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Weaponomics
The Economics of Small Arms

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Abstract

The small arms market has received considerable attention since the end of the Cold War. Small arms may be viewed as the specific capital of rebel groups yet no statistical analysis of this market for weapons has yet taken place due to the absence of data. This paper introduces the first effort to quantitatively document the small arms market by collating field reports and journalist accounts to produce a cross-country time-series price index of Kalashnikov assault rifles. The new data is used to quantitatively investigate the nature of the small arms market. A simultaneous equations demand and supply model of the small arms market is developed and empirically estimated to identify the key determinants of assault rifle prices. Variables which proxy the effective height of trade barriers for illicit trade, both within and between countries are consistently significant in weapon price determination. Neighbours' average military expenditure is also a robust predictor of cheap weapon prices. When controlling for other factors, the collapse of the Soviet Union does not have as large an impact on weapon prices as is generally believed.

1. Introduction

Small arms are estimated to be responsible for between 200,000 - 500,000 deaths each year, approximately half of which occur during civil conflict (SAS (2005) and Kopel, Gallant and Eisen (2004)). As economic commodities, weapons respond to forces of demand and supply and are actively traded on legal and illicit markets. In order to make sense of the small arms market it is necessary to view the market as a function of the incentives and constraints faced by buyers, suppliers and regulators. This paper introduces the first round of cross-country, time-series data on weapon prices thus making it possible to quantitatively examine the nature of the small arms market.

Small Arms

> Small arms are attractive tools of violence for several reasons. They are widely available, low in cost, extremely lethal, simple to use, durable, highly portable, easily concealed, and possess legitimate military, police, and civilian uses. As a result they are present in virtually every society.
>
> – Boutwell and Klare (1999)

Despite being a key component in conflict, small arms have only recently begun to receive academic attention. So far research has been almost exclusively case-study driven making it difficult to draw general empirical lessons. Book length treatments of small arms which follow this trend include Boutwell and Klare (1999) and Lumpe, ed (2002).

Brauer (2007) surveys the small arms literature in the forthcoming Handbook of Defense Economics and concludes that the small arms market has not been well examined theoretically, or empirically. The first tentative steps towards generalisable models of the small arms market are currently underway. Brauer and Muggah (2006) develop a conceptual theory of small arms demand as a function of means and motivation, an adaptation of the standard determinants (income, prices and preferences) of neoclassical consumer demand theory (Varian 1992).

On the supply side, Marsh (2006) develops a conceptual model for the illicit acquisition of small arms by rebel groups. Among other hypotheses, Marsh's model predicts that the more liquid is the arms supply in a particular country, i.e. the more easily individual combatants can obtain weapons through independent suppliers, the more difficult it will be to mount and maintain a co-ordinated insurgency.

Bringing Small Arms to Civil Conflict Research

Civil conflict is the most common and, since 1945, the most lethal form of warfare. Collier and Hoeffler (2004) theorise that a factor increasing the opportunity for rebellion arises when conflict-specific capital (such as military equipment) is atypically cheap. The authors proxy the cost of conflict-specific capital by the time since the most recent conflict, reasoning that a legacy of weapon stocks and war skills remain in the country after conflict but depreciate over time. Clearly, a more refined measure of the cost of conflict-specific capital would be desirable if it were available.

Since civil conflict is the most common form of warfare, and the majority of battle deaths are inflicted with small arms, there would seem to be a factor in the quantitative analysis of civil war that has been overlooked.[1] As necessary inputs for conventional insurgency, one would expect the availability of weapons to be an important component of a rebel's conflict calculation.

There are a number of reasons why small arms have been all but ignored in quantitative analysis of civil war. The historic state-centric bias of defense economics led to an almost exclusive focus on inter-state military strategy. In relation to weapons, research has principally been concerned with the development and acquisition of large-scale military technology, such as nuclear weapons.[2] Perhaps the most important reason for the dearth of attention given to the role of weapons in civil war is that usable data has, until now, been unavailable. The policy research community, led by the Small Arms Survey (SAS), the UN's Small Arms and Demobilisation Unit, the Bonn International Center for Conversion, and the Norwegian Initative on Small Arms Transfers (NISAT), has produced a great deal of survey and case-study work. However, no statistical analysis of the growing volume of survey information has yet taken place.

