The Effect of IMF Programs on Deforestation

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Abstract

According to International Monetary Fund (IMF) officials, "The IMF is acutely aware that natural resource degradation that threatens growth cannot be ignored" (Fischer, 1996). Critics of IMF programs, however, claim that Fund policies hurt the environment by encouraging budget cuts to environmental programs, promoting primary product export-oriented development, and inducing economic contractions that lead to extensive migration to marginal lands. As the first large-n study of the effects of IMF programs on the environment using a methodology that controls for nonrandom selection, our question is narrow: What is the effect of IMF programs on rates of deforestation? We use a dynamic version of the Heckman selection model to estimate the effect of the IMF with a data set of 2,258 observations from 112 countries from 1970 to 1990. We find that deforestation increases when governments participate in IMF programs, even after controlling for nonrandom selection.

Key Words: IMF, deforestation, environmental, nonrandom selection, international, cross-country

1. Introduction

What is the effect of International Monetary Fund (IMF) programs on the environment? Critics of the Fund claim that IMF structural adjustment programs hurt the environment by encouraging budget cuts to environmental programs, promoting primary product export-oriented development, and inducing economic contractions that lead to extensive migration to marginal lands. As a result, IMF Structural Adjustment Programs may cause widespread environmental destruction, squandering the country's natural resources, environmental capital and economic future (Hayter, 1989; George, 1992, 1998; Cruz and Repetto, 1992; Cruz and Munasinghe, 1996; Owusu, 1998).

Yet, IMF officials contend that their programs have beneficial effects on the environment. They argue that the macroeconomic stability their programs promote is vital for environmental preservation (Fischer, 1996). Furthermore, programs reduce resource waste and improve resource allocation by correcting market distortions and stimulating competition (Owusu, 1998).

Despite the disagreement over how IMF programs affect the environment, there has been no large-n study of the systematic effects of these programs using a methodology that controls for the problem of nonrandom selection. IMF programs may affect all sorts of environmental factors – raw materials exports, mineral depletion, and deforestation, to name a few. Our question, as a first step towards assessing the overall environmental impact of IMF programs, is a very narrow one: What is the effect of IMF programs on deforestation? We have chosen to study deforestation because of its saliency to global environmental issues vis-à-vis climate change, biodiversity, clean air and water, and many other environmental and human considerations. Moreover, there is a large body

of quantitative literature available on deforestation to inform our study (see Allen and Barnes, 1985; Palo *et al.*, 1987; Capistrano and Kiker, 1995; Angelsen and Kaimowitz, 1999).

Note that analyzing the effects of IMF programs is not straightforward (Goldstein and Montiel, 1986). If countries entered into IMF programs as random experiments, then the impact of the IMF could be measured as the difference between the average rate of deforestation in countries that do implement IMF programs and in those that do not. These two groups would conveniently serve as the necessary treatment and control groups. However, previous research concludes that countries do not enter IMF agreements randomly (Przeworski and Vreeland, 2000). Usually they approach the IMF because they need a loan due to a balance of payments disequilibria, low foreign reserves, or high debt. They may also participate in IMF programs only when governments have the political will to swallow the "bitter pill" of economic reform. Note that the factors that influence selection into IMF programs may also influence rates of deforestation. The methodology used to evaluate IMF programs must, therefore, distinguish the effects of selection from the inherent effects of these programs. In this paper we use a dynamic version of the Heckman selection model to ascertain the effects of IMF programs on deforestation (Przeworski *et al*., 2000). Our sample includes 2,258 observations from 112 countries from 1970 to 1990.[1] We find that deforestation increases when governments participate in IMF programs, even after controlling for nonrandom selection.

The data on deforestation come from the Food and Agriculture Organization (FAO) Forest Resource Assessments. The valuation of forest area is problematic, and

[1] All of the variables used in this study are defined in Appendix 1.

critics have pointed out flaws in the data set that we use (see Angelsen and Kaimowitz, 1999). However, because the data are collected by the FAO and not the IMF, there is little reason to suspect that the errors in measurement are systematically related to participation in IMF programs. And if the measurement error is not correlated with IMF participation, the flaws in the FAO measure should not bias our results. This data set allows us to determine how IMF programs affect deforestation globally – a question we feel is too important to be ignored.

In the following section, we review the theoretical link between IMF programs and deforestation, discussing the ways in which IMF programs can potentially decrease or increase rates of deforestation. We analyze in depth a particular case, Ghana, in Section 3. Then we turn to a wider empirical study of the effect of the IMF. First, in Section 4, we address the problem of nonrandom selection into IMF programs. And in Section 5, we present an econometric model of deforestation. We use this model to estimate the impact of the IMF on deforestation. Section 6 concludes.

2. The deforestation debate

The ostensible goals of IMF programs are to promote economic stability and growth. Fund officials recognize the importance of safeguarding the environment to achieve these goals.[2] According to the First Deputy Managing Director of the IMF, Stanley Fischer, poor environmental conditions can have an adverse impact on economic

[2] Others outside of the Fund have also underscored these concerns. The Director-General of the Philippines National Economic and Development Authority has repeatedly emphasized "it is environmental sustainability that will ensure sustainability of economic growth in the longer run" (Gandhi, 1996, p. 18). Wilfrido Cruz, an associate at the World Resources Institute, writes, "The deterioration of a nation's natural resource endowment is at least as serious an obstacle to sustainable development as the deterioration of its international credit standing" (Cruz and Repetto, 1992, p. 67).

growth and macroeconomic balances (Fischer, 1996, p. 248). The Assistant Director of the Fiscal Affairs Department at the Fund writes,

> Ignoring environmental degradation means ignoring its impact on human capital, natural capital, and output, all of which have a bearing on the sustainability of macroeconomic stability and economic growth. The Fund staff is therefore ill advised to ignore instances of serious environmental degradation or depletion of natural resources (Gandhi, 1996, p. 20).

When a country enters an IMF Structural Adjustment Program, it accepts a number of conditions imposed by the IMF. The policy conditions generally include eliminating barriers to export growth, lowering tariffs, devaluating the currency, and cutting government expenditures (McQuillan and Montgomery, 1999, p. 65). If compliance with these conditions leads to the macroeconomic stability of a country, the IMF program may result in improved environmental conditions. As Fischer notes, "macroeconomic stability is good, indeed essential, for environmental protection" (Fischer, 1996, p. 248). Instability can preclude environmental preservation by distorting intertemporal choices, leading to an uncertain future where the preservation of environmental resources is less attractive. As Gandhi (1996, p. 3) explains the point of view of the IMF, "macroeconomic stability is a minimum and necessary condition for preserving the environment."

