Supplemental Appendix
War and Default

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Contents

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A Descriptive Statistics

Table A.1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
External Default	0.155	0.362	0	1	12030
Default Rate	0.137	0.212	0	1	12030
Won War	0.591	0.492	0	1	296
In War	0.037	0.188	0	1	18825
Default Data	0.422	0.494	0	1	19013
Iron/Steel Prod Per Capita	0.118	0.763	0	18.163	14345
Iron/Steel Prod Growth	0.091	1.859	-81	75.304	14104
ln (Urban Population)	0.135	0.134	0	2.922	14274
Time since last war	43.463	45.332	0	191	18825
Polity	-0.053	0.707	-1	1	13769
Global Interest Rate	4.192	1.835	1.484	10.926	18829
Regional Default	0.585	0.257	-0.03	1	19013
Capabilities	-4.145	0.694	-4.605	-0.932	14176
Inflation Crisis	0.084	0.277	0	1	11768
Global Interest Rate	4.192	1.835	1.484	10.926	18829
Default Rate	0.137	0.212	0	1	12030
Time since last war	43.463	45.332	0	191	18825
Years since War$ˆ2$	3.944	7.177	0	36.481	18825
Years since War$ˆ3$	47.931	117.521	0	696.787	18825
Rivals	0.658	1.881	0	22	19013
Disputes	1.223	4.604	0	73	19013
Number of Major Powers	5.923	1.056	4	8	14370
Global Interest Rate	4.192	1.835	1.484	10.926	18829
Years since Default	44.993	49.044	0	191	12030
Years since Default$ˆ2$	4.429	7.518	0	36.481	12030
Years since Default$ˆ3$	0.549	1.201	0	6.968	12030
Default Rate (20 yrs)	0.154	0.278	0	1.05	12030
Default or Inflation Crisis	0.206	0.404	0	1	12408
Currency Crisis	0.092	0.349	0	19.7	11508
ln(Debt-to-GDP)	3.701	0.918	0	7.647	8206
Energy Per Cap	0.003	0.008	0	0.132	11416
Energy Growth	0.967	46.759	-1	4903.792	12364
GDP Per Cap (Maddison)	1.578	8.676	0.001	307.156	10056
GDP Growth (Maddison)	0.018	0.064	-0.615	0.869	10670

B Alternative Cross Tabulation Specifications

The section presents alternative cross tabulations specifications from the crosstabs presented in the manuscript in "The Default History of War Winners and Losers" section. None of alternatives changes our main substantive inferences.

Table B.2: War Outcomes and Default After 5 Years

	Lose	**Win**	Total
No Default	65	123	188
%	87.8	93.9	91.7
Default	9	8	17
%	12.2	6.1	8.3
Total	74	131	205

No statistical difference in default rates between war winners and losers. $\chi^2 = 2.279$; p-value = 0.131

Table B.3: War Outcomes and Default Including Ties

	Ties	**Lose**	**Win**	Total
No Default	28	68	125	221
%	100.0	91.9	95.4	94.8
Default	0	6	6	12
%	0.0	8.1	4.6	5.2
Total	28	74	131	233

No statistical difference in default rates between war winners and losers. $\chi^2 = 2.932$; p-value = 0.231

Table B.4: War Outcomes and Domestic and External Default

	Lose	**Win**	Total
No Default	69	125	194
%	92.0	95.4	94.2
Default	6	6	12
%	8.0	4.6	5.8
Total	75	131	206

No statistical difference in default rates between war winners and losers. $\chi^2 = 1.0168$; p-value = 0.313

Table B.5: War Outcomes and Default by War Initiators

	Lose	**Win**	Total
No Default	23	68	91
%	88.5	94.4	92.9
Default	3	4	7
%	11.5	5.6	7.1
Total	26	72	98

No statistical difference in default rates between war winners and losers. $\chi^2 = 1.0309$; p-value = 0.310

Table B.6: War Outcomes and Default by War Targets

	Lose	**Win**	Total
No Default	35	25	60
%	94.6	100.0	96.8
Default	2	0	2
%	5.4	0.0	3.2
Total	37	25	62