[1] The Small Arms Survey 2005 (SAS 2005) estimates that of 60-90 percent of all direct battle deaths are attributable to small arms and light weapons (SALW)

[2] Arms races during the Cold War were a fruitful area of research for economists, most notably Robert Aumman and Thomas Shelling who shared the 2005 Nobel Prize in part for their development of game theoretic methods to inform superpower military strategy.

2. Data

Existing data on aspects of the small arms market is extremely limited. Since 2001, the *Small Arms Survey* has gathered a range of information on small arms products, stockpiles, producers and trade. Despite occasional references to observed prices, the *Survey* has not regularly collected price data which would be of most benefit for generating inferential statistics.

Why the Kalashnikov

Collecting price data for panel analysis requires an operational definition of the variable of interest that will provide consistency across time and countries. In the case of small arms there is an obvious choice: the AK-47 assault rifle. Of the estimated 500 million firearms worldwide, approximately 100 million belong to the Kalashnikov family, three-quarters of which are AK-47s (SAS 2004).

The pervasiveness of this weapon may be explained in large part by its simplicity. The AK-47 was initially designed for ease of operation and repair by glove-wearing Soviet soldiers in arctic conditions. Its breathtaking simplicity means that it can also be operated by child soldiers in the African desert. Kalashnikov's are the weapon of choice for armed forces and non-state actors alike. They are to be found in the arsenals of armed and special forces of more than 80 countries. In practically every theatre of insurgency or guerrilla combat a Kalashnikov will be found.

The AK-47's popularity is generally attributed to its functional characteristics; ease of operation, robustness to mistreatment and negligible failure rate. The weapon's weaknesses - it is considerably less accurate, less safe for users, and has a smaller range than equivalently calibrated weapons - are usually overlooked, or considered to be less important than the benefits of its simplicity. But other assault rifles are approximately as simple to manage, yet they have not experienced the soaring popularity of the Kalashnikov.[3]

The AK-47's ubiquity could alternatively be explained as a result of a path dependent process. Economic historians recognise that an inferior product can persist when a small but early advantage becomes large over time and builds up a legacy that makes switching costly (David 1975). In the case of the AK-47 that early advantage may be that it was not subject to patent, and so could be freely copied. Furthermore, large caches of these weapons were freely distributed to regimes and rebels sympathetic

[3]The popularity of the AK-47 is accentuated by the view that it was a necessary tool to remove colonial rulers in Africa and Asia. Indeed, an image of the rifle appears on the Mozambique national flag, and "Kalash", an abbreviation of Kalashnikov, is a common boy's name in some African countries.

to the Soviet Union - more freely, that is, than weapons were distributed by the US - thereby giving the AK-47 a foothold advantage in the emerging post-World War II market for small arms.

According to a path dependence interpretation, inferior durable capital equipment may remain in use because the fixed costs are already sunk, while variable costs (ammunition, for example) are lower than the total costs of replacing Kalashnikovs with a new generation of weapons. Puffert (2003) notes that the duration of this sort of path dependence is limited by the service life of the equipment. In the case of the AK-47, the service life is 20-40 years depending on the conditions it has been exposed to.

Whatever the exact causes, it remains that for the last half-century the AK-47 has enjoyed a near dominant role in the market for assault rifles. Since the technology used in the AK-47 is essentially unchanged from the original, one can be confident that the prices observed across time and countries are determined market conditions rather than changes in the product.

Data Collection Methodology

In order to maintain consistency, the exact variable of interest is "the quoted or transacted price in $US for a non-government entity to take possession of a AK-47 assault rifle." Data were sought for four five-year periods from 1986 to 2005. Each price observation is coded with:

- Price ($US)
- Country
- Time period (1986-1990, 1991-1995, 1996-2000, 2001-2005)
- The exact assault rifle type observed (e.g. AK-47, AK-74, craft replica)
- The location where the price was quoted: (1) city, (2) province or (3) border
- Whether the weapon was: (1) new, (2) used, or (3) in need of repair
- The source of the price observation (e.g. URL link, reference to published document, name and/or affiliation of field worker)

Data Sources

The weapon price data is compiled from a range of journalistic reports and industry interviews. The foundation of the dataset is made possible by the Small Arms Blackmarket Archive, maintained by the Norwegian Institute for Small Arms Transfers (NISAT 2006). The *Archive* contains over 9,000

documents relating to illicit small arms trade. Articles with references to quoted prices or reported transactions involving AK-47 or equivalent assault rifles were extracted and the information converted into the data format using the coding rules outlined above.