Furthermore, IMF policy conditions can have a direct effect on preserving the environment. Summarizing existing studies (Abaza, 1997; Opschoor and Jongma, 1996; Reed, 1996), Kessler and Van Dorp (1998) note that by removing perverse subsidies,

IMF programs can discourage “excessive and inefficient use of chemical pollutants and [stimulate] more efficient use of scarce natural resources” (p. 268). In general, when governments reduce spending, they may curtail or eliminate subsidies for pesticides, fertilizer, water, and energy. Such cuts lower incentives to clear forest area. By lowering tariffs, governments facilitate the arrival of environmentally-friendly products from abroad, such as water-saving devices. Furthermore, some argue that the currency devaluations often associated with IMF programs can have beneficial side-effects for the environment. Gandhi, for example, notes that an exchange-rate devaluation “improves the capacity of exporters to undertake environmental investments” (Gandhi, 1998, p. 10).

These policy conditions, however, may also have detrimental effects on deforestation rates. Just as lowering tariffs may increase environmentally-friendly imports, for example, they may also increase importation of fertilizers, seed, and tractors that can induce farmers to clear more forest for agriculture.

Additionally, consider the effect of removing barriers to exports in a developing country where timber composes a large proportion of exports. Obviously rates of deforestation may increase. As Kessler and Van Dorp (1998) warn, “export promotion stimulates high-input cash-crop farming causing environmental destruction and pollution and increased export of primary resources” (p. 268). Devaluation of the national currency may also increase incentives to cut down forests, as devaluing the currency effectively lowers the price of forest products on world markets, thereby increasing demand (Gandhi, 1998). Furthermore, politically active organizations such as “Global Exchange” assert that governments under IMF agreements must raise foreign capital to repay the IMF loans. In order to do this, these critics claim, governments are more likely to promote

exports, including forest products, even though such policies might prove unsustainable in the long-run (Global Exchange, 2001).

Furthermore, cutting government expenditures may adversely effect the environment. Environmental protection and enforcement programs often lose funding when government budget deficits are reduced (Kessler and Van Dorp, 1998). Officials from the IMF and the World Bank recognize this possibility. The World Bank Environment Director, Andrew Steer, notes, "this category of public expenditure [environmental programs] may be cut as much or more than other categories of expenditure" (Steer, 1996, p. 67). In some countries, environment departments are important mechanisms for helping companies manage sustainable forests, curtailing illegal timber harvesting and educating individuals about deforestation. When these programs are cut, deforestation is apt to increase.[3]

IMF policy conditions may also lead to deforestation if they cause economic contraction. Recent evidence shows that IMF programs hurt economic growth, at least in the short-run (Conway, 1994; Przeworski and Vreeland, 2000). Such downward turns lead to unemployment and income decline, and may force population shifts from urban centers to subsistence living in rural areas. The poverty-stricken population is driven to overexploit fragile, unproductive environments (Cruz and Repetto, 1992).[4]

The theoretical link between IMF policy conditions and deforestation rates is, therefore, not clear. IMF structural adjustment programs produce both costs and benefits

[3] Gandhi (1996, p. 14) suggests that this is precisely what happened under IMF programs in Thailand, Mexico, Cameroon, Zambia, and Tanzania.

[4] Cruz and Repetto (1992) cite this migration as the primary cause of deforestation in the Philippines.

for the environment. The net effect on deforestation can potentially be positive or negative, hence our empirical study.

3. The case of Ghana

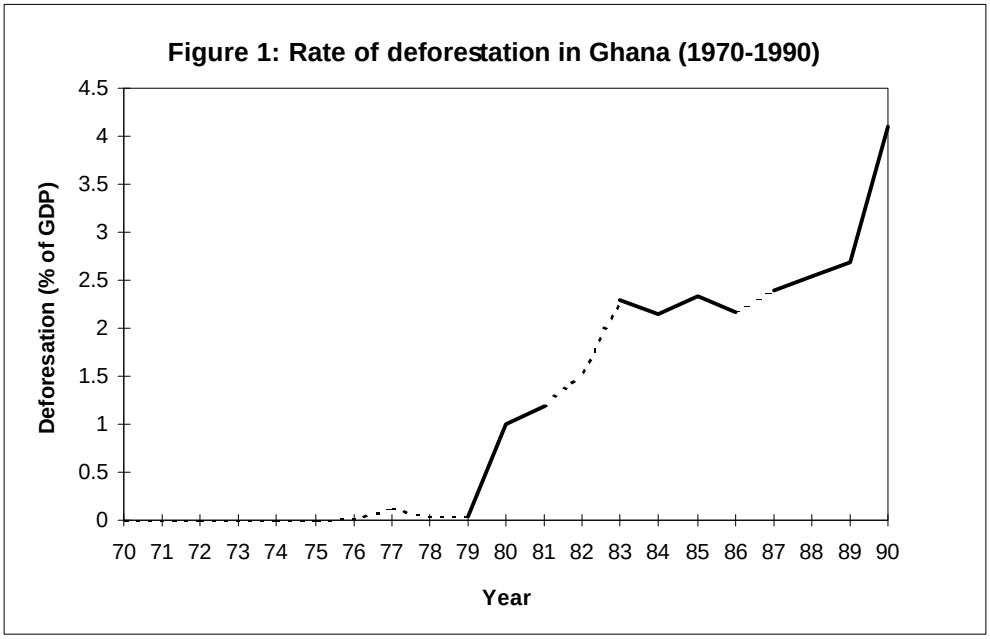
Simply considering the observed world, we find 23 cases where the rate of deforestation drops during the first year a country enters into a series of IMF agreements. In Gambia, for example, the deforestation rate was 6.58 percent of GDP in 1976. The country entered an IMF agreement in 1977 and the rate dropped to 5.82 percent of GDP. After the IMF program ended, the deforestation rate rose to 6.37 in 1981. The country entered a new IMF agreement in 1982 and the rate dropped to 4.76 percent of GDP. Similarly in Lesotho the rate of deforestation was 3.26 percent of GDP in 1986. After the government signed an IMF agreement in 1988, the rate dropped to 2.26 percent of GDP, the lowest rate since 1983. The IMF program continued and by 1990, the rate had dropped to 1.86 percent of GDP.

