Dixon (1998) and McReynolds *et al*. (1994) also for samples of farmers in El Salvador. However, only one interaction term (tenure*cash crops) significantly affects the adoption of soil conservation structures.

Labor presents a positive and significant effect on the adoption of soil conservation in almost all models. It is important to indicate that this variable includes mostly family labor (84% of total labor). This result agrees with the outcomes reported by López and Valdéz (2000) regarding the importance of family labor in the success of development projects in Central America.

The positive association between diversification and the adoption of conservation technologies supports the idea that land allocation decisions may influence significantly the pattern of technology adoption (Moreno and Sunding, 2003; Winters *et al*., 2004; Barbier, 1990; Hopkins *et al*., 1999; Kruseman, 2000). For instance, Murray (1994) argues that farmers are more open to implement soil conservation measures when they are presented not as the main component of rural extension, but rather as secondary items in a menu featuring innovations with good short-term income-generating potential. The literature suggests that diversified farmers usually adopt sustainable technologies in order to reduce production risk (Neill and Lee, 2001; Reardon *et al*., 1995; and Clay *et al*., 1995).

Off-farm income presents a positive but small association with the adoption of soil conservation technologies. In addition, in most of the models the coefficient for off-farm income is not statistically significant. By comparison, the literature presents mixed results concerning this variable. Rogers (1995), and Abdulai and Huffman (2005) indicate that external sources of income provide the means to invest in new technologies in order to improve resource quality and thus agricultural productivity. However, opposite effects are reported by Bonnard (1995), Hopkins *et al*., (1999), and Mbaga-Semgalawe and Fomer (2000).

The data presented in Tables 2 and 3 show that social participation also correlates positively with adoption. These results confirm the notion that social interactions promote the diffusion of technical information (Winters, *et al*., 2002; Shultz, *et al.*, 1997).

Table 4 presents elasticities calculated at the mean of the data for all non-pooled models. For example, the elasticity of 0.073 for Land in the first column of Table 4 indicates that a 10.0% increase in the quantity of cultivated land would lead to

a 0.73% rise in the use of conservation practices among PAES farmers during 2002. Overall, the variables affecting adoption of conservation the most are slope, social organizations, diversification, land and erosion. In addition, the elasticities suggest that for the control group the most important variable related to adoption is participation in social organizations. Conversely, crop diversification seems to be the key variable among beneficiaries.

B. Determinants of Disadoption

Table 5 presents the probit estimates of the disadoption models for practices and structures among PAES beneficiaries. As defined earlier, the dependent variables are equal to one if the area under practices or structures in 2005 is smaller than in 2002 and zero otherwise. Therefore, a positive (negative) coefficient indicates that the corresponding explanatory variable is positively (negatively) associated with the probability of disadoption (adoption). The null hypothesis that all coefficients are simultaneously zero is rejected consistently at the 1% significance level, while the percentages of correctly predicted responses are quite high (76.9% for practices and 72.6% for structures).

Overall, off-farm income, education, frequency of extension visits, diversification, years with PAES and social participation significantly reduce the probability of disadopting conservation technologies. In turn, farm size (land) is the only variable that significantly increases the probability of disadoption in both models.

Table 5 also displays marginal effects (ME), which measure the percent change in the probability of adoption due to a one unit change in an explanatory variable. Marginal effects (ME) for the continuous variables in the Probit models are equal to:

(4) $$\mathrm{ME} = \phi(\delta Z)\delta$$

where ϕ is the probability density function, Z is the vector of exogenous variables and δ are the estimated parameters (Madalla, 1983). The marginal effects are measured at the mean value of the regressors. Marginal effects for the *dummy* variables are measured by taking the difference between the value of the prediction when the dummy equals 1 and when it equals 0, holding all other variables at their respective means (STATA, 2003).

Diversification has the largest marginal effect in the model for practices, followed by the two variables reflecting human capital: education and frequency of extension visits. Other things being equal, an extra crop in the farm plan is

associated with a 22.7% decrease in the probability of disadoption of conservation practices. Meanwhile, an additional year of education or an extra visit by an extensionist reduces the same probability by 19.8% and 6.4%, respectively. In the case of structures, diversification reduces disadoption by 13.7%, education by 14.6% and frequency of visits by 12.2%. The significant effect of schooling is in line with the robustness of the empirical evidence on the returns to education at the micro-economic level (Besley and Burgess, 2003; Krueger and Lindhal, 2001; Lau *et al*., 1990; Glewwe, 1996).

Off-farm income is also negatively related to disadoption especially with respect to soil conservation structures. Households who are involved in off-farm activities are, respectively, 1.5% and 16.3% more likely to continue using conservation practices and structures in their farms.

VI. SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

This paper examines the determinants of adoption of soil conservation technologies among farmers participating in the PAES project in El Salvador. We use detailed data gathered from surveys applied to representative samples of farm households at two points in time. Originally, a sample of PAES households was surveyed in 2002, from which a sub-sample (N=260) was re-surveyed in 2005, this time along with a control group of non-participating families (N=260).

First, we evaluate factors affecting the adoption of conservation practices and structures among PAES beneficiaries between 2002 and 2005 and among beneficiaries and control groups in 2005. For this purpose, two adoption models (Soil Conservation Practices and Soil Conservation Structures) were estimated using two separate samples (PAES beneficiaries 2002-2005 and beneficiaries-control group 2005). We then analyzed the factors associated with disadoption of the technologies in 2005 relative to 2002. Separate probit models for disadoption of practices and structures were estimated using the 2002-2005 data for the PAES beneficiaries.

