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Income and Armed Civil Conflict: An Instrumental Variables Approach

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Abstract:

The large empirical conflict literature has established that there is a strong negative link between economic variables and the onset of an armed civil conflict. However, it has been difficult to demonstrate a clear causality between poor economic performance and increased risk of conflict because of potential endogeneity issues, especially for large country samples. Most existing studies that analyse the causal links focus on the effects of economic growth on conflict, even though conventional conflict studies find the strongest relationship for income levels. In this article, we use three new exogenous instruments for income per capita, based on historical data for mailing times, telegram charges and urbanization rates. Using instrumental variables methods and global panel data for the period 1946–2014, we show that the negative effect of income per capita on the probability of conflict onset is consistently strong and larger than in conventional estimations using pooled ordinary least square regressions.

Keywords: civil conflict, income, panel data, IV estimation

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1 Introduction

Economic variables have long been established in the empirical conflict literature as the most robust predictors of armed civil conflict (see e.g. Collier & Hoeffler 2002; 2004; Fearon & Laitin, 2003; Hegre & Sambanis, 2006). However, although the link between economic variables and armed civil conflict seems strong, the causality is uncertain due to endogeneity issues, mainly arising from reverse causality and omitted variable bias. Several recent articles use 2SLS estimations, either with weather-based instruments (e.g. Bohlken & Sergenti, 2010; Bergholt & Lujala, 2012; Hodler & Raschky, 2014; Sarsons, 2015), or with commodity-price-based instruments (Bazzi & Blattman, 2014; Berman et al., 2017; Brückner & Ciccone, 2010), and analyze the effects of economic shocks on the likelihood of armed civil conflict, often with regional country-samples.¹

This article contributes to this strand of literature by employing three new exogenous instruments for income per capita that can be used for a global sample of countries in armed conflict studies. Our instruments are based on historical data from the early 20th century on mailing times, telegram charges, and urbanization rates. They have several advantages over those used in other studies. First, they instrument income *levels*, while the vast majority of the existing papers that use two-stage least squares (2SLS) to explicitly model the intervening economic variable focus on income *growth*. The distinction is crucial since income *levels* have proven to be the more robust explanatory variable of the two in the conventional conflict literature (see e.g. Fearon & Laitin, 2003; Hegre & Sambanis, 2006). Second, our instruments are available for up to 179 countries, giving our results excellent external validity and allowing us to draw conclusions on global average causal effects. Finally, our instruments do not rely on climate-based or commodity-price data like most of the current instruments for economic conditions, but instead use new sources of exogenous variation.

Using our three instruments in pooled 2SLS estimations, we confirm the importance of income levels for explaining the onset of armed civil conflict, and find that the magnitude of the effect is substantially larger than in conventional pooled ordinary least squares (OLS) estimations.

2 Methodology and data description

We follow the literature and explain the onset of armed conflict in year t in country i with income per capita levels and a vector of other covariates X according to:

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$$\text{conflict}_{it} = a + \alpha_1 \cdot \text{incomepc}_{it} + \alpha_2 \cdot X_{it} + \epsilon_{it}, \quad (1)$$

where a is the constant term and ϵ the error term. Conflict is a zero-one dummy taken from the UCDP/PRIO Armed Conflict Database v.4-2014a (Gleditsch et al., 2002; Pettersson & Wallensteen, 2015). It indicates the onset of a new armed civil conflict with over 25 battle related deaths or reactivation of a conflict after more than 2 years since the last observed fighting. Information for (ln) income per capita and (ln) population size comes from the Maddison dataset (Bolt & van Zanden, 2013).² Other covariates include a polity measure and its square from the Polity IV dataset p4v2015 (Marshall, Gurr & Jaggers, 2013); ethnic polarization (Montalvo & Reynal-Querol, 2005); mountainousness (Fearon & Laitin, 2003); (ln) oil reserves (Cotet & Tsui, 2013); the time in years since a country's independence or since 1945; a dummy for the post-Cold War period; a dummy equal to unity if a country was a colony in 1903 (own coding); and a dummy variable for historical conflict between 1816 and 1910 (own coding based on the Correlates of War dataset). The last two dummy variables are included in tests of instrument exogeneity, explained in more detail below. Note that we lag all time-varying covariates except the post Cold War dummy by 1 year.