On the other hand, we find 30 cases where rates of deforestation increase the year during the first year a country enters into a series of IMF agreements. Consider, for example, Ghana.

Between 1983 and 1993, Ghana makes a good case for the study of the IMF's effects on deforestation because there is no question of compliance: Ghana is known widely to have embraced and implemented the IMF program (Owusu, 1998). Moreover, the economic changes during structural adjustment programs were touted by the IMF and the international finance community as a great success.

Ghana is also of interest because it has suffered from some of the highest deforestation rates in the world. The only countries that have experienced higher rates of

deforestation under IMF programs are Gambia, Kenya, Haiti, Rwanda, Nepal, Ethiopia, and Burundi. When the country did not participate in IMF programs (1971-1978, 1981-1982, 1986) the average deforestation rate was 0.46 percent of GDP. When Ghana did participate, (1970, 1979-1980, 1983-1985, 1987-1990) the average annual deforestation rate was 1.95 percent. In 1990, after seven out of the past eight years under IMF programs, Ghana's deforestation rate was 4.10 percent of GDP. (See Figure 1 for an illustration. Dashed lines represent years when Ghana did not participate in IMF programs; heavy solid lines represent years when Ghana did participate in IMF programs.)



Troubled about the possibility of being declared insolvent by the IMF, Ghana entered an orthodox structural adjustment program after sinking into a severe depression in 1983. At the beginning of the program, The World Bank specifically informed the Ghanaian government that “the forestry sector offers the greatest immediate potential for growth and foreign exchange earnings” (World Bank, 1984 as cited in Owusu, 1998).

The forestry sector was injected with one of the largest sector adjustment loans in order to replace worn forest equipment in preparation for its coming role as the primary source of foreign exchange. In addition, Ghana eliminated some of the existing export restrictions that had been imposed as conservation and valorization measures in 1979 (Owusu, 1998, p. 425). Furthermore, to ensure high export performance, the Ghana Timber Marketing Board was replaced with two new agencies: the Timber Export Development Board (for export promotion) and the Forest Products Inspection Bureau (to monitor production) (Hutchful, 1996 as cited in Owusu, 1998). Finally, a series of devaluations of the local currency enabled the government to continue to pursue higher export levels in an attempt to maintain the stability of its hard currency revenues (Owusu, 1998, p. 429).

According to Owusu (1998) after the first ten years of the program (1983-1993) the volume of exported lumber had increased by 500% while the volume of logs exported had increased by 806%. The database for deforestation we utilize does not extend to 1993; however, it likewise records a jump in deforestation from 1.52% GDP to 4.10% GDP by 1990. Between 1983 and 1991, the total foreign exchange generated by the export of wood and wood products had jumped from US $15.77m (Timber Exports Development Board, 1998) to $114.2m (Forest Products Inspection Bureau, 1991). This dramatic rise in foreign exchange, evaluated in consideration of the service interest payments on outstanding external public debt over the same period, illustrates how the Ghanaian government used “desperate deforestation” in order to satisfy international capital and return to normal relations with Ghanaian creditors (Owusu, 1998, p. 428). As Owusu argues, “the market -driven hunt and extract system of logging to meet export

demands constitutes a major component of deforestation in Ghana" (Owusu, 1998, p. 431).

Note that Ghana is just one case. Perhaps because the country has experienced one of the highest rates of deforestation of all countries that have participated in IMF programs, much has been written about deforestation in this country. The value of considering such an extreme case is that it provides a stark example of what can go wrong under an IMF program. Our question is whether on average countries have experiences closer to that of Ghana or to that of the positive examples of Gambia and Lesotho listed at the beginning of this section.

Further note that due to the problem of nonrandom selection, we are also unable to verify from these simple observations that it was in fact the IMF programs themselves that affected deforestation. In Ghana, the increase in deforestation may have simply been the result of duress from economic crisis. In the other cases, the decrease in deforestation may have occurred in the absence of IMF participation. The purpose of this paper is to use an empirical analysis to control for such spurious correlations and isolate the effect of the Fund on deforestation. Thus, before turning to the effects of IMF programs, we must first tell a story of selection.

4. The selection problem[5]

To estimate the effects of IMF programs, one must draw inferences about an unobserved counterfactual. The standard difficulty in estimating the counterfactual necessary to evaluate the effects of any policy or program is nonrandom selection (Heckman, 1988). What one observes in the real world are not experiments, which would

[5] This section follows Vreeland (2001).

match “treatment” and “control” groups, thus permitting direct inferences about the effects of IMF programs. Since the situations of countries that participate in IMF programs differ from those that do not, observed differences in deforestation may depend on these differing situations as well as the inherent effects of the IMF program.

Note that because selection is nonrandom, one may not always be able to match the observed cases for these conditions. For example if high debt service – a determinant of deforestation – leads to participation in IMF programs, we may not find cases of non-participation and high debt service.

Not all variables correlated with selection and outcome are observable (Przeworski and Vreeland, 2000). Suppose, for example, that in good faith the IMF chooses to enter into agreements with governments that are committed to long-run protection of the environment. A methodology failing to account for such an unobserved variable may result in biased estimates of the effects of IMF programs. The “political will” of the government to protect the environment will be mistakenly attributed to the policies imposed by the IMF. Indeed, if such selection occurs, controlling for observed variables can actually increase the bias caused by the unobserved variables (Achen, 1986; Przeworski and Limongi, 1996).

How can one capture the effects of the relevant unobserved variables? Note that in all statistical models there is a stochastic component, usually referred to as the “error term.” In fact, the error term represents unobserved explanatory variables, which are usually assumed to be random disturbances. Yet, if the errors from the estimation of selection are correlated with the errors from the estimation of deforestation, then the effects of unobserved variables are not random. The correlation indicates that unobserved

variables that drive participation also determine performance. The method for correcting for selection effects caused by unobserved variables involves measuring the correlation between the errors from selection and the errors from performance. This correlation serves as an approximation of the effects of the relevant unobservable variables. These effects can then be removed, and what is left is the unbiased effect of the IMF-treatment.

The literature on the determinants of selection into IMF programs is growing (for example see Bird, 1996 and Knight and Santaella, 1997). Unfortunately, there are only a few hundred observations of certain determinants of IMF programs such as balance of payments, foreign reserves, and government budget deficit that coincide with the observations available on our deforestation variable. Fortunately, Alvarez *et al.* (1996) have collected 4,126 observations for 135 independent countries from 1950 (or date of independence) to 1990 on several economic variables that have been reported as significant predictors of IMF programs.[6]

Table 1 compares the results of two specifications of the determinants of IMF program participation. The first specification (Full model) includes the variables that Bird (1996, p. 1754-1755) reports there to be a consensus about their importance in the literature on IMF program participation: per capita income (Level), economic growth (Growth), change in exchange rate (Exchg rate), balance of payments (BOP), and past participation in IMF programs (Years under).