Overall, the results indicate that PAES beneficiaries increased significantly the area treated with conservation between 2002 and 2005. Besides, the adoption of practices and structures are positively associated with labor, schooling, slope, crop diversification, social participation, and frequency of extension visits. The results also confirm that the project intervention, captured by the frequency of extension visits and years with the project, are positively associated with adoption. This is in line with the hypothesis that adoption of conservation technologies is heavily influenced by incentives given to offset some of the investment costs. Our findings also support the idea that access to markets and infrastructure facilitate the adoption and diffusion of new technologies. However, more detailed analysis is needed to understand the best mechanisms to implement a well structured market system in the area.

A Chow test also reveals that the samples of beneficiaries and non-beneficiaries exhibit a different structure regarding the determinants of conservation adoption. While output diversification is the most important factor in determining adoption levels among beneficiaries, participation in a social organization appears to be the key factor for the control group.

The probit models of disadoption reveal that off-farm income, education, frequency of extension visits, years with PAES and participation in social organizations are significant contributors to reducing the probability of

disadoption of conservation technologies. In turn, disadoption is positively associated only with farm size.

Project beneficiaries are found to be significantly more likely to decrease the area treated with structures than with practices. The more frequent disadoption of conservation structures is consistent with a wealth of empirical evidence of poor private economic returns associated with such technologies. It is increasingly recognized that structures are expensive to build and maintain and that they add little to land productivity in the short run. Further, terracing often entails movements of earth that brings unproductive soil to the surface. This finding needs to be corroborated with an analysis of the relationship between conservation structures and household income.

Finally, disadopters of practices tend to be younger than adopters and have more diversified and larger farms with more access to input and output markets. In turn, disadopters of structures tend to have larger and steeper farms, are more involved in social organizations and have less access to input and output markets and local infrastructure.

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ANNEX 1: MAP AND TABLES

Map 1: Areas of Influence of PAES 1 and PAES 3

Table 1: Beneficiaries, Neighbors, No-Neighbors, Adopters and Disadopters: Variable Definitions, Means, and Test of Means

Variable Definitions	2002	2005					Conservation Practices			Conservation Structures		
	Beneficiaries	Beneficiaries	Test	Neighbors	No-Neighbors	Test	Adopters	Disadopters	Test	Adopters	Disadopters	Test
Farm												
Adoption of conserv. practices (ratio)	1.77	2.3	***	1.4	1.5		2.7	1.4	***	2.5	1.8	***
Adoption of conserv. structures (ratio)	0.67	1.38	***	0.38	0.30		1.4	1.3		1.8	0.4	***
Disadoption of practices (%)		28.1										
Disadoption of Structures (%)		28.5										
Diversification (count)	1.1	3.1	***	2.3	2.8	***	0.93	1.41	**	1.10	0.96	
Land (Manzana=0.7 Has.)	4.8	4.0		2.1	2.3	***	3.61	7.92	***	4.02	6.83	***
Distance house-plot (Km)	0.9	1.1		1.0	1.2		0.85	1.12	**	0.92	0.95	
Tenure, 1 if owns > 50% total land (%)	81.3	82.0		75.0	83.6		0.79	0.86		0.80	0.84	
Slope, 1 if >15% (%)	50.8	66.4	***	66.4	53.9		0.51	0.49		0.49	0.55	**
Household												
Family size (#)	5.3	5.4		4.5	5.1	***	5.28	5.49		5.38	5.23	
Off-farm income, 1 if earns (%)	53.85	31.15	***	36.92	36.15		541.8	447.7	**	477.3	611.0	***
Age Household Head (HH) (Years)	48.3	51.8	***	50.1	51.2		47.7	50.2	**	47.9	49.5	
Gender HH, 1 if male (%)	84.4	84.4		88.3	89.1		0.83	0.85		0.85	0.81	
Education HH (Years)	2.8	2.6		2.9	3.7	***	3.63	3.90		3.69	3.75	

Variable Definitions	2002	2005					Conservation Practices			Conservation Structures		
	Beneficiaries	**Beneficiaries**	**Test**	**Neighbors**	**No-Neighbors**	**Test**	**Adopters**	**Disadopters**	**Test**	**Adopters**	**Disadopters**	**Test**
Social orgs., 1 if participates (%)	52.7	50.8		15.6	21.9	***	0.51	0.59		0.52	0.57	**
Labor ($)	204.0	73.9		92.2	74.6		459.5	704.7	***	474.2	664.3	*
Animal products share on income (%)	0.1	0.3		0.2	0.2		12.0	13.7		13.1	11.0	
Cash-crops share on income (%)	0.1	0.2		0.1	0.2		10.5	15.3	**	11.3	13.1	
Erosion perception, 1 if perceives (%)	86.9	32.3		46.2	43.8		87.2	86.3		83.9	94.6	*
Project												
Years with PAES (Years)	2.7	3.6	***			***	1.74	1.75		1.68	1.91	
Frequency visits (# per year)	29.5	14.6	***	2.8	4.2	***	28.9	31.0	**	29.9	28.6	
Local												
Access to markets		0.06		0.12	-0.25	***	0.01	0.20	**	0.08	0.03	**
Local infrastructure		0.03		-0.01	-0.04		0.05	0.00	**	0.05	-0.01	**
Number of Observations	260	260		130	130		187	73		186	74	

*Test of Means *p < 10%; **p <5%;***p<1%*

Table 2: GLS Estimates of Determinants of Adoption of Conservation Practices and Structures: Beneficiaries 2002-2005

