A Appendix

A.1 Bivariate Probit with Partial Observability

Our approach is similar to one that has been used by Vreeland (2003), Przeworski and Vreeland (2000), and Przeworski and Vreeland (2002), but differs in several key respects, so this appendix is included to explain the differences. Przeworski and Vreeland argue that selection models for IMF programs should incorporate the fact that two decisions are involved in the selection process: both the borrowing country and the IMF must consent to an agreement before one can be observed. Since only the outcome of the joint decision can be observed, they propose using bivariate probit with partial observability to estimate the unobserved parameters (Poirier, 1980). In the bivariate probit with partial observability approach discussed in Vreeland (2003), the government's and the IMF's decisions are modeled with two latent variable equations:

$$G^*_{BP} = \gamma\omega + \upsilon_G \tag{A.1}$$
$$I^*_{BP} = \alpha\kappa + \upsilon_I \tag{A.2}$$

where ω is the set of factors affecting a government's decision to seek a program, κ is the set of regressors influencing the IMF's decision to enter into an agreement with a government, υ_G and υ_I are standard normally distributed error terms. We only observe a program when both the government and the IMF are willing to sign one. In other words,

$$\begin{aligned} Pr(P=1) &= Pr(G^*_{BP} > 0, I^*_{BP} > 0) \\ Pr(P=0) &= 1 - Pr(G^*_{BP} > 0, I^*_{BP} > 0) \end{aligned}$$

If we allow that υ_G and υ_I are correlated with ϵ, such that $\text{Corr}(\epsilon, \upsilon_G) = \rho_G$ and $\text{Corr}(\epsilon, \upsilon_I) = \rho_I$, then, the expected growth rate for countries that are under an IMF program becomes[1]:

$$\begin{aligned} E(Y_1|P=1) &= X_1\beta_1 + E(\epsilon_1|G^* > 0, I^* > 0) \\ &= X_1\beta_1 + \rho_G\sigma_\epsilon\lambda_G + \rho_I\sigma_\epsilon\lambda_I \end{aligned} \tag{A.3}$$

where $\lambda_G = \frac{\phi(\gamma\omega)}{\Phi(\gamma\omega)}$ and $\lambda_I = \frac{\phi(\alpha\kappa)}{\Phi(\alpha\kappa)}$; and ϕ and Φ are probability density and cumulative distribution functions of standard normal distribution respectively.

For countries that are not under an IMF program, if we assume that neither the IMF nor the country wanted a program, the expected growth rate is:

$$\begin{aligned} E(Y_2|P=0)) &= X_2\beta_2 + E(\epsilon_2|\{G^* \leq 0, I^* \leq 0\}) \\ &= X_2\beta_2 + \rho_G\sigma_\epsilon\lambda_{\sim G} + \rho_I\sigma_\epsilon\lambda_{\sim I} \end{aligned} \tag{A.4}$$

where $\lambda_{\sim G} = \frac{-\phi(\gamma\omega)}{1-\Phi(\gamma\omega)}$ and $\lambda_{\sim I} = \frac{-\phi(\alpha\kappa)}{1-\Phi(\alpha\kappa)}$. If, instead, government wanted a program but the IMF did not grant it,

$$\begin{aligned} E(Y_2|P=0)) &= X_2\beta_2 + E(\epsilon_2|\{G^* > 0, I^* \leq 0\}) \\ &= X_2\beta_2 + \rho_G\sigma_\epsilon\lambda_G + \rho_I\sigma_\epsilon\lambda_{\sim I} \end{aligned} \tag{A.5}$$

[1] for simplicity and for practical difficulties in estimation, Vreeland assumes $\text{Corr}(\upsilon_G, \upsilon_I) = 0$. We also make this assumption for the rest of the paper.

Finally, if it is the case that the IMF wants a program and the government does not,

$$\begin{aligned} E(Y_2|P=0)) &= X_2\beta_2 + E(\epsilon|\{G^* \leq 0, I^* > 0\}) \\ &= X_2\beta_2 + \rho_G\sigma_\epsilon\lambda_{\sim G} + \rho_I\sigma_\epsilon\lambda_I \end{aligned} \tag{A.6}$$

Therefore, depending on which of the equations A.4, A.5, and A.6 is predicted or assumed to apply to the country i, that equation can be used in calculating GB or EB as defined in equations 4 and 5 in the text.