No statistical difference in default rates between war winners and losers. $\chi^2 = 1.3964$; p-value = 0.237

Table B.7: Long War Outcomes and Default (2 or more years)

	Lose	**Win**	Total
No Default	43	76	119
%	95.6	95.0	95.2
Default	2	4	6
%	4.4	5.0	4.8
Total	45	80	125

No statistical difference in default rates between war winners and losers. $\chi^2 = 0.0195$; p-value $= 0.889$

Table B.8: Multilateral War Outcomes and Default (2 or more states)

	Lose	**Win**	Total
No Default	36	84	120
%	90.0	96.6	94.5
Default	4	3	7
%	10.0	3.4	5.5
Total	40	87	127

No statistical difference in default rates between war winners and losers. $\chi^2 = 2.2585$; p-value $= 0.133$

Table B.9: War Outcomes and Default with 10,000 Battle Deaths or More

	Lose	**Win**	Total
No Default	34	56	90
%	89.5	93.3	91.8
Default	4	4	8
%	10.5	6.7	8.2
Total	38	60	98

No statistical difference in default rates between war winners and losers. $\chi^2 = 0.4623$; p-value $= 0.497$

Table B.10: War Outcomes and Default and/or Inflation Crisis

	Lose	**Win**	Total
No Default	60	109	169
%	80.0	83.2	82.0
Default	15	22	37
%	20.0	16.8	18.0
Total	75	131	206

No statistical difference in default rates between war winners and losers. $\chi^2 = 0.3327$; p-value $= 0.564$

C Selection Stage Model For Table 3 (models 2–5)

Table C.11: Selection Stage for Table 3 (models 2–5)

	(1)
Iron/Steel Prod Per Capita	0.657
	(0.48)
Iron/Steel Prod Growth	0.041
	(0.03)
ln (Urban Population)	1.406**
	(0.68)
Time since last war	0.008***
	(0.00)
Polity	0.299*
	(0.16)
Global Interest Rate	-0.041**
	(0.02)
Regional Default	2.525***
	(0.46)
Constant	-1.451***
	(0.34)
Log-Likelihood	-6375.4***
AIC	12766.7
N	12412

$***p < 0.01; **p < 0.05; *p < 0.1$; Standard Errors, clustered on country, in parentheses.

Two-stage Heckman selection model; selection stage only (manuscript for outcome stages).

D Alternative Default Rate Measures (Table 3 in Manuscript)

We examine alternatives measures of our main explanatory variable, *default rates*. We argued that *defaults rates* are indicative an measure of a state's future debt behavior, though it is obviously not the only measure available. We simply set out to establish an empirical association between *default rates* and war to demonstrate the selection argument we put forward in the manuscript. We briefly evaluate other alternative measures that are related to a state's expected default behavior to ensure the robustness of our results. First, we measure the default rate as the number of years, limited to 20, in default up until year t, divided by the previous 20 years (or shorter if the state has not been the sample for 20 years). There is no substantive difference in our results using this alternative measure, as shown in model 1 in Table D.12.

Next, we use the measure *Years since default*. We expect that the farther in time a state is from a default episode, the less likely it will default again. Therefore states recently experiencing default will avoid entering the war sample. The results for this alternative measure are in model 2. Both models are consistent with the main results in the manuscript.

Table D.12: Probit Regressions Examining War Participation

	(1)	(2)
Default Rate (20 yrs)	-0.341*	
	(0.160)	
Years since Default		0.002*
		(0.001)
Polity	-0.095	-0.113
	(0.065)	(0.071)
Capabilities	0.032	0.052
	(0.038)	(0.033)
Time since last war	-0.105*	-0.104*
	(0.007)	(0.007)
Inflation Crisis	0.075	0.080
	(0.119)	(0.120)
ln (Urban Population)	0.631	0.525
	(0.331)	(0.294)
Global Interest Rate	-0.174*	-0.159*
	(0.023)	(0.023)
Rivals	0.036*	0.034*
	(0.011)	(0.012)
Disputes	0.001	-0.001
	(0.003)	(0.004)
Number of Major Powers	0.062*	0.065*
	(0.027)	(0.026)
Mill's Inverse Ratio	-0.042	-0.022
	(0.137)	(0.131)
Constant	-0.302	-0.416*
	(0.201)	(0.179)
Log-Likelihood	-1135.0*	-1136.3*
AIC	2298.0	2300.5
N	6929	6929

$*p < 0.05$; Standard Errors, clustered on country, in parentheses. Heckman selection models; selection equation not shown (see section above). Time splines coefficients are not presented in the table.

