

# Determinants of Civil War: Excess Zeroes

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- Civil War has been a common place, but until recently has escaped notice of most economists.
- Since 1960, nearly 60 percent of countries have been afflicted with civil conflict.
- These wars are not only common and persistent, but is a problem of the poor.
- Incidence of conflict for poorest countries is almost 30%; for the richest, drops to less than 3% (Blattman and Miguel, 2010).
- Researchers, one question has been what causes civil war?
  - Is it greed or grievance?

- Violent conflict commonly been thought to be caused by differences in religion, income, class, ethnicity.
- Following Fearon and Laitin (2003) & Collier and Hoeffler (2004) consensus - Economic factors 'Greed' - predictors of civil war, while contentious issues remain on objective grievance.
- Majority of empirical work use probit or logit model to estimate a zero-one dependent variable.
- Concern in the analysis of civil war incidence.
  - Excess number of peace observations "excess zeroes"

- Existence of excess zeroes - methodological challenges:
  - ① Coding of ordered dependent conflict variable.
  - ② Observable and Latent factors that generate the high proportion of zero observations.
  - ③ Models that don't conform to the process that generated the data (Smith and Tasiran, 2012).
- Lead to model misspecification and biased estimations (Bagozzi et al 2014).

- Zero-inflated model (Split population model) may be more appropriate.
  - Allows one to estimate binary variables that arise from different underlying populations.
- ZI models combines two probability distributions that are presumed to jointly produce the observed data.
- Empirical Investigation
  - Re-estimate Elbadawi and Sambanis (2002)
  - Revisit Greed vs. Grievance debate

# Modelling Conflict (cont.)

- Zeroes reflect different states
  - Complete Peace
  - In-complete Peace
  - In-complete War
- Model different populations using split-population model (Harris and Zhao, 2007) (Vance and Ritter, 2014) - Zero-inflated Poisson (ZIP).
- Estimation follows two stages
  - 1 Probit selection equation
  - 2 Poisson equation
- Observations are split into two processes, each having different sets of explanatory variables.

# Modelling Conflict (cont.)

- Split between process 0 ( $w_i = 0$ ) and process 1 ( $w_i = 1$ ).
  - Zeroes in process 0: zero observations (inflated) - never conflict
  - Zeroes in process 1: probability of transition to conflict is not zero
- $w_i$  relates to  $w_i^*$  such that  $w_i = 1$  for  $w_i^* > 0$  and  $w_i = 0$  for  $w_i^* \leq 0$
- The latent variable  $w_i^*$  represents the propensity to enter process 1 and is given by the split-probit (1st stage) equation:

$$w_i^* = x_i\gamma + \mu_i \quad (1)$$

- $x_i$  is vector of covariates,  $\gamma$  is vector of coefficients and  $\mu_i$  is the error term.



# Modelling Conflict (cont.)

- The outcome equation of the ZIP, developed from a Poisson equation is defined as:

$$\Pr(Y_i = y_i) = \begin{cases} p_i + (1 - p_i)e^{(-\lambda_i)} & , y_i = 0 \\ (1 - p_i)e^{(-\lambda_i)} \frac{\lambda_i^{y_i}}{y_i!} & , y_i > 0 \end{cases} \quad (2)$$

- see Lambert (1992)
- Probability of a zero observation in (2) is modelled conditional on:
  - 1 Probability of it being assigned a value of 0 in the Poisson process
  - 2 The probability of it being in process 0 from (1) or the splitting equation

## Re-estimate Elbadawi and Sambanis (2002)

- Elbadawi and Sambanis (2002) predict civil war prevalence based on opportunities for rebellion against its constraints.
- Opportunities are divided into greed vs. grievance (rebellions that generate profit vs. rebellions triggered by grievance).
- Probit model - 150 countries, 1960-1999
- Find civil war prevalence to be consistent with earlier studies on war onset and duration.
  - Greed matters, grievance does not.
- Given possible heterogeneous zeroes - ZIP may be more appropriate.