In effect, the bivariate probit approach assumes that the government and the IMF make simultaneous decisions about whether to initiate a program, and compares the case of program participation to the three logical alternatives: only the country wants a program, only the IMF wants a program, or neither wants a program. In contrast, our strategic model captures the fact that only a borrowing country can initiate an application for a program, so the IMF only faces the option of approving programs when countries have already indicated that they desire to participate. This captures the essence of the problem of adverse selection. Our model generates different estimates for government and IMF utilities, and different selection corrections.

A.2 Penalized Maximum Likelihood Estimation

To estimate the strategic probit model with partial observability in Vreeland's (2003) data set (1951-1990), we employed a penalized maximum likelihood estimation (PMLE) approach. PMLE is first introduced by Firth (1993) as a small sample bias reduction method in maximum likelihood models. It is later offered as a solution to separation and quasi-complete separation problems in binary response models where maximum likelihood estimates either do not exist or are problematic (Heinze and Schemper, 2002; Zorn, 2005). PMLE works by introducing a 'penalty' term to the likelihood function that asymptotically disappears. This penalty term acts as a Bayesian prior on the coefficients, and keeps the estimates from approaching infinity when separation is an issue.[2] The penalized likelihood function we maximize is equal to

$$L_{PMLE}(\beta|P) = L_{MLE}(\beta|P)|I(\beta)|^{\frac{1}{2}} \tag{A.7}$$

Where $I(\beta)$ is the information matrix (Firth, 1993; Zorn, 2005). The reason we use this approach in estimating the selection model is that, in some of the specifications for countries that are already under an IMF program, we were unable to calculate the MLE estimates of the parameters due to the small sample size and the complexity of the partial observability likelihood function.

[2]For the exponential family link functions, the penalty term is equivalent to Jeffrey's Invariant Prior (Firth, 1993; Zorn, 2005)

A.3 Replications and Robustness Checks

This section presents a number of replications and the results of analyses that we performed to probe the robustness of our findings.

Tables:

- Table 1 presents our replication of the main selection model used in Vreeland (2003), using data he generously provided.
- Table 2 presents a replication of our main growth regressions using the data from Vreeland (2003). The data begin in 1951, but the estimation sample begins in 1970 because of missing data. The results are similar to those we obtain from the extended data set used in the paper.
- Table 4 presents the results of additional growth regressions using the 1970-2008 data. These represent tests of the robustness of the results presented in Table 2 of the paper, and the results are qualitatively similar across a wide range of specifications.
- Table 4 introduces additional controls and compares the results using the data set from in the paper and using multiple imputation to fill in missing values, as recommended by King et al. (2001).
- Table 5 cross-tabulates estimated growth benefits and actual growth rates using the selection model in Table 1 and the growth model in Table 2 (model 3), using the Vreeland (2003) data.
- Table 6 cross-tabulates predicted and actual selection outcomes using the selection model in Table 1 and the Vreeland (2003) data.
- Table 7 describes the pattern of missing data in the data set used for the paper (1970-2008).
- Table 8 presents the average benefit, percentage of observations with a positive gross benefit, and percentage of observations with a positive expected benefit using the selection model in Table 1 and a variety of specifications of the growth equation, using the Vreeland (2003) data. The results are robust to a wide range of specifications in this data set as well.
- Table 9 presents a series of observations drawn from the Vreeland (2003) data with high and low predicted probabilities of government participation, the corresponding estimated growth benefits, and their actual growth performance. As with the similar table in the paper that used the 1970-2008 data, high predicted probabilities correspond to negative growth effects, and low probabilities to positive growth effects.
- The final table presents summary statistics from the Vreeland (2003) data.

Figures:

- Figure 1 reproduces Figure 2 in the paper using the Vreeland (2003) data and the corresponding estimates. Although the curvature of the functions is more dramatic in this version, the signs of the first and second derivatives are the same for all variables in both data sets.
- Figure 2 reproduces Figure 3 in the paper using the Vreeland (2003) data and the corresponding estimates. The results illustrate the result that expected growth benefits are predominantly positive.