References to assault rifle prices were extracted from the 2001 to 2005 editions of the *Small Arms Survey*, which had been obtained on an *ad hoc* basis from field work. The dataset also benefited from interviews with arms industry experts who have had considerable experience with arms bazaars throughout Africa and Asia. Of particular note, is Brian Thomas, an investigative journalist, who has been following the illicit arms trade from factory-to-fight for the last 15 years and has assiduously recorded the going prices for assault rifles in a range of locations at different times. The frequency distribution of data sources for price observations is as follows: NISAT Small Arms Black Market Archive (58%); Small Arms Survey (17%); US Alcohol Tobacco and Firearms Authority (16%); Brian Thomas (6%); other sources (3%).

Summary of Kalashnikov Price Data

This section discusses the strengths and weaknesses of the data, and presents descriptive summary statistics. The major strengths of the data include the broad coverage of countries for which data was obtained (117); a consistent operational definition of the price variable across time and countries; collection of multiple country-period observations to verify that data is of the correct order of magnitude. The AK-47 variable is also a strong proxy for the price of conflict-specific capital.

A potential weakness of the data relates to the randomness of the sample collected. The time dimension suffers from a temporal selection bias. There are relatively more observations for more recent periods. For the period 1986 to 1990 there are 46 unique country observations, whereas for 2001 to 2005 there are 101. This is most likely a due to the combination of more thorough information dissemination facilitated by the internet and the recent increase in attention given to the small arms trade.

The country dimension potentially involves a nonrandom sample as there are relatively more weapon price observations for low-income countries which have experienced civil war compared with peaceful low-income countries. Small arms will naturally be more actively traded in or near war-affected countries. A concern is that journalistic accounts may exaggerate or only report extreme prices. One would expect such measurement error to be biased downwards in poor or war-afflicted countries. However, adherence to the coding rules above generally precludes extreme or outlier data points as

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Table 1: Descriptive Statistics ($US)

Region	Min	Max	Average	Stdev	#Obs
Asia	40	6000	631	810	81
Africa and Middle East	12	3000	267	417	106
Eastern Europe and former Soviet states	50	3000	574	808	75
Americas	25	2400	442	437	59
Western Europe	225	1500	990	443	12
Total observations					335
Total unique countries					117

they do not conform to the definition which is used to provide a consistent measure of equivalent AK-47 trades.

Summary Statistics

The dataset potentially contains $i = 208$ countries over $t = 4$ time periods. The 208 countries are those for which the World Bank collects data for the World Development Indicators (WDI) data base. Subtracting data points for those countries which did not exist due to achieving independence later than 1986 leaves 742 potential observations. As shown in Table 1 there are 335 independent country-period data points for weapon prices. Coverage for just under half of all potential data points would suggest sufficient coverage for purposes of inferential statistics.

In addition to a temporal selection bias towards the present, there are comparatively more observations for Africa and the Middle East, and fewer in Western Europe. The low rate of observation in Western Europe (12 observations in the whole sample) may give rise to sample selection effects which must be addressed in the future. One possible method to overcome this would be to impute AK-47 prices from the prices of competing, equivalent assault rifles.

Figures 1 and 2 track the movement of average weapon prices for regions, and for countries with civil conflict experience. What can be seen is that in peaceful and developed countries weapon prices have been rising. In conflict-affected countries prices has remained roughly constant while in Africa prices have in fact been trending down. A country is deemed conflict-affected if it has experienced a civil war in the last 20 years.

Table 2: Kalashnikov Price Summary ($US)

Year Ending	**1990**	**1995**	**2000**	**2005**
All countries	448	425	559	534
Countries: civil war	382	376	378	348
Countries: no civil war	530	464	669	655
Africa only	235	177	139	140
Observations per period	46	82	106	101

Figure 1: Average Kalashnikov Prices, 1990-2005 (Current US$)