# Elbadawi and Sambanis Revisited

Variable	(1)	(2)		(3)	(4)	
	Probit	ZIP	Inflation	Probit	ZIP	Inflation
	Outcome	Outcome		Outcome	Outcome	
Pri Exports/GDP	10.53*	9.488*	-2.276	10.57**	10.14**	
	(4.136)	(4.341)	(5.061)	(3.835)	(0.020)	
Pri Exports/GDP <sup>2</sup>	-21.24*	-23.41*		-20.79*	-22.68*	
	(9.325)	(11.31)		(8.646)	(8.966)	
Log RGDP	-0.003**	-0.004**	0.002*	-0.002*	-0.002*	0.001*
	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)	(0.000)
ΔRGDPPC	-0.090**	-0.122**		-0.072**	-1.054**	
	(0.029)	(0.034)		(0.027)	(0.021)	
Polity Index (1lag)	-0.012	0.014		-0.011	0.034*	0.296*
	(0.020)	(0.018)		(0.018)	(0.059)	(0.044)
Polity Index <sup>2</sup> (1lag)	-0.003	0.004		0.003	-0.009*	
	(0.004)	(0.004)		(0.004)	(0.003)	
Ethno Diversity	0.039	0.066**	-0.231**			
	(0.026)	(0.018)	(0.076)			
Ethno Diversity <sup>2</sup>	0.004	-0.001**	0.002**			
	(0.003)	(0.000)	(0.001)			
Ethnic Dom.				0.362	0.389*	
				(0.291)	(0.177)	
War in Past 10 Years				0.735**	1.442**	
				(0.214)	(0.235)	

Notes: Standard Errors in Parentheses, \*\*  $p < 0.01$ , \*  $p < 0.05$ , †  $p < 0.1$

## Revisit Greed vs. Grievance debate

- Strong case for ZI model over standard probit or logit.
- Move onto estimating a more general greed-grievance model based on Collier and Hoeffler (2004) and Fearon and Laitin (2003).
- 134 countries, 1960-2013.
- Data Sources: WB, Penn World Tables 8.0, WTO and various author databases.

# Empirical Investigation (cont.)

- Opportunity variables
  - Income
  - Natural resource dependence
  - Mountainous Terrain
- Grievance variables
  - Ethnic and religious hatred
  - Political repression
  - Income inequality
- Control variables
  - Population
  - Cold war dummy

# Greed and Grievance Revisited

Variable	(1)	(2)		(3)	
	Probit	ZIP	ZIP	ZIP	ZIP
	Outcome	Outcome	Inflation	Outcome	Inflation
Pri Exports/GDP	-4.145* (1.107)	-2.842** (0.819)	10.377** (2.231)	-5.243** (0.747)	
Pri Exports/GDP <sup>2</sup>	6.593** (1.571)	3.177* (1.257)	-19.618** (3.420)	7.324** (1.240)	
Log RGDP	-0.129* (0.063)	-0.962** (0.038)	1.129** (0.110)	-0.988** (0.032)	2.551** (0.386)
$\Delta$ RGDPPC	-2.396** (0.506)	-2.242** (0.473)	2.392* (1.059)	-2.697** (0.432)	9.793 <sup>†</sup> (5.412)
Log % Mountainous Terrain	0.020 (0.094)	0.060 <sup>†</sup> (0.025)	0.077 (0.072)	0.057* (0.025)	
Polity Index	0.004 (0.007)	0.051* (0.026)	-0.270** (0.074)	0.017** (0.006)	-0.534* (0.218)
Polity Index <sup>2</sup>	-0.010** (0.001)	-0.013** (0.004)	0.003 (0.008)	-0.009** (0.001)	0.070* (0.029)
Ethno Fractionalisation (CH)	0.032 (0.024)	0.014 <sup>†</sup> (0.008)	-0.084** (0.014)	0.011 <sup>†</sup> (0.006)	-0.043** (0.005)
Ethno Fractionalisation <sup>2</sup> (CH)	-0.001 (0.001)	-0.001 <sup>†</sup> (0.000)	0.003** (0.001)	-0.001** (0.000)	
Ethnic Dominance	0.326 (0.414)	0.357** (0.111)	-0.123 (0.233)	0.298** (0.098)	-0.255 (0.283)
Religious Fractionalisation	-0.272 (0.682)	1.085** (0.239)	-3.393 (2.183)	-0.193 (0.171)	