- Figure 3 reproduces Figure 4 in the paper using the Vreeland (2003) data and the corresponding estimates. The figure demonstrates that the estimated growth benefit is a decreasing function of the estimated probability that a government applies for a program.

- Figure 4 is a scatterplot of the predicted probability that a government applies for an IMF program against the estimated program benefit, with country abbreviations and years as labels. The plot illustrates the result that the estimated benefit is a decreasing function of the estimated probability of applying.

- Figure 5 reproduces Figure 5 in the paper using the Vreeland (2003) data and the corresponding estimates. The figure illustrates the results that the estimated growth benefit is increasing in central bank reserves, investment and the government budget balance, but decreasing in the debt service ratio.

- Figure 6 reproduces Figure 6 in the paper using a non-parametric regression of the growth effect on the duration of prior program participation. This figure does not reproduce the shape of the relationship in the paper, but confirms the result that prior program participation increases the growth effect, at least for the first few years, and that the effect remains elevated for at least fifteen years.

References

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	Government	
	B. Probit (Vreeland)	
Variable	Enter	Remain
Reserves	-.833	-4.464
	(.125)	(.007)
Budget Bal.	-.952	1.145
	(.011)	(.014)
Debt Serv.	1.377	2.363
	(.004)	(.125)
Investment	-6.059	17.485
	(.001)	(.019)
Years Under	.358	-1.140
	(.083)	(.112)
Num. Under	.444	-.708
	(.014)	(.176)
Lagged Elec.	.869	-1.025
	(.007)	(.181)
Under	-	-
Constant	-2.271	6.537
	(.000)	(.013)
	IMF	
	B. Probit (Vreeland)	
Variable	Enter	Remain
BOP*Size	-.914	-.296
	(.014)	(.067)
Num. Under	-.728	.200
	(.027)	(.023)
Under*Num.Und.	-	-
Regime	.430	.387
	(.114)	(.041)
Under	-	-
Constant	2.145	.117
	(.150)	(.747)
N of Observ.	1024	
Log-likelihood	-353.93	

a. p-values for each coefficient
are reported in parentheses.

Table 1: Selection into IMF Programs (Replication of Vreeland (2003) results)

		Selection Corrected			
	Model 1	**Model 2**		**Model 3**	
Variable	Pooled	Under	Not Under	Under	Not Under
Under	-.065	-	-	-	-
	(.808)				
Lagged Growth	-	-	-	.063	.002
				(.002)	(.952)
Cap. Stock Gr.	.454	.478	.441	.477	.442
	(.000)	(.000)	(.000)	(.000)	(.000)
Labor Force Gr.	.434	.484	.378	.489	.373
	(.000)	(.000)	(.013)	(.000)	(.017)
λ_{GOV}	-	.683	-1.331	.465	-1.038
		(.042)	(.000)	(.100)	(.140)
λ_{IMF}	-	-.686	-.374	1.217	.007
		(.078)	(.522)	(.087)	(.993)
Constant	-.018	-.308	-.048	-2.629	.431
	(.951)	(.367)	(.919)	(.002)	(.724)
N. of Observ.	1024	465	559	465	559

a. p-values for each coefficient are reported in parentheses.

Table 2: The Effect of IMF Programs on Growth from Data Set (1970-1990)