E Alternative Selection Specifications (Table 3 in Manuscript)

Table E.13 examines alternative specifications of the main models in Table 3 in the manuscript. Specifically, we examine whether utilizing a two-step selection model versus a maximum-likelihood (ML) approach makes a difference. Model 1 in Table E.13 estimates a ML selection model using Stata's "heckprobit" command. We find similar results as the results in the manuscript. Model 2 examines the robustness of our results to our choice of covariates. Often, Heckman selection models have the same set of covariates in both the selection and outcome stage, except for the instrument. We deviate from this specification given that (1) default rates cannot logically explain selection into the default data sample and (2) we want to include variables in the outcome stage that block other potential confounding factors (not just selection factors). While theoretically justified, if we mistakenly include or exclude the wrong variables from the selection stage, this can lead to inconsistent estimates (Wooldridge 2015). Model 2 restricts the covariates in the outcome stage to be exactly the same of the selection stage, except the instrument and default rates. Again, our main inferences do not change.[1]

Model 3 in Table E.13 replicates model 3 from Table 3 in the manuscript using the ML "heckprobit" command again. Model 4 restricts the covariates to be the same in each stage (again, expect the instrument and default rates). Our results remain consistent.

[1] Including default rates into the selection stage also does not change our results. This result can be replicated using our data and .do files.

Table E.13: ML Heck–probits

	(1)	(2)	(3)	(4)
Outcome Stage				
Default Rate	-0.524***	-0.431***	-0.671***	-0.663***
	(0.14)	(0.15)	(0.17)	(0.16)
Polity	-0.128***	-0.018	-0.092*	-0.110**
	(0.04)	(0.04)	(0.05)	(0.05)
Capabilities	0.096***	0.072	-0.001	-0.007
	(0.03)	(0.05)	(0.04)	(0.04)
Time since last war	-0.103***	-0.107***	-0.104***	-0.102***
	(0.01)	(0.01)	(0.01)	(0.01)
Global Interest Rate		-0.117***	-0.155***	-0.162***
		(0.02)	(0.03)	(0.02)
Inflation Crisis			0.061	0.063
			(0.11)	(0.11)
ln (Urban Population)			0.497*	0.700**
			(0.26)	(0.28)
Rivals			0.038***	0.037***
			(0.01)	(0.01)
Disputes			0.001	0.001
			(0.00)	(0.00)
Number of Major Powers			0.075***	0.087***
			(0.03)	(0.03)
Constant	0.165	0.196	-0.492**	-0.629***
	(0.11)	(0.17)	(0.25)	(0.24)
Selection Stage				
Iron/Steel Prod Per Capita	0.646***		0.793***	
	(0.08)		(0.08)	
Iron/Steel Prod Growth	0.039***		0.043***	
	(0.01)		(0.01)	
ln (Urban Population)	1.410***		1.513***	-1.974***
	(0.12)		(0.13)	(0.23)
Time since last war	0.008***	0.014***	0.009***	-0.014**
	(0.00)	(0.00)	(0.00)	(0.01)
Polity	0.295***	0.386***	0.302***	0.699***
	(0.02)	(0.02)	(0.02)	(0.07)
Global Interest Rate	-0.039***	0.005	-0.046***	0.020
	(0.01)	(0.01)	(0.01)	(0.03)
Regional Default	2.573***	2.322***	2.771***	0.777***
	(0.06)	(0.07)	(0.07)	(0.22)
Capabilities		1.595***		0.196**
		(0.05)		(0.10)
Inflation Crisis				0.351**
				(0.17)
Rivals				0.115***
				(0.04)
Disputes				2.301
				(314.19)
Number of Major Powers				-0.281***
				(0.04)
Constant	-1.486***	5.359***	-1.662***	4.425***
	(0.06)	(0.21)	(0.06)	(0.54)
ρ	-0.468***	-0.110	-0.078	-0.408*
	(0.09)	(0.12)	(0.12)	(0.22)
Log-Likelihood	-7547.7***	-6548.0***	-7105.6***	-1663.1***
AIC	15127.5	13130.0	14255.2	3380.1
N	12372	12503	11880	7093

$*p < 0.05$; Standard Errors, clustered on country, in parentheses. Heckman ML selection models; Time splines coefficients are not presented in the table.