	Conservation Practices						Conservation Structures					
	Pooled		2002		2005		Pooled		2002		2005	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	-0.495	0.499	0.529	0.748	-0.669	0.776	-0.759*	0.416	-0.281	0.280	-0.302	0.209
Land	0.060*	0.032	0.128***	0.049	0.107**	0.052	0.261***	0.027	0.044**	0.018	0.024*	0.014
Land*Land	0.000	0.000	-0.001***	0.000	0.001	0.000	-0.002**	0.000	0.001***	0.000	0.000	0.000
Labor	0.001***	0.000	0.001***	0.000	0.001***	0.000	0.001*	0.000	0.000	0.000	0.000	0.000
Off-farm income	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000***	0.000
Age	0.005	0.006	-0.003	0.008	0.011	0.009	0.005	0.005	0.005*	0.003	0.005**	0.002
Gender	0.251	0.214	0.061	0.298	0.395	0.313	0.184	0.179	-0.218*	0.111	-0.053	0.084
Education	0.004	0.030	-0.011	0.039	0.012	0.046	0.025	0.025	0.037**	0.015	0.037***	0.012
Slope	0.007	0.180	-0.178	0.251	0.456	0.297	0.052	0.150	0.103	0.094	-0.044	0.080
Slope*Land	0.067**	0.022	0.093***	0.026	0.098*	0.054	-0.053***	0.018	-0.003	0.010	-0.026*	0.015
Social organizations	0.370**	0.163	0.501**	0.218	0.217*	0.130	0.297**	0.136	0.159*	0.082	-0.147**	0.067
Frequency visits	0.001	0.004	0.000	0.005	0.008	0.008	0.002	0.003	0.001	0.002	0.005**	0.002
Diversification	0.373*	0.220	0.141	0.348	0.609**	0.305	0.238*	0.124	-0.037	0.130	0.133*	0.072
Erosion	-0.071	0.196	-0.516*	0.305	0.077	0.240	0.019	0.163	0.381***	0.131	0.072	0.065
Animal Products	0.085	0.632	-0.033	0.982	0.394	0.850	-0.646	0.527	-0.492	0.367	-0.028*	0.229
Cash-Crops	-0.366	0.792	-0.119	0.147	-0.280	0.391	-0.828	0.661	-0.458	0.429	-0.594*	0.321
Tenure	-0.101	0.271	-0.349	0.334	0.055	0.466	-0.430*	0.226	-0.169	0.125	-0.220	0.125
Tenure*Animal Products	-0.033	0.726	0.253	0.240	-0.654	0.999	0.718	0.606	0.260	0.426	-0.040	0.269
Tenure*Cash-Crops	0.577	0.961	0.175	0.368	0.238	0.432	0.305	0.802	0.891*	0.512	0.381	0.386
Years with PAES	0.070	0.085	0.107	0.130	0.024	0.116	0.164**	0.071	0.120**	0.049	0.011	0.031
Year	0.424*	0.243	--		--		0.644***	0.219	--		--	
PAES1	0.521***	0.162	0.813	0.220	0.368	0.240	-0.048	0.135	-0.037	0.082	0.082	0.065
R-Square	*0.376*		*0.505*		*0.293*		*0.245*		*0.221*		*0.179*	
N	*520*		*260*		*260*		*520*		*260*		*260*	

[a] *Dependent variable: area under soil conservation practices and structures*
p < 10%; **p <5%;*p<1%*

Table 3: GLS Estimates of Determinants of Adoption of Conservation Practices and Structures: Beneficiaries 2005 and Control Groups

	Conservation Practices						Conservation Structures					
	Pooled		Beneficiaries		Control		Pooled		Beneficiaries		Control	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Constant	0.005	0.424	-0.168	0.685	-0.084	0.463	-0.719*	0.416	-0.583	0.680	-0.632*	0.370
Land	0.169***	0.038	0.108**	0.052	0.549***	0.069	0.448***	0.037	0.548***	0.051	0.108*	0.058
Land*Land	0.000	0.000	-0.001	0.000	-0.015***	0.003	-0.001***	0.000	-0.002***	0.000	-0.007***	0.002
Labor	0.001***	0.000	0.001***	0.000	0.000	0.000	0.000	0.000	-0.001***	0.000	0.001*	0.000
Off-farm income	0.001**	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Age	0.008	0.005	0.010	0.009	0.002	0.005	0.001	0.005	0.002	0.009	-0.001	0.005
Gender	0.018	0.025	-0.012	0.047	0.157	0.208	0.052**	0.025	0.055	0.046	0.035	0.175
Education	0.374**	0.190	0.441*	0.211	0.033*	0.014	0.408**	0.187	0.531*	0.309	0.045**	0.020
Slope	0.050	0.177	0.429	0.294	0.067	0.208	0.553***	0.169	0.648**	0.292	-0.120	0.175
Slope*Land	-0.096**	0.040	-0.067	0.054	-0.053	0.077	-0.251***	0.039	-0.302*	0.054	0.088	0.065
Social organizations	0.311*	0.172	0.052	0.252	0.108	0.179	0.339*	0.174	0.458*	0.250	-0.081	0.151
Frequency visits	0.013***	0.005	0.008	0.008	0.016**	0.007	-0.002	0.005	0.003	0.008	-0.008*	0.005
Diversification	0.386**	0.179	0.516*	0.302	0.028	0.195	0.120	0.176	0.009	0.300	0.089	0.164
Erosion	-0.041	0.138	0.061	0.242	-0.015	0.136	-0.139	0.135	-0.193	0.240	-0.087	0.115
Animal Products	0.385	0.585	0.101	0.853	0.833	0.922	0.084	0.574	-0.047	0.847	-0.132	0.776
Cash-Crops	-0.171	0.847	-0.125	1.195	0.323	1.534	0.646	0.831	0.447	1.186	0.312	1.292
Tenure	0.071	0.240	-0.065	0.459	0.176	0.225	0.089	0.236	-0.235	0.455	0.114	0.190
Tenure*Animal Products	-0.926	0.657	-0.427	1.000	-1.450	0.990	0.151	0.645	0.224	0.992	0.759	0.833
Tenure*Cash-Crops	-0.295	0.960	0.245	1.426	-1.403	1.590	-0.484	0.942	0.273	1.414	-0.519	1.339
Access to Markets	0.077	0.076	0.140	0.128	-0.007	0.078	0.020	0.074	0.048	0.127	0.055	0.066
Local Infrastructure	0.066	0.128	0.280	0.240	0.037	0.128	0.299*	0.125	0.255	0.238	0.189*	0.108
Neighbor	-0.529***	0.175	--		0.020	0.134	-0.558***	0.171	--		0.100	0.112
No-neighbor	-0.566***	0.201	--		--		-0.572***	0.197	--		--	
No-neigh* Organ	0.140	0.352	--		--		0.589*	0.346	--		--	
R-Square	***0.319***		***0.293***		***0.355***		***0.412***		***0.450***		***0.501***	
N	***520***		***260***		***260***		***520***		***260***		***260***	