	M. 4	M. 5	M. 6	M. 7	M. 8	M. 9	M. 10	M. 11	M. 12
Lag. Gr.		-0.022	-0.046		0.187	0.169		0.063	-0.009
		(0.544)	(0.213)		(0.000)	(0.000)		(0.067)	(0.807)
Cap. Gr	0.071	0.072	0.070	0.092	0.092	0.089	0.080	0.077	0.078
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Labor Gr.	-0.433	-0.437	-0.460	-0.494	-0.440	-0.393	-0.357	-0.366	-0.390
	(0.005)	(0.004)	(0.003)	(0.000)	(0.000)	(0.000)	(0.103)	(0.095)	(0.073)
Inflation	-1.078	-1.114	-1.055	-0.164	-1.220	-1.192	-0.716	-0.433	-0.639
	(0.005)	(0.004)	(0.011)	(0.000)	(0.004)	(0.006)	(0.421)	(0.629)	(0.479)
λ_{GOV}	-0.032	-0.032	-0.022	-0.022	-0.021	-0.005	-0.022	0.017	0.009
	(0.030)	(0.028)	(0.165)	(0.015)	(0.021)	(0.619)	(0.237)	(0.366)	(0.663)
λ_{IMF}	0.104	0.104	0.021	0.086	0.082	0.012	0.089	0.095	0.003
	(0.006)	(0.006)	(0.707)	(0.000)	(0.001)	(0.729)	(0.070)	(0.056)	(0.965)
Life Exp.	0.001	0.001	0.001						
	(0.133)	(0.124)	(0.206)						
Schooling	-0.001	-0.001	-0.001						
	(0.094)	(0.083)	(0.009)						
Fertility	-0.010	-0.010	-0.003						
	(0.038)	(0.033)	(0.704)						
Constant	0.045	0.047	0.060	0.077	0.054	0.020	0.125	-0.006	-0.074
	(0.551)	(0.538)	(0.447)	(0.038)	(0.143)	(0.593)	(0.094)	(0.934)	(0.329)
Coun. Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dum.	No	No	Yes	No	No	Yes	No	No	Yes
N	667	667	667	928	925	925	927	925	925

p-values in parentheses.

Models 7, 8 and 9 use GDP per capita growth from World Development Indicators as the DV.

Models 10, 11 and 12 use GDP growth from Penn Word Tables as the DV.

Table 3: Robustness Checks on Growth

	Extended		**Imputed**	
Variable	Under	Not Under	Under	Not Under
Lagged Growth	-.004	.157*	-.117*	-.107
	(.077)	(.060)	(.048)	(.088)
Lagged GDP p.c	-.001	-.002	-.005*	-.004
	(.001)	(.002)	(.002)	(.010)
Cap. Stock Gr.	.028	.013	.001	.002
	(.019)	(.015)	(.009)	(.017)
Labor Force Gr.	-.117	.280	.029	.018
	(.173)	(.203)	(.039)	(.049)
Life Exp.	-.001	-.001	-.009†	-.005
	(.001)	(.001)	(.005)	(.007)
Schooling	.001	.001	-.001	-.001
	(.001)	(.001)	(.001)	(.003)
Inflation	-.001	-.001	.001	-.001
	(.001)	(.001)	(.001)	(.001)
Fertility	-.013*	-.015*	.005	-.001
	(.003)	(.004)	(.021)	(.025)
Subs. Africa	-.012	.014	-.451*	-.221
	(.008)	(.009)	(.096)	(.171)
Latin Am.	-.023*	-.007	-.209*	-.108†
	(.007)	(.008)	(.033)	(.068)
Elections	.001	-.001	-.019	-.022
	(.007)	(.005)	(.049)	(.043)
λ_{GOV}	.009	-.069*	-.083	-.035
	(.006)	(.025)	(.095)	(.107)
λ_{IMF}	-.002	.031†	-.065	.016
	(.006)	(.017)	(.090)	(.099)
Constant	.128*	.085	.867*	.520
	(.047)	(.062)	(.398)	(.616)
N. of Observ.	1496	1496	8257	8257

a. standard errors for each coefficient are reported in parentheses.

Table 4: Updated Data Set: The Effect of IMF Programs on Growth

	Est. Benefit		
Actual Gr.	Neg.	Pos.	Total
Neg.	51	96	147
Pos.	20	298	318
Total	71	394	465

Table 5: Estimated Growth Benefit and Actual Growth Rates for Countries Under a Program (1970-1990)

	Actual Outcome		
Pred. Outcome	No Program	Program	Total
No Program	486	56	542
Program	73	409	482
Total	559	465	1024

Table 6: Predicted vs. Actual Program Cases (Old Data Set)

	All Observations			Selection Model			Growth Model		
Decade	Obs.	Prog. Coun.	All Coun.	Obs.	Prog. Coun.	All Coun.	Obs.	Prog. Coun.	All Coun.
pre-90s	2965	106	157	780	61	74	353	40	54
1990s	1783	106	186	336	41	52	275	36	43
2000s	1724	94	194	380	54	77	299	46	61
Total	6472	140	198	1496	87	104	927	70	82