F Alternative GDP Measures (Table 3 in Manuscript)

This section examines the alternative GDP measures. These alternative measures do not change our results, and they provide less data coverage.

Table F.14: Two-Step Selection Probit Model Examining War

	Model 1		Model 2	
	Selection *Stage*	Outcome Stage	Selection Stage	Outcome Stage
Default Rate		-0.399*		-0.582*
		(0.21)		(0.33)
Energy Per Cap	-12.524			
	(10.30)			
Energy Growth	-0.004*			
	(0.00)			
GDP Per Cap (Maddison)			-0.320***	
			(0.10)	
GDP Growth (Maddison)			0.497	
			(0.38)	
Polity	0.223	-0.069	0.418***	-0.160***
	(0.16)	(0.05)	(0.16)	(0.06)
ln (Urban Population)	1.552**		1.738**	
	(0.76)		(0.77)	
Years since War	0.786***		0.912***	
	(0.28)		(0.28)	
Global Interest Rate	-0.057***		-0.017	
	(0.02)		(0.02)	
Regional Default	2.610***		2.913***	
	(0.54)		(0.54)	
Capabilities		0.125***		0.126**
		(0.04)		(0.05)
Time since last war		-0.109***		-0.119***
		(0.01)		(0.01)
Mills		-0.702***		-0.659***
		(0.13)		(0.17)
Constant	-1.218***	0.322**	-1.435***	0.339**
	(0.35)	(0.16)	(0.32)	(0.14)
Log-Likelihood	-5058.1***	-1008.2***	-4192.4***	-830.1***
AIC	10132.3	2032.5	8400.8	1676.3
N	10128	6374	9473	5947

$***p < 0.01; **p < 0.05; *p < 0.1$

Standard Errors clustered on country. Time splines coefficients not reported.

Dependent variable in selection stage is whether state has debt default data.

Dependent variable in outcome stage is external default.

G Pr (Default) and Pr(Default Onset) models

We present the probit models described in the manuscript from which we derive our *Pr(Default)* and *Pr(Default Onset)* measures utilized in Table 3 in the main manuscript.

Table G.15: Probit Model Predicting Default and Default Onset (Table 3)

	Default	Default Onset
	(1)	(2)
Years since Default	-0.167***	
	(0.01)	
Years since Default Onset		-0.022***
		(0.01)
Iron/Steel Prod Per Capita	-0.989*	-1.023**
	(0.52)	(0.48)
Iron/Steel Prod Growth	-0.074**	-0.103***
	(0.03)	(0.04)
Time since last war	0.000	0.000
	(0.00)	(0.00)
ln (Urban Population)	-0.967**	-0.485
	(0.42)	(0.42)
Polity	-0.090	-0.009
	(0.07)	(0.06)
Global Interest Rate	0.128***	0.126***
	(0.03)	(0.02)
Constant	-5.606***	-9.175***
	(1.40)	(1.62)
Log-Likelihood	-1907.7***	-757.6***
AIC	3845.3	1545.1
N	7433	6260

$***p < 0.01; **p < 0.05; *p < 0.1$; Standard Errors, clustered on country, in parentheses.

Regional Effects and time splines coefficients are not presented in the table.

H Selection into Treatment

This section examines an alternative selection problem, states' selection into the treatment (default). While this problem does not affect the composition of the sample, it does threaten statistical assumptions regarding the homogeneity of treatment across observations. In the manuscript, we address this problem by including confounders that we expect affects both default and decisions to enter war. This section explicitly models this selection process, but finds similar results.