In addition to these variables, the "full" specification also includes variables that Przeworski and Vreeland (2000) find to be significant predictors of IMF program

[6] The Alvarez *et al.* (1996) data set (*ACLP World Political/Economic Database*) draws most of these economic variables from the *Penn World Tables 5.6* (Heston and Summers, 1995).

participation: foreign reserves (Reserves), government budget deficit (Deficit), debt service (Debt service), private and public investment (Investment), the number of other countries participating in IMF programs (Number under), whether elections were held the previous year (Lagged election), and whether a country is a democracy or dictatorship (Regime).

The second specification (Stripped model) includes only the variables for which the are no missing values: Level, Growth, Debt service, Exchange rate, Years under, Investment, Number under, Lagged election, and Regime.[7] The "stripped" specification is used to avoid losing observations that are missing on the other variables. Of the 1,034 observations available for the "full" specification, only a few hundred are in common with the 1,541 observations on deforestation. While some of the results of the two specifications differ, the instruments used to correct for selection bias (described below) are highly correlated.

Note that because governments usually enter into IMF programs and remain under them for a number of years (typically 5 years, according to my data), we model the selection process as a dynamic one, where governments can choose to enter and then remain under programs.[8] Governments already participating in IMF programs face a decision of whether to continue the program or end participation. The factors that

[7] The only variable in this list which has missing values is Debt service. By including this variable here, we lose no observations from the total we have to work with when we evaluate the effect of IMF programs on deforestation, because Debt service is also a determinant of deforestation and is included in the outcome specification as well as the selection specification.

[8] For details on the dynamic probit model see Amemiya (1985, chapter 11), Przeworski *et al*. (2000), or Przeworski and Limongi (1997). The model is also described in Appendix 2.

influence this distinct decision may be different from those influencing the decision of the government to enter an IMF program in the first place.

Table 1: Determinants of participation in IMF programs

	Determinants of entering		***Determinants of remaining***			
Variable	**Full model (1034 obs)**	**Stripped model (1657 obs)**	**Full model (1034 obs)**	**Stripped model (1657 obs)**	**1,034 obs sample means**	**1,657 obs sample means**
Constant	**-0.6598***	**-1.2921****	**0.5597**	**0.224**	1.0	1
(standard error)	(0.360)	(0.261)	(0.445)	(0.339)		
Level	**-0.00003**	**-0.00003**	**-0.00002**	**-0.00003**	2146.46	2129
(standard error)	(0.00005)	(0.00004)	(0.00007)	(0.00006)		
Growth	**-0.0103**	**-0.0135***	**-0.0004**	**-0.0096**	1.06	1.34
(standard error)	(0.010)	(0.008)	(0.010)	(0.008)		
Years under	**0.0074**	**0.0181****	**-0.0142**	**-0.006**	6.87	6.29
(standard error)	(0.012)	(0.009)	(0.013)	(0.011)		
Number under	**-0.0088**	**-0.0005**	**0.0104**	**0.0137****	36.70	35.92
(standard error)	(0.007)	(0.006)	(0.008)	(0.007)		
Lagged election	**0.4101****	**0.3593****	**-0.0169**	**0.132**	0.19	0.07
(standard error)	(0.165)	(0.128)	(0.195)	(0.167)		
Regime	**0.0738**	**0.1038**	**0.2004**	**0.1845**	0.73	0.76
(standard error)	(0.185)	(0.142)	(0.184)	(0.157)		
Exchg rate	**0.0002**	**0.0005**	**0.0010**	**0.0023**	9.47	14.54
(standard error)	(0.002)	(0.0003)	(0.002)	(0.001)		
Investment	**-0.0245****	**-0.0273****	**0.0038**	**-0.0007**	13.30	13.97
(standard error)	(0.012)	(0.008)	(0.013)	(0.011)		
Debt service	**0.0626****	**0.0700****	**0.0329***	**0.0403****	5.13	2.41
(standard error)	(0.020)	(0.013)	(0.019)	(0.017)		
Deficit	**-0.0106**		**0.0140**		-6.22	
(standard error)	(0.011)		(0.013)			
Reserves	**-0.0890****		**-0.0341**		3.00	
(standard error)	(0.039)		(0.037)			
BOP	**-0.0215**		**-0.0246**		-1.45	
(standard error)	(0.015)		(0.017)			

	Full model (1034 obs)	Stripped model (1657 obs)		
Correctly predicted participating	83%	83%	**Predicted Pr correlation:**	**0.99**
Correctly predicted not participating	88%	90%	**Hazard rates correlation:**	**0.98**

This "stripped" selection model performs well, correctly predicting 83 percent of "participating" observations and 90 percent of the "not participating" observations (where the "prediction" cut-off is at 50 percent probability of participating/not participating). According to the "stripped" specification, countries with low per capita income growth (Growth) are more likely to enter programs, although this variable is not a significant predictor of continued participation. History matters: Years under measures the number of years in a country's history it has spent under IMF programs. Countries that have spent longer periods of time participating in past agreements are more likely to return to IMF agreements. This variable does not determine how long the current spell of participation will last, however, as it does not have a significant effect on the decision to remain. What other countries are doing also matters. Number under measures the number of other countries around the world that are currently participating in IMF programs. While this variable does not appear to influence the decision to enter into programs, it determines why countries remain. The more countries currently participating in an IMF program, the more likely a particular country is to continue participating. Table 1 shows that political considerations matter. Lagged election is a dummy variable coded 1 if the previous year had legislative elections and 0 otherwise. Governments are more likely to enter into IMF programs after elections. Finally, low Investment and high Debt service are both predictors of entering into IMF programs, and high Debt service is also a predictor of continued participation.[9]

[9] Because the main point of our paper is to use these results to ascertain the effects of IMF programs on deforestation, we do not go into detail about interpreting our results. For fuller discussions of the use of these variables to determine participation in IMF programs, see Bird (1996) and Przeworski and Vreeland (2000).