Table 7: Patterns of Missingness

	Original	Robustness Checks					
Measure	**Model**	Version 1	Version 2	Version 3	Version 4	Version 5	Version 6
Avg. Benefit	.52	.47	.80	.84	.90	.20	.76
Gross %	69	69	71	78	71	65	65
Expected %	85	83	80	90	81	56	79
N	465	441	306	365	251	465	251

	Version 7	Version 8	Version 9	Version 10	Version 11
Avg. Benefit	.54	.52	.55	.53	.54
Gross %	69	69	70	69	68
Expected %	82	85	85	85	75
N	465	465	465	465	441

Version 1: GDP per capita
Version 2: Life Expectancy, Male Schooling, Fertility
Version 3: GDP per capita, Openness, Inflation
Version 4: GDP per capita, Openness, Inflation, Life Expectancy, Male Schooling, Fertility
Version 5: Latin America, OPEC, Sub-Saharan Africa
Version 6: GDP per capita, Openness, Inflation, Life Expectancy, Male Schooling, Fertility, Latin America, OPEC, Sub-Saharan Africa
Version 7: Defense Pact with the US
Version 8: Defense Pact, Neutrality, or Entente with the US
Version 9: African countries
Version 10: Dummy for pre-1970[3]
Version 11: Dummy for poor countries (GDP per capita $< \$2{,}000$)

Table 8: Robustness Checks (Variables Added to the Original Model)

Country Country	ACLP Code	Year	Pr_G(Apply)	Pr_{IMF}(Sign)	Est. Growth Benefit	Actual Growth
Somalia	38	1980	1	.260	-1.735	-18.49
Jordan	86	1989	1	.280	-1.352	-11.04
Congo	12	1986	1	.191	-1.184	-2.98
Benin	3	1989	1	.312	-.852	-4.87
Sudan	40	1979	.999	.495	-.957	-8.98
Trinidad and Tobago	64	1989	.999	.284	-.562	-2.02
Gambia	17	1982	.999	.331	-.339	1.44
Philippines	94	1983	.996	.650	.055	.070
Congo	12	1987	.995	.999	-.604	-2.32
Ghana	18	1979	.995	.291	-.769	-5.86
Gabon	16	1987	.988	.999	-1.060	-12.19
Sudan	40	1973	.985	.953	-.675	-7.19
Nicaragua	62	1979	.977	.425	-2.028	-27.72
Niger	32	1984	.976	1	-.739	-11.58
Mauritania	28	1987	.960	.999	-.657	-1.03
Guyana	72	1982	.917	.999	-1.08	-21.50
Guyana	72	1978	.899	.999	-.716	-16.17
Guyana	72	1977	.899	.962	-.659	-14.38
Uganda	45	1984	.798	.999	-1.799	-45.47
Uruguay	76	1980	.558	.995	2.013	6.37
Bangladesh	78	1985	.525	.312	1.800	8.95
Guatemala	57	1981	.371	.149	1.714	1.27
Philippines	94	1973	.313	.138	1.938	7.60
Rwanda	34	1979	.139	.257	3.194	6.41
Uruguay	76	1975	.111	.628	3.707	4.29
Peru	74	1977	.082	.810	3.833	.68
Lesotho	23	1988	.080	.544	4.640	14.23
El Salvador	55	1980	.078	.267	2.821	-8.07
Chad	10	1987	.044	.369	3.720	-2.43
Thailand	99	1978	.016	.458	5.174	8.63
Gambia	17	1977	.006	.541	5.777	5.56
Fiji	130	1974	.001	.379	10.730	5.99

Table 9: Probability of Applying and Estimated Growth Benefit from Data Set (1951-1990)

Variable	**Observ.**	**Mean**	**St. Dev.**	**Min**	**Max**
BOP*Size	2197	-.002	.223	-2.589	2.611
Budget Bal.	1700	-.535	.707	-7.072	2.649
Cap. Stock Gr.	4126	7.006	12.817	-72.265	195.386
Debt Serv.	1753	.496	.513	0	10.745
Growth	4126	4.233	6.263	-45.477	69.165
Investment	4125	1.689	.949	-.45	6.95
Labor Force Gr.	4126	2.005	1.739	-32.447	23.772
Lagged Elec.	4125	.217	.412	0	1
Num. Under	4125	3.025	1.325	0	5.2
Regime	4125	.601	.489	0	1
Reserves	1746	.319	.301	-.01	1.87
Under	4126	.261	.439	0	1
Years Under	4125	.381	.554	0	2.7
Year	4168	1973	11	1951	1990

Table 10: Summary statistics of the variables used in empirical analysis from data set (1970-1990) (some variables are scaled by magnitudes of 10 to ease estimation).