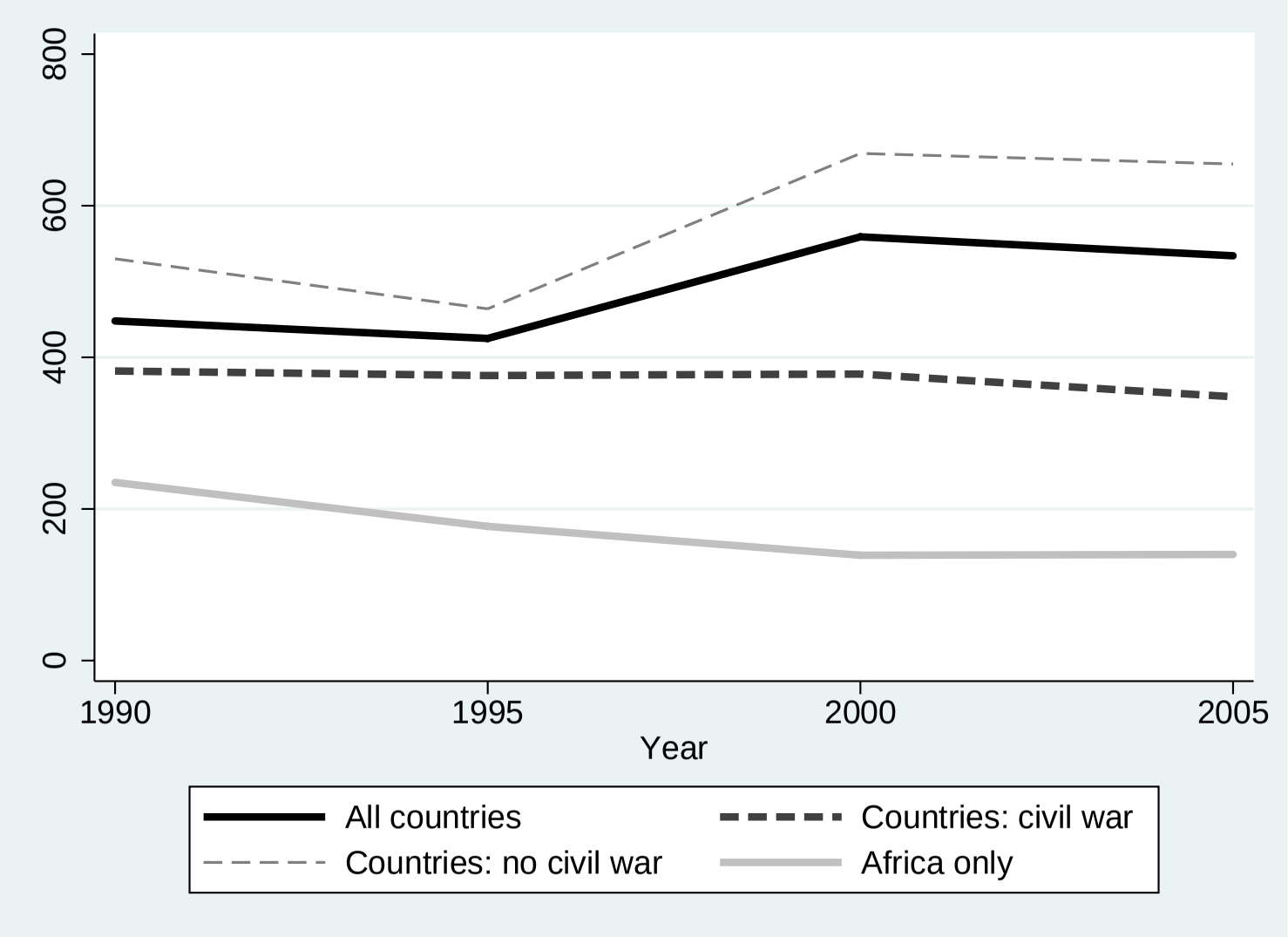
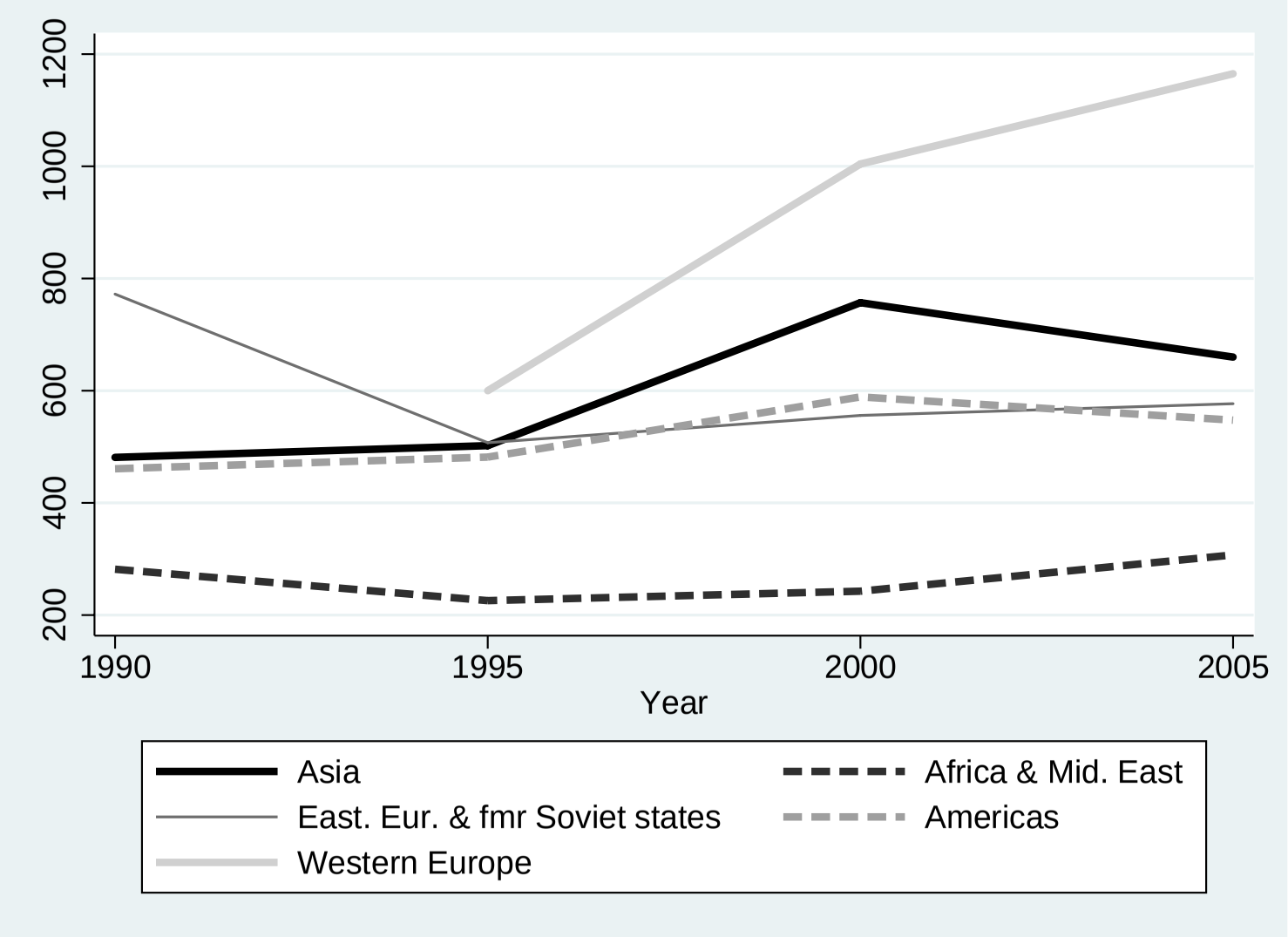