Table H.16: Two-Step Selection Probit Model Examining Default

Variable	**Coefficient** (Std. Err.)	
	Selection Stage *DV = Default*	Outcome Stage *DV = War*
Default Rate		-0.617***
		(0.20)
Iron/Steel Prod Per Capita	-1.120**	
	(0.56)	
Iron/Steel Prod Growth	-0.021	
	(0.02)	
Polity	-0.122	0.037
	(0.11)	(0.06)
Inflation Crisis	0.525***	
	(0.11)	
ln (Urban Population)	-0.757	
	(0.72)	
Years since War	0.110	
	(0.11)	
Global Interest Rate	0.040	
	(0.03)	
Regional Default	2.758***	
	(0.38)	
Capabilities		0.121***
		(0.04)
Time since last war		-0.109***
		(0.01)
Mills Ratio		-0.221**
		(0.11)
Constant	-1.449***	0.326
	(0.22)	(0.25)
Years since Default		
Log-Likelihood	-2746.0***	-1160.5***
AIC	5510.1	2337.1
N	6935	6929

$***p < 0.01; **p < 0.05; *p < 0.1$

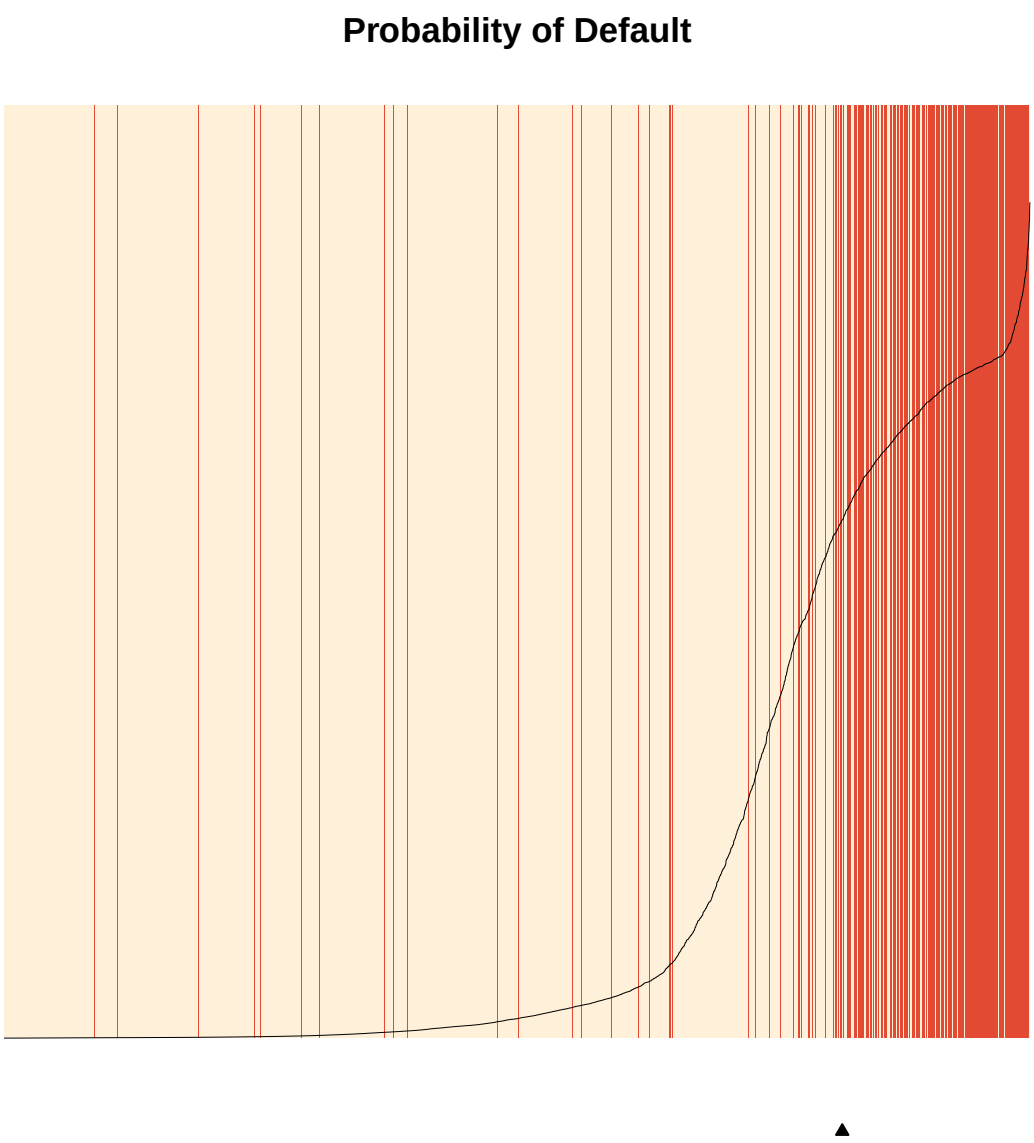
Standard Errors clustered on country.