To take into account the likely endogeneity of income per capita, we follow Miguel, Satyanath, and Sergenti (2004) and choose linear, pooled two-stage least squares (2SLS) as our approach³ for the following first-stage estimation:

$$\text{incomepc}_{it} = c + \beta_1 \cdot I_i + \beta_2 \cdot X_{it} + \epsilon_{it}. \quad (2)$$

We have a total of three different exogenous instruments I , which allows us to achieve a strong first-stage identification and to test for overidentifying restrictions.⁴ Our dataset covers the period 1946–2010 and includes up to 9253 country-year observations and 179 countries. Summary statistics are provided in Table 1.

Table 1: Descriptive statistics.

Variable	Obs	Mean	SD	Min	Max
Conflict onset	9253	0.034	0.181	0	1
ln Income p.c.	7861	7.969	1.083	5.315	10.667
ln Population	8545	9.02	1.57	4.824	14.107
Polity	9155	10.608	7.460	0	20
ln Oil reserves	5738	-4.579	5.274	-9.210	5.596
Mountainousness	8888	18.288	21.665	0	94
Ethnic polarization	7474	0.5191	0.242	0.017	0.982
Years since independence	9253	29.683	18.63	1	69
Colony	9253	0.397	0.489	0	1
Conflict 1816–1910	9250	0.541	0.498	0	1
Telegram	9253	38.137	33.373	0.5	171
Mailingspeed	9253	348.819	155.060	75.702	1000
Urbanization 1920	9253	12.690	14.065	0	90

For easier interpretation, *Telegram* and *Mailingspeed* are not reported in natural logs.

Exogenous instruments. Our first instrument is based on mailing times in 1903 from either London or Washington, D.C. – whichever is faster – to the rest of the world. The two cities were chosen as they were the capitals of the world's most powerful economy at the time and of the world's soon-to-be most powerful economy, respectively. We used data on mailing times and distances for regular correspondence from Post Office Department (1903) and Post Office (1903),⁵ supplemented by own calculations for missing cases. The "mailing speeds" are calculated as miles covered per "mailing day". We then took the natural logarithm to construct our final measure, *Mailingspeed*. Mailing times are positively linked to economic development: not only did it take longer for correspondence to reach the more remote parts of the world; but at equal distances, letters reached a more developed and better-connected country before its "backwater" counterpart.

The second instrument is international *Telegram* charges from Britain in (ln) pence in 1903, from Post Office (1903) and again supplemented by own calculations for missing cases. Telegram pricing principles were similar across the globe: they depended on distance and the number of words in the message, and also included labor costs right down to final delivery. A stated charge would apply to the first ten words together, and then to each single additional word (Downey, 2002; Ross, 1928). The resulting pattern meant that it cost less to send a telegram from London to Australia than to the West African coast, for example, so that telegram charges should be negatively related to income levels.

Our third and final instrument is the *Urbanization* rate (for towns 20,000 or larger) in 1920, taken mainly from UN (1969) and supplemented by information from McEvedy and Jones (1978), the *Statesman's Yearbook* (1922) and Bairoch (1988). Historical urbanization is strongly linked to the level of economic development at the time. We expect that higher urbanization rates in 1920 are related to higher income per capita in more recent decades. Urbanization from a century ago is unlikely to affect conflict after WWII directly. Also, post-war urbanization patterns particularly in the developing world differed significantly from those seen earlier in the century (Bairoch, 1988). So while cities may often be the epicenters of social unrest today, urbanization rates no longer have the strong positive link with economic development that they used to have.

All three of our instruments could conceivably be correlated with colonial status: colonies might on average be more prone to conflict after WWII as well as more developed, which would weaken our exclusion restriction. Similarly, historical conflict could be correlated both with development level and more recent conflict probability. In our instrument validity checks, we therefore add dummies for colonial status (i.e. whether a country was a colony in 1903, at the time the telegram charges and mailing speeds were measured) and for the occurrence of an armed conflict in the present-day country in the period between 1816 and 1910.