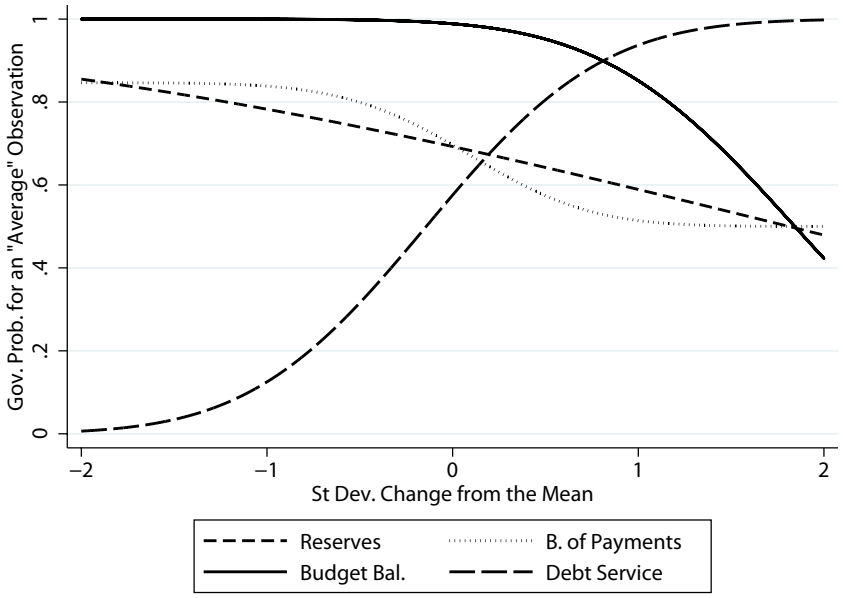

Figure 1: The Effect of Reserves, B.of Payments, Debt Service and Budget Balance on the Government's Choice Probability