Table 4: Partial Elasticities for Non-Pooled Models

	Conservation Practices				Conservation Structures			
	2002	**2005**	**Beneficiaries**	**Control**	**2002**	**2005**	**Beneficiaries**	**Control**
Land	0.073	0.047	0.047	0.380	0.061	0.419	0.397	0.315
Labor	0.000	0.000	0.000	0.000	0.000	0.001	-0.001	0.002
Off-farm income	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000
Age	-0.002	0.005	0.004	0.001	0.009	0.162	0.002	-0.002
Gender	0.034	0.172	0.192	0.109	-0.058	-0.066	0.385	0.101
Education	-0.006	0.005	-0.005	0.022	0.062	0.181	0.040	0.131
Slope	-0.101	0.198	0.187	0.046	0.169	-0.294	0.469	0.256
Social organizations	0.283	0.007	0.023	0.075	0.261	-0.360	0.332	-0.236
Frequency visits	0.000	0.003	0.004	0.011	0.001	0.145	0.002	-0.025
Diversification	0.080	0.265	0.224	0.019	-0.060	0.327	0.006	0.258
Erosion	-0.292	0.033	0.027	-0.011	0.126	0.127	-0.140	-0.253
Animal products	-0.585	0.171	0.044	0.576	-0.808	-0.126	-0.034	-0.384
Cash-crops	-0.633	-0.122	-0.054	0.224	-0.753	-0.078	0.324	0.906
Tenure	-0.198	0.024	-0.028	0.122	-0.278	-0.501	-0.171	0.332
Years with PAES	0.061	0.011	--	--	0.197	0.320	--	--

Table 5: Probit Estimation of Disadoption of Conservation Practices and Structures: PAES Beneficiaries 2002-2005

	Conservation Practices			Conservation Structures		
	Coef	**S.E.**	**M.E.**[a]	**Coef**	**S.E.**	**M.E.**
Constant	-0.664***	0.107	--	0.321	0.602	--
Land	0.052*	0.026	0.016	0.019*	0.011	0.010
Land*Land	-0.001	0.002	--	-0.002	0.005	--
Labor	0.058	0.041	0.018	-0.055	0.043	-0.019
Off-farm income	-0.048*	0.027	-0.015	-0.294**	0.129	-0.163
Age	-0.009	0.006	-0.003	0.001	0.006	0.001
Gender	0.265	0.273	0.081	-0.149	0.245	-0.051
Education	-0.594***	0.209	0.198	-0.440**	0.204	-0.146
Slope	-0.132	0.235	-0.051	-0.401	0.277	-0.012
Slope*Land	-0.033	0.035	--	0.107	0.080	--
Social organizations	-0.034*	0.020	0.011	-0.423**	0.170	0.144
Frequency visits	-0.192*	0.111	-0.064	-0.357*	0.212	0.122
Diversification	-0.693***	0.249	-0.227	-0.221	0.248	-0.074
Erosion	-0.026	0.401	0.009	-0.062	0.301	-0.015
Animal Products	-0.039	0.708	-0.012	-0.079	0.697	-0.026
Cash-Crops	0.171	0.905	0.056	-0.596	0.897	-0.199
Tenure	0.217	0.369	0.092	-0.015	0.368	-0.011
Tenure*Animal Products	0.057	0.815	--	0.378	0.79	--
Tenure* Cash-Crops	-0.303	0.445	--	0.154	0.163	--
Access to Markets	-0.200*	0.121	--	-0.190*	0.109	--
Local Infrastructure	-0.114	0.193	--	-0.151	0.188	--
Years with PAES	-0.147*	0.089	0.041	-0.073*	0.043	-0.019
PAES1	0.139	0.223	--	0.179	0.222	--
Likelihood Ratio Test	***53.6****			***58.2****		
% of Right Predictions	***0.769***			***0.726***		
N	***260***			***260***		

[a] *Dependent variable equals one if the area under soil conservation practices and structures in 2005 diminished with respect to 2002.*

[b] *The marginal effect for the dummies variables is computed as Pr[y| x=1]-Pr[y| x=1].*

p < 10%; **p <5%;*p<1%.*

APPENDIX 1

Matching of Participants and Control Group based on Predicted Probabilities of Participation (PPP) and Principal Components for Market Access and Local Infrastructure