I Separation Plots

Researchers often evaluate their predicted outcomes in comparison to actual outcomes. However, given that the probability of default is continuous, it is not clear how we should compare these probabilities to the dichotomous actual outcomes. If we dichotomize the probabilities by separating values at the arbitrary value of 0.50, we can calculate the percentage that our binary predicted outcomes correctly predict: 91 percent. While this appears a reasonable high prediction rate, this approach is limited because it treats predicted probabilities of 0.51 and 0.99 as equivalent. As an alternative, we use Greenhill, Ward, and Sacks's (2011) proposed approach, the separation plot. A separation plot is constructed by arranging the predicted probabilities in ascending order (left to right) and then highlighting any actual positive outcome (with red vertical bars) associated with that predicted probability. The model's fit is then evaluated if the actual positive outcomes are concentrated on the right end of the plot (with the higher predicted probabilities) and if the non-positive outcomes (i.e. zeros) are concentrated on the left end of the plot (with the lower predicted probabilities). Note that an inefficient model would produce a plot with actual positive outcomes distributed somewhat equally across the range of predicted probabilities.

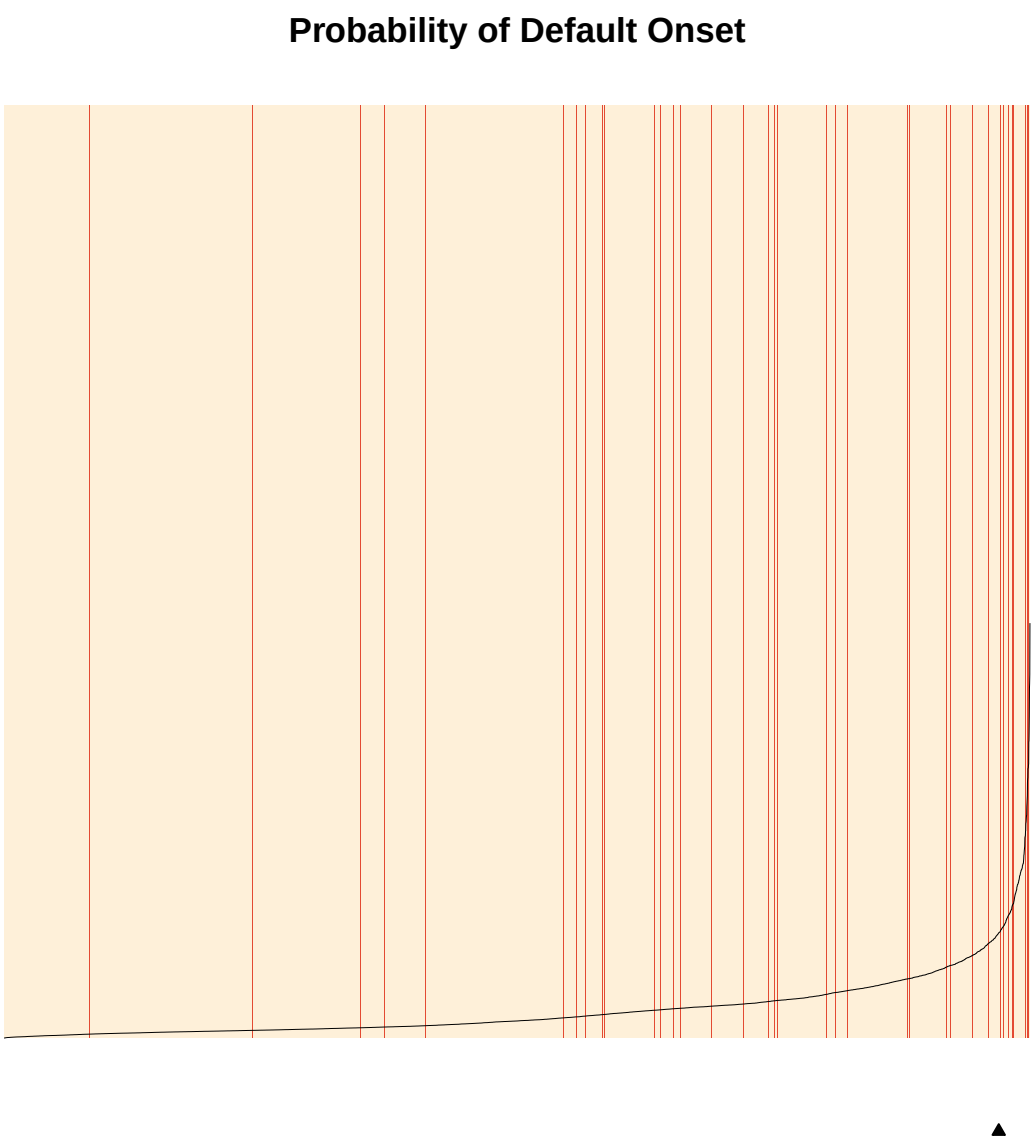
To assess the fit of the model in Table H.16 we graph a separation plot in Figure I.1. Our plot shows that the actual positive outcomes (i.e. states in default) are concentrated at the right end of the graph with the higher predicted probabilities. The separation plot clearly demonstrates that higher values of predicted probabilities of default are associated with actual default events. We repeat this process for our model of predicted default onsets in Figure I.2. Although the incidence of default onset are more widely distributed across the distribution of predicted probabilities, there are still concentrated on the higher end of probabilities.