In the reduced-form estimations in Table 2, we use variables from a parsimonious baseline specification including (ln) population and the dummy for a conflict in the previous year. Each instrument has the right sign and is highly significant when introduced on its own (columns 1–3). The instruments are not all individually significant when added together (column 4), but they are jointly highly significant (the null of joint insignificance is rejected at the 1% level).⁶ Population and lagged conflict have the expected signs, though only population is significant. This first check supports the validity of our instruments. We also provide results of several statistical tests of instrument strength with the 2SLS estimation results below, and show some sensitivity checks.

Table 2: Reduced-form estimations.

	(1)	(2)	(3)	(4)
Mailingspeed	−0.0176*** (−3.160)			−0.0056 (−0.872)
Telegram		0.0077*** (4.180)		0.0028 (1.245)
Urbanization			−0.0009*** (−4.620)	−0.0008*** (−3.686)
Conflict _{t−1}	0.0228 (1.490)	0.0216 (1.446)	0.0178 (1.222)	0.0171 (1.163)
Population _{t−1}	0.0115*** (3.652)	0.0108*** (3.457)	0.0114*** (3.670)	0.0120*** (3.850)
Observations	8535	8535	8535	8535
Countries	171	171	171	171
R ²	0.014	0.015	0.017	0.018

The dependent variable is onset of an armed civil conflict. All specifications include a constant term (not shown). S.e. are clustered at the country level. Robust t-statistics in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

3 Results

Table 3 first shows results using pooled Probit and OLS to confirm the standard finding of a highly significant negative coefficient for income per capita (columns 1–3). The remaining columns show the results of 2SLS estimations, initially using only one instrument at a time (columns 4–6), and finally using all three instruments together (columns 7–8). Income per capita is negative and highly significant across all specifications. The increase in the magnitude of the per capita coefficients in 2SLS estimations suggests that the upward bias in OLS estimations due to reverse causality is much smaller than the probable downward bias caused by omitted variables. The other explanatory variables are in line with the existing literature on armed civil conflicts.

Table 3: Income and armed civil conflict onset.

	(1) Probit	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS	(7) 2SLS	(8) 2SLS
Income p.c. _{t-1}	-0.23*** (-6.58)	-0.015*** (-6.02)	-0.024*** (-3.77)	-0.018*** (-3.39)	-0.020*** (-4.53)	-0.021*** (-6.14)	-0.020*** (-6.15)	-0.032*** (-3.17)
Population _{t-1}	0.14*** (4.40)	0.011*** (3.26)	0.0069 (1.46)	0.011*** (3.34)	0.011*** (3.33)	0.011*** (3.35)	0.011*** (3.35)	0.0055 (1.33)
Conflict _{t-1}	0.12 (0.96)	0.014 (1.00)	-0.0056 (-0.38)	0.013 (0.82)	0.011 (0.77)	0.010 (0.72)	0.011 (0.75)	-0.0095 (-0.67)
Polity _{t-1}			0.0043** (2.01)					0.0034 (1.45)
Polity ² _{t-1}			-0.0002 (-1.50)					-0.0001 (-0.77)
Mountainousness			-0.0002 (-1.35)					-0.00023 (-1.37)
Ethnic polarization			-0.0023 (-0.16)					-0.0050 (-0.33)
Oil reserves _{t-1}			0.0033*** (3.84)					0.0041*** (3.64)
Post Cold War			-0.012 (-1.41)					-0.014* (-1.68)
Years since independence			0.0005* (1.96)					0.0007** (2.25)
Observations	7817	7817	4481	7817	7817	7817	7817	4481
Countries	161	161	94	161	161	161	161	94
R ²		0.019	0.025					
First-stage results								
Telegram					-9.65		-3.04	-1.71
Mailspeed				7.30			2.96	3.91
Urbanization						7.29	6.18	8.58
F-statistic				53.3	93.2	53.2	43.2	30.7
Partial R ²				0.18	0.25	0.36	0.44	0.40
Hansen J p-value							0.75	0.72