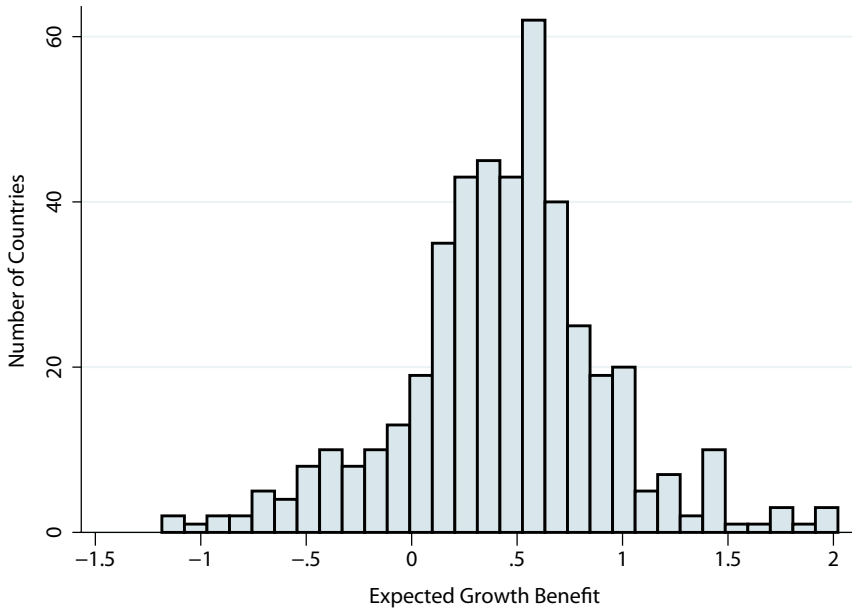

Figure 2: Estimated Growth Benefit for Countries in the Sample

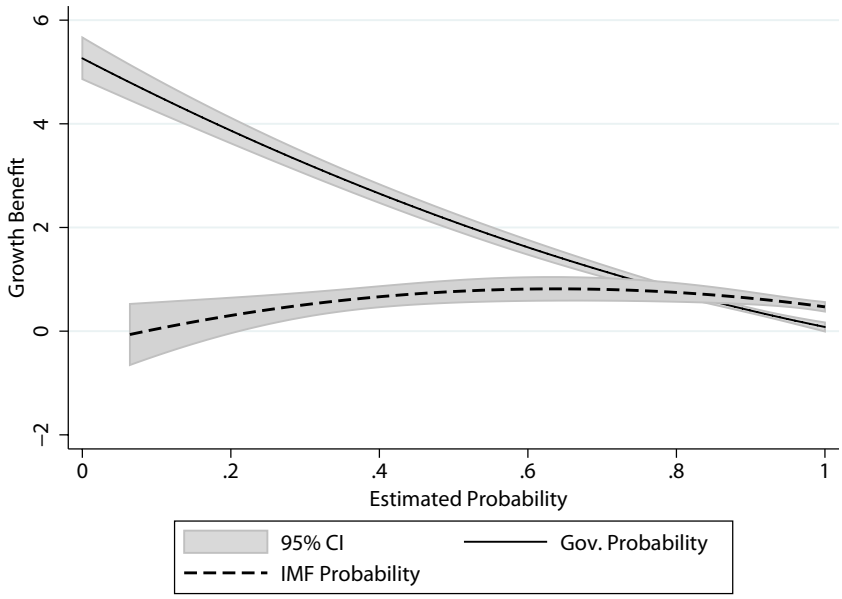

Figure 3: Quadratic Fit of Estimated Growth Benefit versus Government's and IMF's Probabilities