Figure 2: Regional Kalashnikov Prices, 1990-2005 (Current US$)



3. The Small Arms Market

Model of the Small Arms Market

This section develops a model of small arms market based on a simultaneous equations model of demand and supply. Demand for small arms depends on their relative price *(P)*, income *(I)* and the motivation for owning a weapon *(M)*. The supply side of the small arms market is determined by price *(P)*, the prevailing regulations in relation to small arms *(R)*, and intrinsic supply costs *(S)*. The structural demand and supply equations of this simultaneous equation system are given by:

$$Q^D = -a - bP + cI + dM \tag{1}$$

$$Q^S = e + fP - gR - hS \tag{2}$$

Given that this model explicitly accounts for regulatory conditions, it is not unreasonable to assume that an equilibrium of demand and supply exists. Setting 1 equal to 2:

$$Q^S = Q^D \tag{3}$$

$$e + fP - gR - hS = -a - bP + cI + dM \tag{4}$$

Solving these equilibrium conditions for the endogenous dependent variables *P* and *Q* yields the following reduced form equations:

$$P = -\left(\frac{e+a}{b+f}\right) + \left(\frac{c}{b+f}\right) I + \left(\frac{d}{b+f}\right) M + \left(\frac{g}{b+f}\right) R + \left(\frac{h}{b+f}\right) S \tag{5}$$

$$Q = \left(\frac{be-af}{b+f}\right) + \left(\frac{cf}{b+f}\right) I + \left(\frac{df}{b+f}\right) M - \left(\frac{gb}{b+f}\right) R - \left(\frac{hb}{b+f}\right) S \tag{6}$$