CONTROL					PARTICIPANT					CONTROL					PARTICIPANT				
#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt		#	TY	PPP	Mkt	Infx
634	4	0.287	-0.947	-0.539	311	1	0.114	0.476	-0.539	676	0	0.453	0.476	-0.539	517	1	0.502	0.707	0.445
608	4	0.288	1.553	0.445	333	1	0.118	0.057	-0.507	760	4	0.453	-0.395	-0.539	160	3	0.502	-0.420	0.445
771	4	0.288	-0.001	0.472	98	3	0.183	-0.576	0.476	601	4	0.454	-0.059	-0.539	123	3	0.504	-0.222	-0.539
555	4	0.290	1.101	-0.539	166	3	0.193	-0.651	0.476	748	4	0.458	-0.256	0.445	128	3	0.505	-0.576	-0.518
752	4	0.290	-0.658	-0.538	327	1	0.198	-0.954	-0.534	738	0	0.463	2.975	-0.539	26	3	0.505	-0.773	0.445
663	0	0.290	-0.280	-0.539	460	1	0.215	-0.083	-0.539	838	0	0.466	0.649	0.445	87	3	0.506	-0.379	0.445
556	4	0.291	0.509	0.477	382	1	0.237	0.139	0.476	662	0	0.469	-0.616	-0.509	457	1	0.506	-0.221	0.445
797	0	0.291	0.312	0.445	99	3	0.248	-0.494	-0.362	864	4	0.469	-0.280	0.445	29	3	0.508	-0.222	-0.539
754	0	0.298	-0.116	-0.510	15	3	0.257	-0.379	0.445	852	0	0.470	3.962	-0.509	144	3	0.510	-0.296	0.446
696	4	0.301	-0.059	-0.539	432	1	0.257	0.312	0.445	709	4	0.472	-0.643	-0.539	445	1	0.510	-0.083	-0.539
633	4	0.303	-0.716	0.445	462	1	0.258	-0.059	-0.539	683	0	0.473	0.476	-0.539	467	1	0.510	0.649	0.445
862	4	0.307	-0.477	-0.539	161	3	0.261	-0.477	0.445	543	4	0.473	-0.947	-0.511	473	1	0.511	-0.083	0.621
774	4	0.308	1.553	0.445	306	1	0.272	-0.716	0.477	609	4	0.473	-0.140	-0.507	526	1	0.511	2.309	0.445
810	0	0.308	-0.001	-0.539	158	3	0.289	-0.576	0.622	648	0	0.473	-0.634	0.468	27	3	0.512	-0.222	-0.509
746	4	0.308	-0.256	0.445	475	1	0.291	3.609	-0.539	597	4	0.476	-0.576	-0.510	436	1	0.514	1.298	0.476
824	0	0.309	-0.223	0.445	163	3	0.294	-0.616	-0.539	749	4	0.477	-0.256	0.445	530	1	0.515	-0.773	0.474
840	0	0.309	0.476	-0.539	23	3	0.296	0.237	-0.516	789	4	0.477	-0.519	-0.509	39	3	0.518	-0.280	-0.539
757	4	0.310	-0.773	-0.539	323	1	0.299	0.707	0.445	747	4	0.477	-0.256	0.475	1	3	0.521	0.172	0.465
821	0	0.311	-0.576	0.622	336	1	0.305	0.476	-0.539	825	0	0.478	-0.691	0.651	11	3	0.521	-0.535	-0.539
830	0	0.313	-0.001	-0.539	63	3	0.306	-0.083	0.475	775	4	0.479	-0.001	-0.539	100	3	0.522	-0.576	0.621
687	0	0.314	0.707	0.445	487	1	0.312	-0.617	0.445	622	4	0.479	-0.280	-0.539	322	1	0.523	-0.223	0.474
593	4	0.316	-0.634	0.445	478	1	0.317	0.213	0.445	560	4	0.480	-0.280	-0.539	456	1	0.524	-0.221	0.476
610	4	0.317	-0.280	-0.539	492	1	0.320	-0.059	-0.539	703	4	0.481	-0.576	0.621	174	3	0.524	-0.616	-0.539
591	4	0.319	0.173	0.445	363	1	0.321	1.972	-0.539	702	4	0.481	-0.576	0.648	28	3	0.526	-0.379	0.445
816	4	0.321	-0.412	-0.539	6	3	0.323	0.237	-0.539	651	0	0.481	-0.140	0.621	109	3	0.527	-0.954	-0.523
811	0	0.323	-0.222	-0.539	58	3	0.323	-0.691	0.621	802	0	0.482	-0.477	0.474	32	3	0.531	-0.222	-0.539
744	4	0.323	-1.110	0.445	481	1	0.326	1.340	0.445	717	0	0.482	-0.913	0.621	130	3	0.531	-0.675	0.477
691	4	0.326	-0.001	-0.539	520	1	0.326	0.707	0.445	546	4	0.486	-0.280	-0.539	137	3	0.531	0.551	-0.510
616	4	0.326	-0.001	-0.539	96	3	0.327	-0.280	-0.539	799	0	0.486	0.312	0.445	513	1	0.532	2.309	0.445
722	0	0.327	0.237	-0.539	515	1	0.330	2.309	0.445	671	0	0.486	0.805	0.445	92	3	0.533	-0.494	-0.362
793	0	0.328	-0.222	-0.539	495	1	0.335	0.707	0.445	637	4	0.488	-0.280	0.622	435	1	0.533	0.509	0.445