The dependent variable is onset of an armed civil conflict. Column (1) shows pooled probit estimations; columns (2)–(3) pooled OLS; columns (4)–(8) pooled 2SLS. All specifications include a constant term (not shown). First stage information includes exogenous instruments' t-statistics, partial R-squareds, excluded instruments' F-statistics, and Hansen J statistic p-value. S.e. are clustered at the country level. Robust t-statistics in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Instrument validity. Looking at the first-stage information in the lower section of Table 3, all instruments have the expected sign and are highly significant both on their own (columns 4–6) and together (columns 7–8). Test statistics further confirm instrument strength and validity; tests based on Kleibergen-Paap rk Wald F statistics (not shown) also reject that we have weak instruments.

As an illustration of the explanatory power of our instruments, Figure 1 depicts scatterplots for the first-stage regression fits of income per capita on our exogenous instruments, based on specifications (4)–(6) in Table 3. The plots illustrate the good performance of our instruments, though plot (c) shows that Singapore (top-right) is a clear outlier in urbanization rates. Plot (d) accordingly shows the same regression specification without Singapore, giving qualitatively unaltered results.

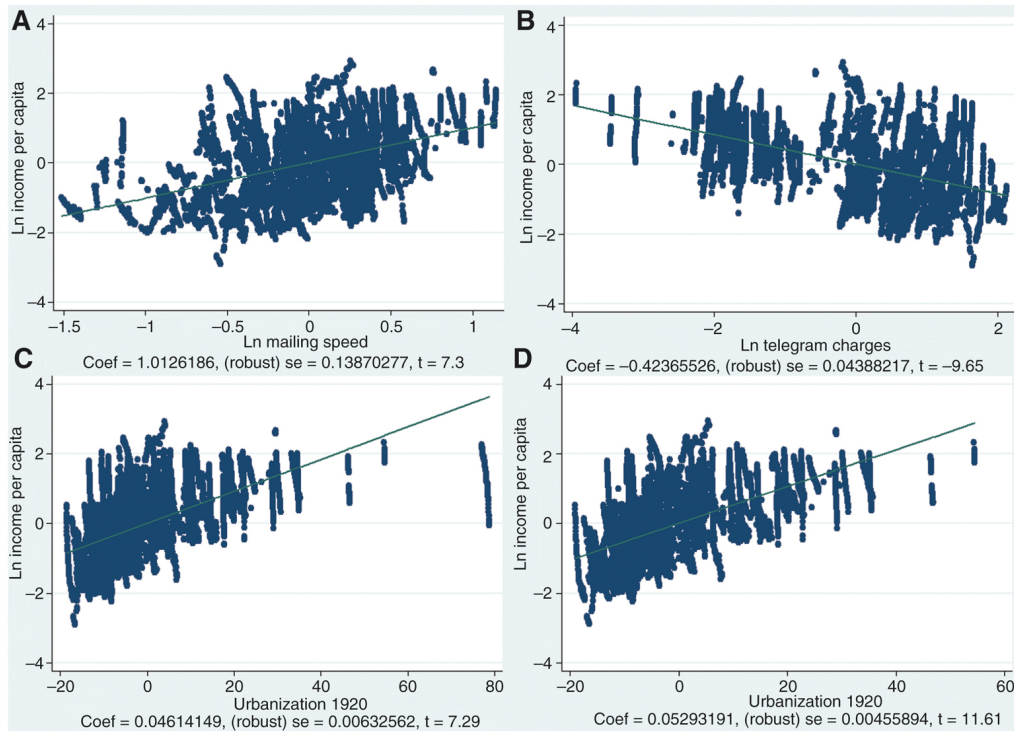


Figure 1: Scatter plots of first-stage results for exogenous instruments. Plots (A)–(C) correspond to specifications (4)–(6) in Table 2. Plot (D) corresponds to specification (6) in Table 2 without Singapore. Lines show regression fits.