Figure I.1: Separation Plot of Predicted and Actual Default



Note: The data is sorted by predicted probabilities, generated from model 1 in Table H.16, in ascending order from left to right. The black line represents predicted probabilities of default with the higher the line represents higher predicted probabilities. The red vertical lines represent actual instances of default in the data. The black triangle represents total number of events predicted by the model compared to the actual number of events in the data.

Figure I.2: Separation Plot of Predicted and Default Onset



Note: The data is sorted by predicted probabilities, generated from model 2 in Table H.16, in ascending order from left to right. The black line represents predicted probabilities of default onset with the higher the line represents higher predicted probabilities. The red vertical lines represent actual instances of default onset in the data. The black triangle represents total number of events predicted by the model compared to the actual number of events in the data.

J Sartori Selection Estimator

To test the robustness of the two-stage selection model and the validity our instrument, we re-run the analysis with Sartori's (2003) estimator that does not require the same exclusion restriction as the Heckman model. The results in Table J.17 are consistent with our main inference.

Table J.17: Sartori Selection Estimator Alternative

Variable	**Coefficient** (Std. Err.)	
	Selection Stage	Outcome Stage
Default Rate	1.354**	**-0.428*** **
	(0.60)	**(0.14)**
Polity	-0.592***	0.010
	(0.13)	(0.04)
Capabilities	0.206**	0.106***
	(0.08)	(0.03)
Time since last war	-0.019**	-0.100***
	(0.01)	(0.01)
Constant	3.863***	-0.158
	(0.40)	(0.10)
Log-Likelihood	-1423.8***	
AIC	2875.6	
N	7561	

$***p < 0.01; **p < 0.05; *p < 0.1$

Standard Errors clustered on country.

References

Greenhill, Brian, Michael D. Ward, and Audrey Sacks. 2011. "The Separation Plot: A New Visual Method for Evaluating the Fit of Binary Models." *American Journal of Political Science* 55 (4): 990–1002.

Sartori, Anne. 2003. "An Estimator for Some Binary-Outcome Selection Models without Exclusion Restrictions." *Political Analysis* 11 (2): 111–138.

Wooldridge, Jeffrey M. 2015. *Introductory econometrics: A modern approach*. Nelson Education.