CONTROL					PARTICIPANT				
#	**TY**	**PPP**	**Mkt**	**Infx**	**#**	**TY**	**PPP**	**Mkt**	**Infx**
614	4	0.330	-0.576	-0.539	483	1	0.335	0.707	0.477
726	0	0.331	-0.913	0.621	496	1	0.337	0.707	0.445
541	4	0.332	-0.239	-0.506	178	3	0.339	0.312	0.445
642	0	0.333	-0.576	-0.539	21	3	0.339	0.312	0.445
646	0	0.334	-0.280	-0.539	141	3	0.346	-0.552	-0.539
562	4	0.335	-0.362	-0.506	72	3	0.349	-0.477	-0.539
729	0	0.336	-0.913	0.621	116	3	0.356	-0.658	-0.539
780	4	0.337	0.173	0.477	466	1	0.357	0.707	0.445
564	4	0.337	0.115	-0.539	79	3	0.359	-0.420	-0.538
682	0	0.337	0.476	-0.539	151	3	0.359	-0.379	0.445
604	4	0.343	1.553	0.445	508	1	0.360	-0.223	0.621
573	0	0.345	-0.420	0.445	33	3	0.361	-0.379	0.445
766	4	0.347	-0.280	0.445	476	1	0.361	0.551	0.470
629	4	0.347	-0.477	0.445	486	1	0.366	-0.617	0.475
826	0	0.349	-0.716	0.445	172	3	0.368	-0.296	0.445
721	0	0.349	-0.913	0.621	477	1	0.372	3.527	-0.511
850	0	0.349	0.805	0.445	450	1	0.372	0.213	0.461
580	0	0.352	-0.083	-0.539	317	1	0.373	-0.083	-0.539
846	0	0.352	0.312	0.445	339	1	0.373	-0.059	-0.539
836	0	0.355	-0.059	-0.539	343	1	0.373	2.309	0.445
613	4	0.355	-0.970	0.445	528	1	0.375	-0.617	0.445
767	4	0.356	-0.412	-0.539	485	1	0.378	0.707	0.445
794	0	0.357	-1.160	0.477	539	1	0.378	-0.256	0.477
762	4	0.358	-0.700	0.445	14	3	0.380	-0.691	0.622
795	0	0.359	0.312	0.445	531	1	0.382	-0.749	0.474
800	0	0.362	0.057	-0.514	168	3	0.383	-1.110	0.445
735	0	0.364	-0.576	-0.539	41	3	0.383	-0.691	0.621
688	0	0.364	0.476	0.445	434	1	0.384	-0.059	-0.539
666	0	0.367	2.975	-0.539	342	1	0.384	2.309	0.445
612	4	0.368	-0.970	0.470	135	3	0.386	-0.395	-0.361
617	4	0.369	-0.140	-0.539	506	1	0.388	-0.552	-0.513
630	4	0.371	-0.280	0.621	440	1	0.389	0.707	0.445
741	4	0.371	-0.396	0.445	37	3	0.390	-0.379	0.445
786	4	0.375	-0.222	-0.539	484	1	0.395	-0.223	0.445
725	4	0.377	-0.140	-0.539	472	1	0.395	-0.083	0.621
730	0	0.379	-0.420	-0.539	387	1	0.396	-0.066	-0.516
606	4	0.380	-0.280	0.445	338	1	0.401	-0.059	-0.539

CONTROL					PARTICIPANT				
#	**TY**	**PPP**	**Mkt**	**Infx**	**#**	**TY**	**PPP**	**Mkt**	**Infx**
854	0	0.490	2.975	-0.539	44	3	0.537	-0.280	-0.539
643	0	0.493	-0.140	0.621	465	1	0.538	-0.083	-0.539
599	4	0.493	-0.280	-0.508	167	3	0.539	-0.616	-0.539
814	0	0.493	-0.420	-0.538	69	3	0.540	-0.494	-0.362
731	0	0.495	-0.535	-0.535	136	3	0.540	-0.280	-0.539
819	0	0.497	-0.576	-0.513	112	3	0.542	-0.420	0.476
834	0	0.498	-0.962	0.445	126	3	0.542	-0.535	-0.539
559	4	0.499	-0.280	-0.516	75	3	0.544	-0.732	0.445
698	4	0.502	-0.600	0.445	538	1	0.545	-0.221	0.445
697	4	0.502	-0.896	0.445	40	3	0.546	-0.280	-0.539
664	0	0.503	-0.280	0.445	49	3	0.547	-0.362	-0.539
586	0	0.505	2.934	0.477	13	3	0.550	0.172	0.445
839	0	0.506	1.340	0.445	9	3	0.551	0.081	-0.519
742	4	0.508	-0.396	0.445	535	1	0.553	-0.083	-0.539
645	0	0.511	-0.280	-0.539	54	3	0.553	-0.222	-0.539
707	4	0.511	-0.643	-0.523	383	1	0.554	0.139	0.445
848	0	0.517	-0.140	0.621	162	3	0.555	0.312	0.445
764	4	0.517	-0.700	0.445	490	1	0.556	2.737	0.445
636	4	0.518	-0.675	-0.538	444	1	0.556	0.312	0.445
783	4	0.518	-0.651	-0.539	47	3	0.557	-0.379	0.445
638	4	0.518	-0.280	0.476	453	1	0.559	1.298	0.445
672	0	0.518	0.805	0.475	514	1	0.559	2.309	0.445
669	0	0.519	1.340	0.445	148	3	0.560	-0.675	0.445
803	0	0.520	-0.395	-0.349	536	1	0.566	-0.083	-0.539
784	4	0.520	-0.773	-0.512	474	1	0.566	0.213	0.445
571	0	0.521	0.476	0.445	133	3	0.567	-0.420	-0.539
657	0	0.523	-0.280	0.473	331	1	0.568	2.309	0.474
804	0	0.523	-0.888	-0.510	60	3	0.568	-0.889	-0.539
576	0	0.524	0.649	0.475	83	3	0.571	-0.494	-0.336
584	0	0.525	-0.083	-0.509	103	3	0.571	0.312	0.445
689	0	0.530	-0.962	0.445	469	1	0.573	-0.083	0.621
544	4	0.531	-0.651	-0.510	64	3	0.573	-0.420	-0.509
791	0	0.532	-0.222	-0.510	140	3	0.575	-0.552	-0.519
589	0	0.534	0.476	-0.539	373	1	0.576	-0.362	-0.538
772	4	0.534	0.033	0.445	499	1	0.577	0.730	0.445
565	4	0.535	0.115	-0.509	364	1	0.578	0.649	0.445
820	0	0.535	0.312	0.475	36	3	0.579	0.312	0.445