These results are not fully consistent with the results from the "full" specification. The result on elections, investment and debt service are robustly significant findings. The differences between results may be due to omitted variable bias, as the significant Reserves variable is not included in the "stripped" model due to missing observations. Yet, the difference in results may also be due to sampling bias. Note the difference in the means of Debt service between the two samples.

The differences between the results of the two models may not be important for the purpose of this paper. The reason it is important to have a good model of the selection process into IMF programs is to obtain the instruments required to correct for potential selection bias when estimating the effect of IMF programs on distribution. The instruments used are derived in part from the predicted probability of participation. Notice the lower right hand corner of Table 1, where it is labeled "Predicted Pr correlation." This reports the correlation between the predicted probability of participation from the two models ("full" and "stripped"). The high correlation of 0.99 indicates that the "stripped" predicted probability of participation for each country-year observation is very close to the "full" predicted probability.

The actual instrument used to correct for potential selection bias is the "hazard rate." The hazard rates produced by the two specifications are also highly correlated (0.98).

The "hazard rate" represents one way of measuring the errors associated with each selection decision. Note that the statistical model used to estimate selection involves two decisions: the decision to enter agreements and the decision to continue/terminate agreements. Both of these decisions represent an area where relevant unobserved variables

may be omitted. Hence, to correct for selection bias, one needs two instruments, one corresponding to each of the selection decisions. For countries currently under agreements, the hazard rate is the marginal probability that the agreement ends, given that it has survived thus far. For countries not currently under agreements, the hazard rate is the marginal probability that a program begins, given that there is no agreement in place. The hazard rates have a convenient property: when included in the estimation of program effects, the parameters capturing their influence indicate the correlation between the selection and the performance error terms. If such hazard rates are not included as explanatory variables, then the estimation of the effects of IMF programs on growth will suffer from a misspecification – specifically omitted variable – bias.

Appendix 2 demonstrates formally how the hazard rates are incorporated into the estimation of the effect of IMF programs on deforestation. The general procedure is the following. A regression model of deforestation is estimated separately for countries observed participating in programs and for those observed not participating. The hazard rates are included in this estimation as instruments to control for the effects of unobserved variables driving selection. This generates two sets of parameters, one characterizing countries under agreement, the other characterizing countries not under. These "under" and "not under" parameters are not biased by selection. The vector of independent variables characterizing each country at each time can then be multiplied alternatively by the "under" parameters and the "not under" parameters. The parameters on the hazard rates, which control for the effects of unobserved variables are left out. This removes the effects of selection and produces two counterfactual observations for each country during each year that are matched for all conditions – observed and

unobserved. These selection-unbiased values of labor share "under" and "not under" are averaged separately over all countries and years, so that the difference between them is the net effect of IMF programs.

Armed with a statistical story of selection, one can now turn to evaluating the effects of IMF programs and control for differences in country conditions, both observed and unobserved.

5. The effect on deforestation

The dependent variable used in this study is Net Forest Depletion from the *World Bank Development Indicators Database, CD-Rom (2000)*. The variable is defined as the product of unit resource rents and the excess of roundwood harvest over natural growth, expressed as a percentage of GDP:

$$\text{NET FOREST DEPLETION} = \frac{\left[(\text{UNIT RESOURCE RENTS}) \times (\text{EXCESS ROUNDWOOD HARVEST})\right] - \text{NATURAL GROWTH}}{\text{GDP}}$$

This deforestation data set was originally assembled by the Food and Agriculture Organization (FAO) Forest Resource Assessments. FAO data are the most common source for deforestation research involving large-n analysis (see Angelsen and Kaimowitz, 1999).[10]

[10] Note, first of all, that there is no clear consensus on exactly what constitutes "deforestation" or how the concept should be quantified (Dore *et al*., 1996). For a critique of the variable we use see Angelsen *et al*. (1999). Other measures such as "change in total forest area" (Allen and Barnes, 1985), "industrially lagged area of tropical broadleaved forest" (Capistrano and Kiker, 1995), and "land conversion" (Phantumvanit and Panayotou, 1990) are only available for one country or region over a limited period of time.

Consider what is observed: our data include 2,258 country-year observations from 112 countries between 1970 and 1990. The average annual rate of deforestation for the entire sample is 0.54 percent of GDP. We observe 1,553 country-years where the country was not participating in IMF programs with an average rate of deforestation of 0.37 percent of GDP. There are 705 observations of countries participating in IMF programs with an average rate of deforestation of 0.91 percent of GDP. Clearly, countries under IMF programs have higher rates of deforestation. The difference is stark: 0.54 percent of GDP.

One can simply not assume that this difference is due to participation in IMF programs. The difference is due, at least in part, to nonrandom selection into programs. Before one can estimate the effect of IMF programs on deforestation, it is first essential to have a story of what determines deforestation. We need to specify what other variables influence this variable. The most often cited factors include GDP per capita and population growth.[11] Following Kahn and McDonald (1995), we also include total debt service as a percentage of GNP. Table 2 reports the results of regression analysis using a random effects model to control for country-specific effects.[12]

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[11] See Allen and Barnes (1985), Capistrano and Kiker (1995), and Palo *et al*. (1987). Other research stresses that inequality is another important contributor to deforestation (Deacon, 1994). We test a measure of inequality in our model (below).

[12] Note that we choose the random effects model so that a single constant terms is estimated for each state, "participation" or "not participation." This is important below, where we split the sample. This is a more convenient approach than the fixed effects model which estimates a country-specific constant term. If a country is observed only in one state of participation, no counterfactual constant term is estimated. Thus, one cannot estimate what deforestation would have been if the country had been in the other state of participation. One way around this is to simply use the average of the fixed effects for each state. When we do this, the results presented below hold and in fact are much more dramatic. These results are presented in Table 4 below.

Table 2: Deforestation regression

Explanatory variables	Coefficient	Standard error	Mean
Constant	0.623**	0.185	1.00
Per capita income	-0.00003	0.00003	2216
Population growth	0.039**	0.020	2.507
Debt service	0.023**	0.004	5.268
IMF participation dummy	0.062*	0.033	0.398
Dependent variable	Mean	Standard deviation	
Deforestation	0.817	1.664	
Number of observations	1406		
Lagrange multiplier test	9055.11		
Hausman test (fixed versus random)	19.78		

The findings shown in Table 1 are broadly consistent with the results of previous research. Although the coefficient is not significant, we find that as per capita income increases, deforestation decreases. Population growth has a highly significant positive effect on deforestation. As population growth increases one percent, deforestation increases 0.04 percent, *ceteris paribus*. Debt service also has a highly significant positive effect: when debt service increases by one percent of GNP, deforestation increases 0.02 percent. Participation in IMF programs appears to increase deforestation by 0.06 percent. This finding is significant at the 90 percent confidence level.