Estimating the Reduced Form

Since we do not currently have country estimates for the quantity of Kalashnikov trades (Q_i), it is not possible to estimate both reduced form equations. Hence the structural parameters $(a \ldots g)$ from 1 and 2 cannot be empirically estimated. With the benefit of the collected weapon price data we can,

Table 3: Variables for Estimating Weapon Price Determinants

Model Variable	**Observed Variables**
Weapon price (*P*)	AK-47 assault rifle price
Income (*I*)	Per capita GDP (PPP $US)
Motivation (*M*)	Lagged per capita GDP growth Young men share Underlying homicide rate
Regulation (*R*)	Government effectiveness Democratic accountability Law and order African continent
Supply cost (*S*)	Neighbours' military expenditure Own military expenditure Civil war legacy Post-Soviet collapse Distance from moscow

however, directly estimate the reduced form equation for weapon price. While the magnitude of the estimated coefficients of the reduced form should not be interpreted in the normal linear fashion, their signs and significance can provide meaningful insight into the nature of the small arms market. In order to estimate the reduced form price equation, it is necessary to obtain data for variables which proxy the desired concepts (*I*, *M*, *R*, *S*). Table 3 outlines the empirically observed variables which will be used to estimate Equation 7.

We use a 20 year cross-country panel to estimate the reduced form model for weapon price determinants:

$$P_{it} = \beta_0 + \beta_1 I_{it} + \beta_2 M_{it} + \beta_3 R_{it} + \beta_4 S_{it} + e_{it} \tag{7}$$

The estimation method used is random effects generalised least squares (GLS). The random effects approach is appropriate where there is reason to believe that some omitted variables may be constant over time but vary between cases (e.g. geography) which could be managed with a fixed effects estimator, while other omitted variables others may be fixed between cases but vary over time (e.g. illicit supply sources) and would be best served by a between estimator. It is possible to include both types using the random effects estimator which is a weighted average of fixed and between effects estimators (Wooldridge 2002). In order to determine whether random effects provides a consistent estimator, we run a Hausman test against the less efficient but assuredly consistent fixed effects model. The Hausman test for the basic model (column 1 in Table on page 13) yields an insignificant ρ-value

(0.26) for the null hypothesis that random effects is consistent and efficient relative to fixed effects.

Results

Tables 3.2 and present regressions based on the reduced form weapon price determinants model (Equation 7) for the global sample of weapon prices. Column 1 begins with a single variable for each concept (income, motivation, regulation and supply costs). Subsequent versions test the robustness of the model to alternative specifications of the explanatory variables.

Income

We expect that the higher is per capita income (I) the higher will be weapon prices, due to the partial non-tradability of weapons from official trade barriers. Results from alternative variations of the model weakly support this hypothesis. According to competitive international trade models, free trade will equalise commodity prices. However, non-government weapons trade between countries is almost always contraband. To the extent that laws prohibiting weapons trade are enforced, weapons will take on the attributes of non-tradable goods. The price of this class of good is determined by domestic factor prices, most importantly labour, and labour costs will be larger the higher is income.[5]

Due to the partial non-tradability of weapons, the theoretically appropriate measure of income is GDP per capita in purchasing power parity (PPP) terms. Other measures of income also find a positive relationship between income and weapon price. However, variables which measure income in nominal or absolute terms are more strongly subject to income's correlation with governance variables. One might expect causation to flow from income to governance: the higher is income the more tax governments have at their disposal to spend on effective regulation and law enforcement. But available evidence suggests that the causal impact of income on governance is negligible, and causation is more robustly demonstrated to operate in the opposite direction (Kaufmann, Kraay and Mastruzzi 2005). When the PPP measure of income was replaced with constant 2000 US$, the regulatory variable (government effectiveness) was rendered insignificant. The PPP income measure is less susceptible to correlation with governance indicators and can be more confidently interpreted as the wealth-mark up on weapon prices for a given regulatory environment.

[5]In the same way, we observe the price of non-tradable goods, such as haircuts, to be more expensive in London than Tallinn.