As a further test of the validity of our exogenous instruments, in Table 4 we add them in pairs (columns 1–3), which does not alter results and confirms IV strength. In column (4), we add a dummy for colonial status in 1903 and for historical conflict. The results clearly show that our instruments remain strong; that the main result for income per capita is not affected; and that neither former colonies nor countries that saw conflict further back in time were more likely to have an armed conflict onset after WWII.

Table 4: IV sensitivity analysis.

	(1)	(2)	(3)	(4)
Income p.c. _{t-1}	-0.019*** (-4.75)	-0.021*** (-6.06)	-0.021*** (-6.19)	-0.019*** (-4.32)
Population _{t-1}	0.011*** (3.34)	0.011*** (3.35)	0.011*** (3.35)	0.011*** (2.96)
Conflict _{t-1}	0.012 (0.79)	0.011 (0.74)	0.011 (0.75)	0.010 (0.74)
Colony				0.0049 (0.50)
Conflict 1816–1910				0.0053 (0.95)
Observations	7817	7817	7817	7817
Countries	161	161	161	161
First-stage results				
Telegram	-5.79	-4.56		-3.09
Mailingspeed	3.38		4.65	2.09
Urbanization		6.33	6.63	7.82

F-statistic	56.8	61.8	47.8	32.6
Partial R^2	0.29	0.42	0.41	0.33
Hansen J p-value	0.66	0.64	0.47	0.85

The dependent variable is onset of an armed civil conflict. All estimations are pooled 2SLS. All specifications include a constant term (not shown). First stage information includes exogenous instruments' t-statistics, partial R-squareds, excluded instruments' F-statistics, and Hansen J statistic p-value. S.e. are clustered at the country level. Robust t-statistics in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

4 Conclusion

We introduce three new instruments for income per capita and use these to test the relationship between income levels and the likelihood of armed civil conflict. We confirm that lower income levels increase the risk of conflict onset, and show that the effect is larger than with OLS.

Notes

¹ See the recent survey by Couttenier and Soubeyran (2015).

² We also used only the Penn World Tables (PWT 8.0, Feenstra, Inklaar & Timmer, 2013) for the economic and population variables. The sample loses three countries and over 1000 observations, but the results are remarkably similar (not shown).

³ We do not use country fixed effects. See Beck and Katz (2001) for a theoretical argument against fixed effects in this context. A recent example in the conflict literature that does not use country fixed effects is given by Esteban, Mayoral, and Ray (2012).

⁴ Detailed descriptions of the instruments will be made available by the authors in an online codebook.

⁵ We are grateful to Jenny Lynch from the US Postal Service and to staff at The Royal Mail Archive for their help.

⁶ Angrist and Pischke (2009) discuss the importance of joint over individual significance in reduced-form estimations when there are several exogenous instruments.