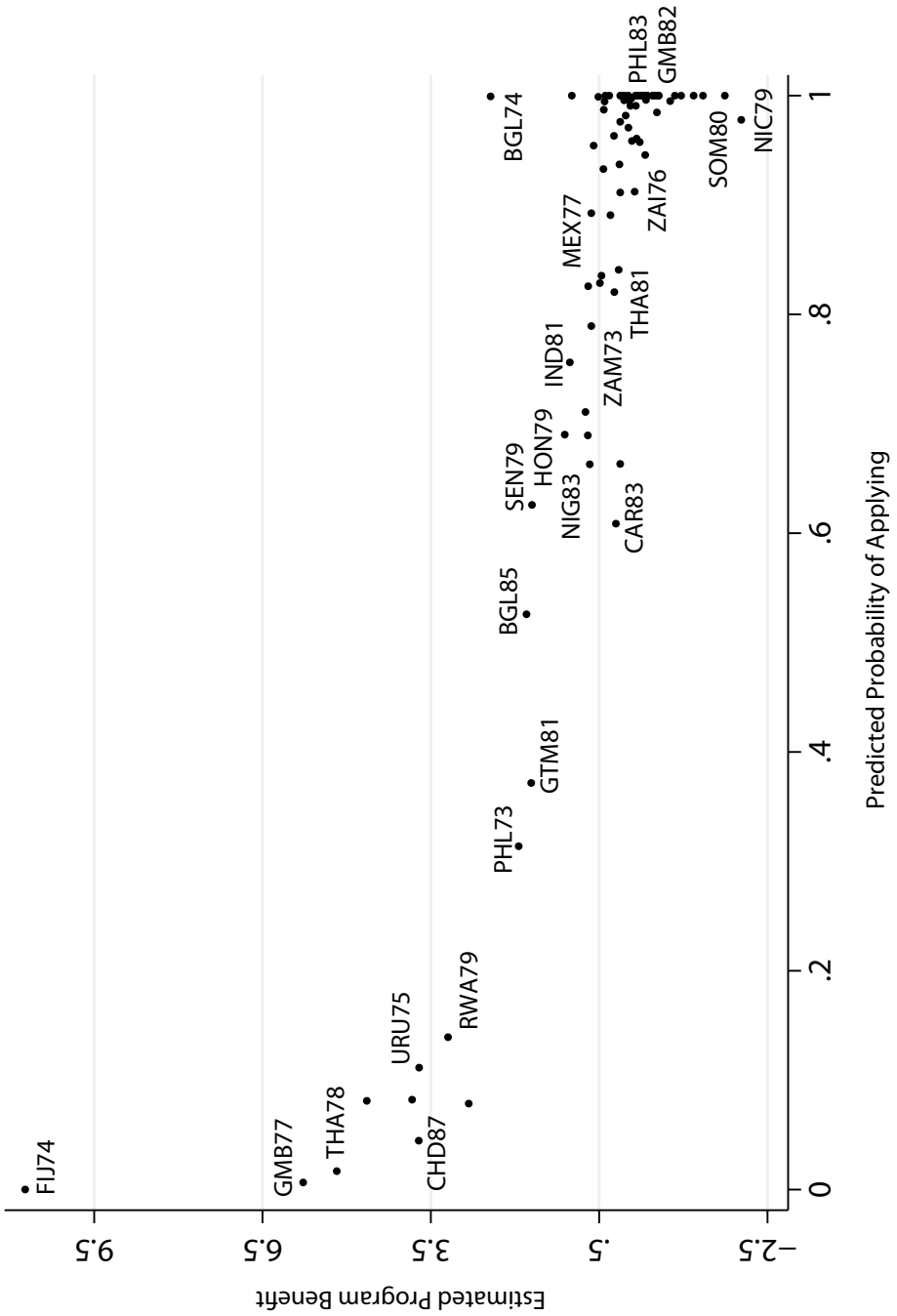

Figure 4: Predicted Probability of Applying and Estimated Growth Benefit (Program Initiation Years)

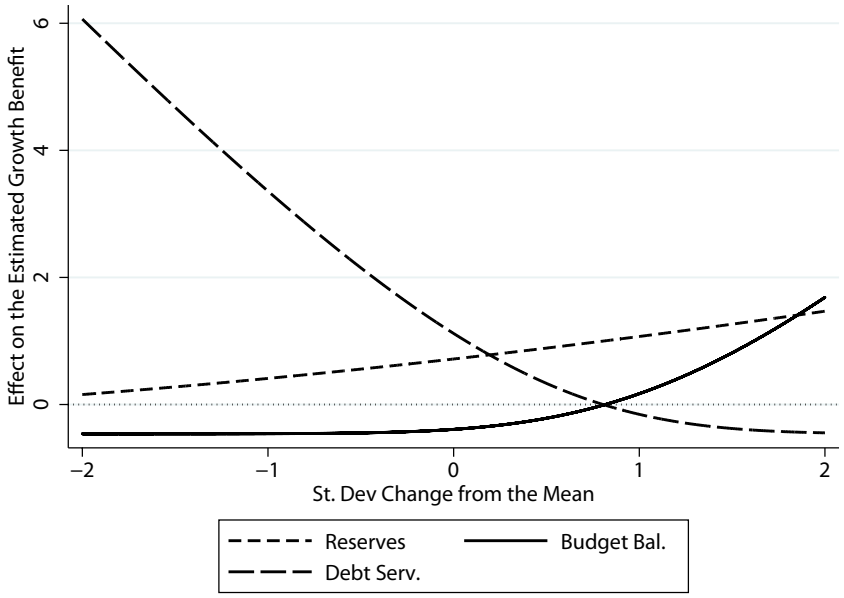

Figure 5: The Effect of Reserves, Debt Service and Budget Balance on the Estimated Growth Benefit of a Program Country

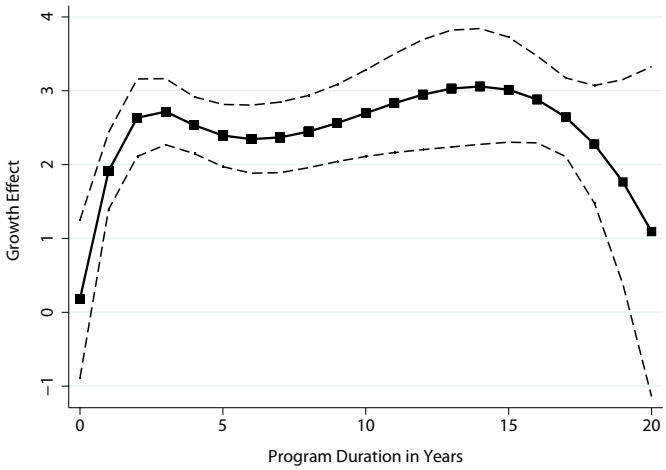

Figure 6: The estimated Effect of Program Duration on Growth Rates (From Model 3 in Table 2)