Thus, even after controlling for level of economic development, population growth and debt service, the IMF appears to have a negative effect on this aspect of the environment: deforestation increases.

And what if unobserved variables also play a role? What if, as it claims, the IMF is concerned with the environment and tends to extend agreements with governments

who have some "political will" to protect the environment despite the bad economic conditions and the austere policies of the IMF? Table 3 presents the results of regression analysis including hazard rates to correct for possible selection bias on unobserved variables:

Table 3: Deforestation regression by participation status controlling for nonrandom selection

	Not **participating in IMF programs**			***Participating*** **in IMF programs**		
Explanatory variables	**Coefficient**	**Standard error**	**Mean**	**Coefficient**	**Standard error**	**Mean**
Constant	0.548**	0.184	1.000	1.098**	0.311	1.000
Per capita income	-0.00001	0.00003	2352	-0.0002**	0.0001	1979
Population growth	0.027	0.020	2.537	0.030	0.063	2.508
Debt service	0.017**	0.006	4.072	0.021**	0.007	7.034
Hazard rate	-0.143**	0.046	-0.326	-0.074*	0.044	0.505
Dependent variable	Mean	Standard deviation		Mean	Standard deviation	
Deforestation	0.665	1.478		1.096	1.932	
Number of observations	806			550		
Lagrange multiplier test	2950.22			3200.02		
Hausman test (fixed v. random)	16.04			12.30		

Noteworthy in Table 3 are the statistically significant hazard rates for both countries observed participating and countries observed not participating. The interpretation of the negative coefficient on hazard rate for the countries *not participating* in IMF programs, is that the observed mean *overestimates* deforestation due to nonrandom selection (because the mean of the hazard rate for countries not participating is negative). The interpretation of the negative coefficient on hazard rate for the countries *participating* in IMF programs, is that the observed mean *underestimates* deforestation due to nonrandom selection (because the mean of the hazard rate for countries

participating is positive). The net effect, as will be shown below, is that once one controls for nonrandom selection on unobserved variables, the effect of the IMF on deforestation appears to be greater than the effect reported in Table 2. As noted in Section 3, this may be because the IMF selects countries that have the "political will" to take actions to protect the environment despite the economic crisis and the policies imposed by the IMF, which appear to increase deforestation.

The effects of the control variables reported in Table 3 – Per capita income, Population growth, and Debt service – have approximately the same effects as reported in Table 2, although the standard error for Population growth is bigger and the coefficients are not statistically significant. The standard error for Per capita income for countries participating is smaller, and the negative effect of this variable on deforestation is statistically significant. When countries with higher per capita income participate in IMF programs, they experience less deforestation.

We use the coefficients above to estimate the inherent effects of IMF programs. One can take the observed values of Per capita income, Population growth, and Debt service, multiply them by the coefficients for "*Participating*" reported in Table 3 to calculate hypothetical deforestation if selection into IMF programs were random. The same can be done to simulate deforestation if countries did not participate. We do so for each country-year observation to generate a pair of counterfactuals. Because the parameters are unbiased by nonrandom selection, differences in country conditions are essentially "matched." Then we average these counterfactual observations for each state. The result of this exercise gives us a difference in the rates of deforestation of approximately 0.26 percent of GDP. This is the inherent effect of IMF programs of deforestation rates. Recall

from the beginning of this section that the observed rate of deforestation under IMF programs averages 0.91 percent of GDP. Thus, in countries that participate in IMF programs, the programs themselves account for nearly 30 percent of the deforestation present in those countries.

Note that finding of 0.26 percent of GDP is less than half of the observed difference of comparing countries under and not under IMF programs (0.54 percent of GDP), but larger than the estimated effect when selection on unobserved factors is ignored (0.06 percent of GDP, from Table 2). The qualitative result of all three approaches to the question, however, is the same: rates of deforestation increase under IMF programs.

There are several questions that should be raised regarding our data analysis.

First of all, the data that we use from the World Bank are suspicious. Out of our total sample of 2,258 country-year observations, there are 1,647 observations that are coded zero. For some of these countries, where there is very little forest area, this is reasonable, for other countries it is highly suspicious. Note that the zeroes are distinct from the World Bank convention of coding missing data as ".." We suspect, however, that some of the zeroes should have in fact been coded as missing values. Thus, we re-ran the entire analysis above using only the observations for which a non-zero value for deforestation was recorded. The qualitative results were the same. Indeed, they were strengthened. The average effect of IMF programs on annual deforestation rates using this sample of non-zero observations was 0.56 percent of GDP. Of course, the larger effect is in part because we are working with larger numbers. The mean of the non-zero sample is 2.29 percent of GDP (hence the effect of 0.56 accounts for 24 percent of the

mean) and the mean of the sample including all observations (Table 3) is 0.84 percent of GDP (hence the effect of 0.26 accounts for 31 percent of the mean). Nevertheless, analysis of either sample leads to the same conclusion.

A second issue that we need to address is one raised by Angelsen and Kaimowitz (1999). They criticize the specification used by Allen and Barnes (1985), Capistrano and Kiker (1995), Palo *et al*. (1987), and in our work above, for including population growth as an independent variable. This is because population growth is one of the variables used by FAO in the extrapolation of deforestation rates.[13] To test whether out conclusions are being driven by the inclusion of population growth in our specification, we ran the model again dropping population growth.[14] The results hold: the average effect of the IMF on annual deforestation rate is exactly 0.26 percent of GDP in the full sample and 0.55 in the non-zero sample.

Thirdly, Deacon 1994 suggests that income inequality is a determinant of deforestation. We do not include income inequality in our baseline model above because there are so few observations available on this variable. When we do include a measure of inequality – we use the Gini coefficient measure of income inequality collected by Deininger and Squire (1996) – we are left with only 123 country-year observations. The variable does not have a significant effect when included in our specification and the overall effect of IMF programs on deforestation rates remains the approximately same: 0.29 percent of GDP.

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[13] Population growth data is used by the FAO to extrapolate missing country-year observations from the available data.

[14] Note that contrary to Allen and Barnes (1985), Capistrano and Kiker (1995), and Palo *et al*. (1987), our results do not indicate a significant relationship between our measure of population growth and deforestation.