CONTROL					PARTICIPANT				
#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt	Infx
773	4	0.382	-0.675	0.445	121	3	0.406	-0.855	0.646
778	4	0.384	-0.519	0.445	389	1	0.407	-0.066	-0.539
769	4	0.384	-0.412	-0.539	316	1	0.409	-0.059	-0.539
841	0	0.384	2.547	-0.539	326	1	0.412	0.476	-0.539
618	4	0.385	-0.223	0.473	468	1	0.413	0.312	-0.509

CONTROL					PARTICIPANT				
#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt	Infx
640	4	0.537	3.609	-0.539	152	3	0.580	-0.296	0.445
600	4	0.539	-0.059	-0.509	113	3	0.582	-0.616	-0.539
781	4	0.539	1.553	0.477	332	1	0.582	2.309	0.445
831	0	0.539	0.476	0.445	308	1	0.583	-0.280	-0.513
542	4	0.540	-0.412	-0.539	315	1	0.583	0.476	-0.539

CONTROL					PARTICIPANT				
#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt	Infx
809	0	0.386	-0.716	0.474	35	3	0.413	-0.223	0.473
628	4	0.388	-0.477	0.451	51	3	0.416	-0.379	0.445
693	4	0.392	-0.600	0.445	340	1	0.416	-0.223	0.651
686	0	0.392	0.707	0.445	324	1	0.421	0.476	-0.539
607	4	0.393	-0.576	-0.539	489	1	0.423	2.737	0.447
753	4	0.394	-0.716	-0.539	125	3	0.424	-0.116	-0.538
701	4	0.395	-0.576	0.621	93	3	0.426	-0.420	-0.539
569	0	0.396	-0.420	0.474	139	3	0.432	-0.552	-0.519
734	0	0.398	-0.280	-0.539	358	1	0.432	1.972	-0.539
615	4	0.400	-0.280	0.472	170	3	0.436	-0.617	0.445
566	0	0.400	0.805	0.445	19	3	0.436	-0.222	-0.509
844	0	0.401	0.476	-0.539	65	3	0.437	-0.223	0.445
737	0	0.401	-0.001	-0.539	341	1	0.441	-0.083	-0.539
694	4	0.404	-0.280	0.445	381	1	0.444	-0.280	0.477
677	0	0.405	0.312	0.445	57	3	0.445	-0.362	-0.514
727	0	0.407	-0.280	-0.508	328	1	0.447	-0.954	-0.539
788	4	0.407	-0.519	-0.539	441	1	0.449	0.312	0.445
755	4	0.411	-0.716	-0.539	94	3	0.449	-0.083	0.445
768	4	0.412	-0.412	-0.511	448	1	0.452	0.730	0.474
815	0	0.412	-0.576	-0.539	17	3	0.454	0.172	0.445
625	4	0.413	1.101	-0.539	147	3	0.454	-0.535	-0.539
759	4	0.415	-0.222	-0.508	346	1	0.456	0.649	0.445
818	4	0.416	-0.716	-0.508	171	3	0.457	0.312	0.445
611	4	0.416	-0.576	-0.539	335	1	0.457	0.057	-0.507
807	0	0.418	-0.576	0.648	355	1	0.458	2.309	0.445
567	0	0.418	0.707	0.445	350	1	0.459	0.476	-0.539
595	4	0.419	-0.634	0.445	524	1	0.461	2.934	0.445
739	0	0.420	-0.362	-0.508	45	3	0.462	-1.160	0.445

CONTROL					PARTICIPANT				
#	TY	PPP	Mkt	Infx	#	TY	PPP	Mkt	Infx
785	4	0.540	-0.716	-0.508	131	3	0.585	-0.576	-0.539
621	4	0.543	0.173	-0.539	521	1	0.586	0.707	0.445
713	4	0.544	-0.280	0.475	153	3	0.589	-0.535	-0.539
743	4	0.544	-1.110	0.476	150	3	0.589	-0.280	-0.539
776	4	0.547	-0.001	-0.539	344	1	0.590	0.476	-0.539
549	4	0.547	-0.412	-0.514	122	3	0.591	-0.222	-0.539
685	0	0.549	0.312	0.477	146	3	0.591	-0.675	0.476
699	4	0.551	-0.519	0.451	104	3	0.592	-0.848	-0.508
588	0	0.552	-0.651	-0.511	120	3	0.593	-0.477	0.445
714	4	0.554	-0.675	0.445	438	1	0.594	-0.059	-0.539
740	0	0.555	-0.420	-0.509	447	1	0.596	-0.083	-0.539
674	0	0.559	0.707	0.445	318	1	0.598	0.649	0.445
733	0	0.560	-0.280	-0.539	309	1	0.598	-0.280	-0.539
667	0	0.562	-0.576	-0.519	30	3	0.601	0.172	0.445
835	0	0.563	-0.083	0.651	68	3	0.603	-0.732	0.456
719	0	0.564	-0.280	-0.514	454	1	0.609	-0.362	-0.539
547	4	0.569	0.033	0.445	67	3	0.613	-0.494	-0.360
808	0	0.570	-0.535	-0.539	110	3	0.616	-0.616	-0.539
568	0	0.572	0.476	0.451	337	1	0.617	-0.083	-0.539
798	0	0.573	-0.535	-0.516	449	1	0.621	0.730	0.445
653	0	0.574	-0.140	0.622	356	1	0.622	2.309	0.445
660	0	0.575	1.972	-0.514	107	3	0.623	-0.296	0.477
823	0	0.577	-0.889	-0.506	525	1	0.623	-0.083	-0.539
626	4	0.583	-0.280	0.651	115	3	0.629	-0.732	-0.340
716	0	0.584	-0.123	0.647	313	1	0.632	0.476	-0.539
558	4	0.584	-0.675	-0.506	82	3	0.637	-0.576	0.621
681	0	0.584	0.476	-0.539	500	1	0.638	-0.083	0.621
724	0	0.584	-0.477	-0.522	177	3	0.643	0.312	0.445