References

- Angrist, J. & Pischke, J.-S. (2009). *Mostly harmless econometrics: An empiricist's companion*. Princeton, NJ: Princeton University Press.
- Bairoch, P. (1988). *Cities and economic development: From the dawn of history to the present*. Chicago, IL: University of Chicago Press.
- Bazzi, S. & Blattman, C. (2014). Economic shocks and conflict: Evidence from commodity prices. *American Economic Journal: Macroeconomics*, 6, 1–38.
- Beck, N. & Katz, J. N. (2001). Throwing out the baby with the bath water: A comment on Green, Kim, and Yoon. *International Organization*, 55(2), 487–495.
- Bergholt, D. & Lujala, P. (2012). Climate-related natural disasters, economic growth, and armed civil conflict. *Journal of Peace Research*, 49(1), 147–162.
- Berman, N., Couttenier, M., Rohner, D. & Thoenig, M. (2017). This mine is mine! How minerals fuel conflicts in Africa. *American Economic Review*, 107(6), 1564–1610.
- Bohlken, A. & Sergenti, T. (2010). Economic growth and ethnic violence: An empirical investigation of Hindu–Muslim riots in India. *Journal of Peace Research*, 47(5), 589–600.
- Bolt, J. & van Zanden, L. (2013). *The first update of the Maddison Project; re-estimating growth before 1820*. Accessed September 19, 2013 Maddison Project Working Paper 4. Available at <http://www.ggd.net/maddison/maddison-project/publications/wp4.pdf>.
- Brückner, M. & Ciccone, A. (2010). International commodity prices, growth and the outbreak of civil war in sub-saharan Africa. *Economic Journal*, 120, 519–534.
- Brunnschweiler, C. N. & Lujala, P. (2015). *Economic backwardness and social tension* UEA Applied and Financial Economics Working Papers Series n.72.
- Collier, P. & Hoeffler, A. (2002). On the incidence of civil war in Africa. *Journal of Conflict Resolution*, 46, 13–28.
- Collier, P. & Hoeffler, A. (2004). Greed and grievance in civil war. *Oxford Economic Papers*, 56, 563–595.
- Cotet, A. M. & Tsui, K. (2013). Oil and conflict: What does the cross country evidence really show? *American Economic Journal: Macroeconomics*, 5(1), 49–80.
- Couttenier, M. & Soubeyran, R. (2015). A survey of the causes of civil conflicts: Natural factors and economic conditions. *Revue d'Economie Politique*, 125(6), 787–810.
- Djankov, S. & Reynal-Querol, M. (2010). Poverty and civil war: Revisiting the evidence. *The Review of Economics and Statistics*, 92(4), 1035–1041.
- Downey, G. J. (2002). *Telegraph Messenger boys: Labor, communication and technology, 1850–1950*. London: Routledge.
- Esteban, J., Mayoral, L. & Ray, D. (2012). Ethnicity and conflict: An empirical study. *American Economic Review*, 102(4), 1310–1342.
- Fearon, J. D. & Laitin, D. D. (2003). Ethnicity, insurgency, and civil war. *American Political Science Review*, 97(1), 75–90.
- Feenstra, R. C., Inklaar, R. & Timmer, M. P. (2013). The next generation of the Penn World Table. Available for download at www.ggd.net/pwt.

- Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M. & Strand, H. (2002). Armed conflict 1946–2001: A new dataset. *Journal of Peace Research*, 39(5), 615–637.
- Hegre, H. & Sambanis, N. (2006). Sensitivity analysis of the empirical literature on civil war onset. *Journal of Conflict Resolution*, 50(4), 508–535.
- Hodler, R. & Raschky, P. A. (2014). Economic shocks and civil conflict at the regional level. *Economics Letters*, 124, 530–533.
- Marshall, M. G., Gurr, T. R. & Jagers, K. (2013). *Polity IV project: Dataset users' manual*. Center for Systemic Peace. Accessed September 19, 2013 <http://www.systemicpeace.org/inscrdata.html>.
- McEvedy, C. & Jones, R. (1978). *Atlas of world population history*. London: Allen Lane.
- Miguel, E., Satyanath, S. & Sergenti, E. (2004). Economic shocks and civil conflict: An instrumental variables approach. *Journal of Political Economy*, 112(4), 725–753.
- Montalvo, J. G. & Reynal-Querol, M. (2005). Ethnic polarization, potential conflict, and civil wars. *American Economic Review*, 95(3), 796–816.
- Petterson, T. & Wallensteen, P. (2015). Armed conflict, 1946–2014. *Journal of Peace Research*, 52(4), 536–550.
- Post Office. (1903). *Post Office Guide n.187*. London: Post Office (Guidance & Services).
- Post Office Department. (1903). *United States Official Postal Guide, January 1903*. Philadelphia: United States of America Post Office Department.
- Ross, N. E. (1928). *How to write telegrams properly, Little Blue Book n. 459*. Girard (USA): Haldeman-Julius Publications.
- Sarsons, H. (2015). Rainfall and conflict: A cautionary tale. *Journal of Development Economics*, 115, 62–72.
- Statesman's Yearbook. (1922). *Statistical and historical annual of the states of the world for the year 1922*. London: Macmillan.
- UN. (1969). *Growth of the world's urban and rural population, 1920–2000. Department of Economic and Social Affairs, Population Studies n.44*. New York, NY: United Nations.