Notes: Standard Errors in Parentheses, \*\*  $p < 0.01$ , \*  $p < 0.05$ , <sup>†</sup>  $p < 0.1$

# Greed and Grievance Revisited - Income Inequality

Variable	(1)	(2)	
	Probit	Outcome	Inflation
Pri Exports/GDP	-4.335** (1.100)	-3.783** (0.854)	
Pri Exports/GDP <sup>2</sup>	6.581** (1.569)	4.045** (1.453)	
Log RGDP	-0.180* (0.073)	-1.002** (0.032)	1.115** (0.208)
ΔRGDPPC	-2.537** (0.507)	-2.039** (0.543)	2.035* (1.037)
Log % Mountainous Terrain	0.013 (0.093)	0.096* (0.028)	
Polity Index	0.004 (0.007)	0.045** (0.007)	-0.098* (0.051)
Polity Index <sup>2</sup>	-0.010** (0.001)	-0.012** (0.001)	0.023* (0.006)
Ethno Fractionalisation (CH)	0.040† (0.022)	0.026** (0.005)	-0.013 (0.085)
Ethno Fractionalisation <sup>2</sup> (CH)	-0.001 (0.001)	-0.001** (0.000)	
Largest Discriminated Ethnic Group	0.821** (0.220)	1.161** (0.173)	-19.76** (3.415)
Positive Horizontal Inequality	-0.137 (0.150)	-0.012 (0.070)	1.346** (0.383)
Negative Horizontal Inequality	0.561** (0.245)	0.088* (0.045)	-0.969** (0.268)

Notes: Standard Errors in Parentheses, \*\* p<0.01, \* p<0.05, † p<0.1

# Empirical Investigation (cont.)

- Robustness of the results were considered.
- Other specification variants include:
  - replacing primary commodity exports with proxies mineral dependence, oil production and oil export
  - replacing Polity IV with freedom house index
  - replacing GDP measures with life expectancy and urbanisation rate
  - add Africa dummy
- Results are relatively robust.
- ZI models preferred to Probit.
  - Vuong Test, AIC, Lower Standard Errors, Higher Log-likelihood



# Empirical Investigation - Result Summary

- Results are two-fold:
  - ① Civil war can be explained by both Greed and Grievance.
  - ② ZI models out performs probit and logit and is able to account for different types of zeroes.
    - Inflation equation: different types of peace observations and probability of peace.
    - Outcome equation: more accurate estimates than probits or logits.
- ZI models gives greed and grievance variables equal emphasis.
  - Previous estimates biased - more weight on opportunity variables
  - Probit and logit gave likelihood of war calculations that included countries conditioned to not experience civil war.
  - High income countries in "always zero"
  - Income variables crowded out grievance variables.

# Conclusion

- Highlights the possible impact of using a standard probit models when the dependent variable has excess zeroes.
  - Zeroes are not homogenous
- More satisfactory approach - ZI models
- Data Replication of Elbadawi and Sambanis (2002) showed differing results:
  - Grievance terms became significant
- Revisit greed-grievance gave further support for the need to recognise problem of excess zeroes.
  - Grievance (polity and inequality) terms became significant
  - Lower standard errors
- Implications:
  - A need to recognise heterogeneity in the excess zeroes.
  - If these models used earlier, the trajectory of the greed-grievance debate might be very different.

*Thank You!*

Comments and Suggestions