Finally, we re-ran all of the above using a fixed effects model instead of a random effects model to control for country-specific effects. Table 4 presents a summary of all of these different specifications that were tested.[15] The finding that IMF programs increase deforestation rates is obviously robust. Note that with the exception of the Fixed effects model Including Gini coefficients (which leaves us with a sample of only 123 observations), the specification which we report above (Random effects Baseline specification) produces the most conservative estimate of the effect of IMF programs on deforestation rates.

Table 4: Robustness tests for estimated effect of participating in IMF programs on average annual deforestation rates

	Random effects model	Fixed effects model
Baseline specification (Table 3)	0.259	0.451
Non-zero sample	0.562	0.464
Excluding population growth	0.261	0.451
Excluding population growth (non-zero sample)	0.549	0.449
Including Gini coefficients (income inequality measure)	0.291	0.169

6. Conclusion

The International Monetary Fund (IMF) is charged with promoting "the development of productive resources" without "resorting to measures destructive of national or international prosperity" (*Articles of Agreement*). In recent years, the Fund has paid closer attention to environmental issues, such as deforestation, recognizing that the

[15] The full results for these specifications are all available from the authors upon request.

preservation and management of environmental resources is an important component to long-run stability and growth.

Yet, our findings show that there is a systematic increase in the annual rate of deforestation in countries when they participate in IMF programs. The macroeconomic stability that the IMF attempts to provide with the intention of protecting the environment is not enough to offset the effects of their austerity policies, at least on the deforestation variable. It seems that the possible benefits of macroeconomic stability do not outweigh – at least in the short-run – the impact of policies that promote export-oriented development models, encourage government budget cuts to environmental programs, and induce economic contractions that lead to extensive migration to marginal lands.

This does not mean that all countries would have lower rates of deforestation if they did not participate in IMF programs. There are certainly cases in the world where IMF programs have helped enormously. As noted above, we observe cases where the rate of deforestation drops during the first year a country enters into an IMF program. Our results indicate that on average, however, IMF programs hurt deforestation – even after considering the factors that lead countries to turn to the Fund in the first place.

Our study is limited. Unlike many of the in-depth case studies on the impact of IMF programs on the environment as a whole, this paper focuses on a single element, deforestation. The advantage of our approach, however, is that we consider many more countries than any previous study. More importantly, our approach allows us to distinguish between the effects of selection into IMF programs and the programs' inherent effects. Nevertheless, we consider this only a first step.

Further research needs to be conducted using the newly developing forest data collected through the use of satellite images (See the Advanced Earth Observing Satellite, the Instituto Nacional de Pesquisas Espaciais, the International Global Observing System, and the Global Observation of Forest Cover) and to see if the concern the IMF has evidenced for the environment in recent years (Gandhi, 1996, 1998) leads to better results.

As far as this study goes, it confirms the studies of Cruz and Repetto (1992), Gandhi (1996), and Owusu(1998): the average annual rate of deforestation increases when countries participate in IMF programs, even after controlling for nonrandom selection into IMF programs.

Appendix 1: Definitions and sources of variables

Selection variables

Dependent variable

Participation in IMF programs: Dummy variable coded 1 for the country-years when there was a conditioned IMF agreement (Stand-by Arrangement, Extended Fund Facility Arrangement, Structural Adjustment Facility Arrangement, or Enhanced Structural Adjustment Facility Arrangement) in force, 0 otherwise. Source: *ACLP Data Set* which takes it from *IMF Annual Reports* and *IMF Survey*.

Explanatory variables

Level: "Level" of economic development measured as real GDP per capita in 1985 international prices, chain index. Source: *ACLP Data Set* which takes it from *Penn World Tables 5.6*, where it appears as "RGDPL."

Growth: Economic growth measured as the annual rate of growth of Level. Source: *ACLP Data Set*.

Years under: Cumulative number of years a country has been under IMF agreements. Source: *ACLP Data Set*.

Number under: Total number of *other* countries in the world currently under IMF agreement (does not include the given country itself). Source: *ACLP Data Set*.

Lagged election: Dummy variable coded 1 if legislative elections were held the previous country-year. Source: *ACLP Data Set* which takes it directly from Banks (1993, p. 20), where it appears as "LEGISLATIVE ELECTION," and is defined as follows: "The number of elections held for the lower house of a national legislature in a given year."

Regime: Dummy variable coded 1 for dictatorships and 0 for democracies. Source: *ACLP Data Set*. For more on this variable, see Alvarez *et al*. (1996).

Exchg rate: Exchange rate (national currency relative to the US dollar). Source: *ACLP Data Set* which takes it from *Penn World Tables 5.6*, where it appears as "ExR."

Investment: Real gross domestic investment (private and public) as a percentage of GDP. Source: *ACLP Data Set* which takes it from *Penn World Tables 5.6*, where it appears as "i."

Deficit: Central government overall surplus as a percentage of GDP. Source: *ACLP* which takes it from *World Development Indicators on CD-ROM 1994*.

Debt service: Total debt service as a percentage of GNP. Source: *World Development Indicators on CD-ROM 1998*.

Reserves: International reserves to imports of goods and services. Source: *World Development Indicators on CD-ROM 1998*.

BOP: Overall balance of payments as a proportion of GDP. Source: *International Financial Statistics on CD-ROM 1994*.

Performance variables

Dependent variable

Deforestation: Net forest depletion defined as the product of unit resource rents and the excess of roundwood harvest over natural growth, expressed as a percentage of GDP:

$$\text{NET FOREST DEPLETION} = \frac{[(\text{UNIT RESOURCE RENTS}) \times (\text{EXCESS ROUNDWOOD HARVEST})] - \text{NATURAL GROWTH}}{\text{GDP}}$$

Explanatory Variable

Per capita income: Same as **Level** above.

Population growth: Annual rate of growth of population. Source: *ACLP Data Set* which takes it from *Penn World Tables 5.6.*

Debt Service: Same as above.

IMF participation dummy: Same as **Participation in IMF programs** above.

Appendix 2: The selection model of IMF program performance

The dynamic probit model:

Assume participation at time *t* depends on participation at time *t*-1 (i.e., assume the data obey a first-order Markov process). Let d_{it} denote participation status in country *i* at time *t*: d_{it}=1 if country *i* is under agreement at time *t*, and d_{it}=0 if country *i* is not under agreement at time *t*.