CONTROL					PARTICIPANT					CONTROL					PARTICIPANT				
#	**TY**	**PPP**	**Mkt**	**Infx**	**#**	**TY**	**PPP**	**Mkt**	**Infx**	**#**	**TY**	**PPP**	**Mkt**	**Infx**	**#**	**TY**	**PPP**	**Mkt**	**Infx**
790	4	0.423	-0.140	-0.508	157	3	0.462	-0.576	0.649	602	4	0.589	0.173	-0.510	452	1	0.646	0.213	0.445
623	4	0.424	-0.280	-0.539	176	3	0.463	-0.296	0.445	692	4	0.590	-0.675	0.476	479	1	0.646	0.312	-0.509
548	4	0.425	0.033	0.445	73	3	0.470	-0.888	-0.539	690	0	0.592	-0.962	0.445	81	3	0.649	-0.756	-0.512
594	4	0.427	-0.634	0.445	46	3	0.472	-0.379	0.445	554	4	0.594	1.101	-0.506	85	3	0.649	-0.732	0.445
700	4	0.428	-0.519	0.445	95	3	0.474	-0.888	-0.337	679	0	0.596	1.340	0.471	509	1	0.650	0.707	0.445
680	0	0.429	0.649	0.445	42	3	0.475	-1.160	0.445	829	0	0.597	0.707	0.445	91	3	0.651	-0.732	0.445
553	4	0.429	-0.716	0.447	154	3	0.475	-0.691	0.621	654	0	0.599	-0.140	0.652	88	3	0.658	-0.732	0.445
792	0	0.430	-0.222	-0.538	48	3	0.476	-0.773	0.445	761	4	0.599	-0.395	-0.512	175	3	0.658	-0.535	-0.539
723	0	0.432	0.237	-0.539	522	1	0.477	2.934	0.445	817	4	0.603	-0.896	0.540	529	1	0.659	-0.617	0.445
658	0	0.432	1.972	-0.539	362	1	0.477	0.649	0.445	763	4	0.605	-0.700	0.459	8	3	0.663	-0.379	0.477
861	4	0.435	-0.535	-0.508	132	3	0.479	-0.362	-0.539	678	0	0.608	0.476	-0.506	345	1	0.665	0.649	0.445
706	4	0.436	-0.140	-0.516	437	1	0.480	1.298	0.445	728	0	0.610	-0.913	0.622	124	3	0.669	-0.222	-0.539
828	0	0.438	0.707	0.445	22	3	0.480	0.237	-0.539	851	0	0.614	2.975	-0.525	431	1	0.672	0.551	-0.508
695	4	0.438	-0.059	-0.539	101	3	0.482	0.312	0.445	665	0	0.617	-0.962	0.476	455	1	0.676	1.298	0.445
745	4	0.441	-0.658	-0.506	179	3	0.483	0.312	0.445	732	0	0.620	-0.913	0.775	310	1	0.676	-0.280	-0.539
720	0	0.445	-0.616	-0.539	50	3	0.485	-0.617	0.445	641	0	0.622	-0.280	-0.514	31	3	0.677	-0.222	-0.539
659	0	0.445	1.972	-0.539	53	3	0.486	-0.773	0.445	822	0	0.628	-0.617	0.477	114	3	0.678	-0.616	-0.539
853	0	0.446	-0.140	0.621	532	1	0.489	2.547	-0.539	859	4	0.646	-0.280	0.445	491	1	0.678	1.340	0.445
704	4	0.447	-0.576	0.621	471	1	0.490	0.312	0.445	603	4	0.654	3.609	-0.511	10	3	0.687	0.081	-0.538
572	0	0.447	-0.223	0.474	7	3	0.492	-0.773	0.476	684	0	0.656	0.707	0.477	180	3	0.693	-0.535	-0.539
661	0	0.447	-0.616	-0.539	71	3	0.493	-0.888	-0.538	668	0	0.664	0.435	0.474	108	3	0.697	-0.658	-0.508
718	0	0.448	-0.280	-0.539	102	3	0.496	0.312	0.476	855	0	0.667	0.237	-0.516	127	3	0.703	3.962	-0.539
579	0	0.448	0.476	-0.539	451	1	0.497	0.213	0.445	856	4	0.680	-0.280	0.445	5	3	0.705	-0.913	0.621
585	0	0.448	-0.059	-0.539	117	3	0.498	-0.280	-0.509	805	0	0.682	-1.110	0.475	349	1	0.718	-0.420	0.621
656	0	0.449	-0.576	-0.511	497	1	0.500	0.707	0.445	577	0	0.685	-0.059	-0.512	24	3	0.726	-0.362	-0.539
708	4	0.449	-0.643	-0.539	388	1	0.501	-0.066	-0.539	777	4	0.706	-0.396	0.475	325	1	0.752	0.476	-0.539
787	4	0.451	-0.519	-0.539	18	3	0.501	-0.379	0.445	705	4	0.707	-0.600	0.477	143	3	0.755	-0.732	0.445
756	4	0.451	-0.773	-0.539	348	1	0.502	-0.420	0.647	770	4	0.756	0.033	0.474	361	1	0.765	0.476	-0.539
750	4	0.451	-0.256	0.445	494	1	0.502	-0.617	0.445	578	0	0.786	-0.083	-0.512	314	1	0.788	0.476	-0.539
											Average	**0.459**					**0.489**		

#: *Identification Number*
TY: *0: Neighbor, 1: PAES1, 3: PAES3, 4: Non-Neighbor*
PPP: *Predicted Probability of Participation*
Mkt: *Principal Component for Market Access*
Infx: *Principal Component for Infrastructure*

Inter-American Development Bank
Washington, D.C.