Let $p_{NU,it}$ denote the "transition probability" that country *i* enters into an IMF arrangement at time *t* (that it goes from *not* under at time *t*-1 to *under* at time *t*). The probability that the country does not enter an arrangement at time *t* is $p_{NN,it}=1-p_{NU,it}$. Similarly, $p_{UU,it}$ denotes the probability that country *i* stays under at time *t*. The probability that participation ends at time *t* (i.e., that country *i* goes from $U_{i,t-1}$ to N_{it}) is $p_{UN,it}=1-p_{UU,it}$.

The probability of participation at time *t*, $p(d_{it}=1)$ is the probability of going under, $p_{NU,it}$, if country *i* was not under at time *t*-1 $(1-d_{i,t-1})$ plus the probability of continued participation, $p_{UU,it}$, if country *i* was already under agreement at time *t*-1 ($d_{i,t-1}$):

$$\begin{aligned} p\left(d_{it}=1 \mid d_{i,t-1}\right) &= p_{NU,it}\left(1-d_{i,t-1}\right)+p_{UU,it}d_{i,t-1} \\ &= p_{NU,it}+\left(p_{UU,it}-p_{NU,it}\right)d_{i,t-1}. \end{aligned}$$

Let $p_{NU,it}=F\left(\gamma' X_{i,t-1}\right)$, where $F(\cdot)$ represents the cumulative distribution function of the standard normal distribution. Let $p_{UU,it}=F\left[\left(\gamma+\alpha\right)' X_{i,t-1}\right]$. Then one can rewrite the probability of an IMF agreement as:

$$p\left(d_{it}=1 \mid d_{i,t-1}\right)=F\left(\gamma' X_{i,t-1}+\alpha' X_{i,t-1}d_{i,t-1}\right).$$

From this, one can write the likelihood function and estimate the probability of selection into IMF programs. Note that this estimation is equivalent to estimating a straightforward probit where the latent variable, d_{it}^{*}, is defined as:

$$d_{it}^{*} = g'X_{i,t-1} + a'X_{i,t-1}d_{i,t-1} + v_{it}.$$

We refer to this last equation in the next section when discussing how to use hazard rates to control for selection bias.

Correcting for Selection Bias from Unobserved Variables:

Following Heckman (1988), the problem of measuring the effect of Fund programs on deforestation is as follows. Let ℓ_{it} be deforestation of country *i* at time *t*. Define:

$$\ell_{it} = \begin{cases} \ell_{it}^{*} & \text{if } d_{it} = 0 \\ \ell_{it}^{*} + d_{it}\Delta_{it} & \text{if } d_{it} = 1 \end{cases}$$

where ℓ_{it}^{*} is a country's "latent" deforestation, the rate of deforestation if a country does not participate in an IMF program; d_{it} is a dummy variable set to 1 if a country participates, and 0 otherwise; and Δ_{it} denotes the impact of the program on deforestation. This is the parameter of interest. We want to estimate the impact of the IMF program on countries which participated in the program:

$$E\left(\ell_{it} - \ell_{it}^{*} \mid d_{it} = 1\right) = E\left(\Delta_{it} \mid d_{it} = 1\right).$$

If assignment into programs were random, mean value of deforestation for non-program countries would equal the latent deforestation of program countries: $E\left(\ell_{it}^{*} \mid d_{it} = 0\right) = E\left(\ell_{it}^{*} \mid d_{it} = 1\right) = E\left(\ell_{it}^{*}\right)$. By virtue of random assignment, ℓ_{it}^{*} would be statistically independent of treatment status, d_{it}.

However, there is no reason, *a priori*, to assume that assignment into programs is random. And if participation is not randomly assigned, the dummy variable indicating participation, d_{it}, will be correlated to the error term e_{it} from the following equation:

$$\ell_{it} = b'Z_{it} + d_{it}\Delta_{it} + e_{it}$$

where Z_{it} is a vector of observable variables affecting ℓ_{it}, b is a vector of fixed parameters, and Δ_{it} is the impact of the IMF program on country *i*'s deforestation at time *t*. If there is selection bias, $E(e_{it}\ d_{it}) \neq 0$. Thus, in expectation, e_{it} will not equal zero and hence:

$$E(\ell_{it} \mid Z_{it}, d_{it}) \neq b'Z_{it} + d_{it}\Delta_{it}.$$

If the correlation between d_{it} and e_{it} comes from the observed determinants of d_{it}, ($X_{i,t-1}$ from the selection estimation of the previous section) correction is straightforward – one simply needs to control for the observed determinants of selection. However, the correlation can also be caused by correlated error terms, $E(e_{it}\ v_{it}) \neq 0$ (where v_{it} also comes from the selection estimation of the previous section).

Heckman suggests correcting for this by incorporating the expected value of the selection error term into the performance equation. The inclusion of such variables corrects for the bias. Note that there are two situations to consider: $d_{it}^* > 0$ and $d_{it}^* \leq 0$:

$$(1)\ E(v_{it} \mid d_{it}^* > 0) = E\left(v_{it} \mid v_{it} > -(g + a)' X_{i,t-1}\right)$$

$$= \frac{f\left[-(g + a)' X_{i,t-1}\right]}{1 - F\left[-(g + a)' X_{i,t-1}\right]} = \frac{f\left[(g + a)' X_{i,t-1}\right]}{F\left[(g + a)' X_{i,t-1}\right]} = l_{it}^1$$

(2) $E\left(v_{it} \mid d_{it}^{*} \le 0\right) = E\left(v_{it} \mid v_{it} \le -\left(g + a\right)' X_{i,t-1} \right)$

$$= \frac{-f\left[-\left(g + a\right)' X_{i,t-1}\right]}{F\left[-\left(g + a\right)' X_{i,t-1}\right]} = \frac{-f\left[\left(g + a\right)' X_{i,t-1}\right]}{1 - F\left[\left(g + a\right)' X_{i,t-1}\right]} = -l_{it}^{0}$$

The Heckman method to correct for this bias involves calculating the hazard rates, l , and including them in the estimation of deforestation:

$$E\left(\ell_{it} \mid Z_{it}, X_{i,t-1}, d_{it}^{*} > 0\right) = b_1' Z_{it} + q^{1} l_{it}^{1}$$

$$E\left(\ell_{it} \mid Z_{it}, X_{i,t-1}, d_{it}^{*} \le 0\right) = b_0' Z_{it} + q^{0} l_{it}^{0}$$

These properly specified equations will give unbiased estimates of b from which one can calculate deforestation under IMF programs and deforestation not under. Thus one can estimate the average Δ, the impact of IMF programs on deforestation.

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