Table 4: Weapon Price Determinants (Part A)

	1	2	3	4	5	6	7	8
GDP per capita PPP 2000$	0.003	0.004	0.004	0.01		0.01	0.01	0.01
	[0.01]	[0.01]	[0.01]	[0.01]		[0.01]	[0.01]*	[0.01]*
Neighbours' Military Expenditure	-36.55	-29.71	-30.24	-31.87	-29.55	-28.32	-27.28	-31.75
	[12.35]***	[12.54]**	[10.81]***	[10.93]***	[9.01]***	[10.89]***	[12.98]**	[13.55]**
Government Effectiveness	215.83	176.17	173.12		135.59	173.4		
	[59.62]***	[61.89]***	[60.67]***		[56.08]**	[60.66]***		
GDP per capita Growth, t-1	0.25	0.74						
	[2.86]	[2.97]						
Civil War Legacy		-0.03	-0.02	-0.03	-0.03	-0.03	-0.05	-0.05
		[0.02]*	[0.01]*	[0.01]**	[0.01]**	[0.01]**	[0.02]*	[0.02]*
Africa Dummy		-292.5	-293.87	-394.04	-356.95	-302.34	-332.79	-364.85
		[122.54]**	[120.93]**	[120.78]***	[113.85]***	[121.06]**	[136.46]**	[139.41]***
Distance from Moscow		124.05	125.45	129.76	112.53	125.16	134.17	130.08
		[62.66]**	[61.54]**	[64.20]**	[53.57]**	[61.52]**	[68.80]*	[71.45]*
Law and Order								2.98
								[25.88]
Democratic Accountability							33.9	
							[19.32]*	
Post-Soviet collapse period						-41.42		
						[30.15]		
Observations	222	212	228	228	265	228	187	187
Number of countries	85	81	81	81	94	81	69	69
R^2	0.08	0.18	0.17	0.18	0.10	0.17	0.18	0.11

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include an intercept

Table 5: Weapon Price Determinants (Part B)

	9	10	11	12	13	14	15	16
GDP per capita PPP 2000$	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]*	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]	0.01 [0.01]
Neighbours' Military Expenditure	-33.16 [12.56]***	-29.54 [12.33]**	-33.78 [11.37]***	-35.25 [10.96]***	-35.46 [10.97]***	-32.04 [10.90]***	-32.16 [10.91]***	-32.16 [10.91]***
Government Effectiveness	175.05 [66.64]***	181.01 [63.68]***	186.26 [62.99]***					
Civil War Legacy	-0.03 [0.02]*	-0.01 [0.02]	-0.02 [0.01]**	-0.03 [0.01]**	-0.03 [0.01]**	-0.03 [0.01]**	-0.03 [0.01]**	-0.03 [0.01]**
Africa Dummy	-325.54 [126.03]***	-271.19 [126.94]**	-282.35 [125.89]***			-331.24 [126.47]***	-337.8 [126.95]***	-337.8 [126.95]***
Distance from Moscow	132.02 [62.89]**	118.18 [64.57]*	82.47 [69.46]	70.81 [64.19]	72.3 [64.50]	120.79 [64.06]*	123.66 [64.27]*	123.66 [64.27]*
Gov Effectiveness 33^{rd}-66^{th} percentile					224.1 [120.90]*		-105.61 [130.42]	125.22 [120.88]
Gov Effectiveness 66^{th}-100^{th} percentile					307.48 [134.81]**			230.83 [131.67]*
Gov Effectiveness 33^{rd} percentile				-257.91 [107.03]**		-169.57 [107.58]	-230.83 [131.67]*	
Young Men			30.66 [30.71]					
War Start		8.34 [70.19]						
Military Expenditure	14.55 [9.40]							
Observations	201	196	215	228	228	228	228	228
Number of countries	77	78	76	81	81	81	81	81
R^2	0.13	0.16	0.18	0.07	0.08	0.13	0.13	0.14

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
All regressions include an intercept

Motivation

Obtaining a satisfactory proxy for the motivation (M) to purchase assault rifles is a difficult task. In the first instance, income growth is adopted as a measure for the desire to buy weapons. Negative income growth has been found to increase the proneness of a country to civil war outbreak (Collier and Hoeffler 2004), even when accounting for the endogeneity of economic growth in the conflict process (Miguel, Satyanath and Sergenti 2004). It is also found to increase the incidence of violent crime (Fajnzylber, Lederman and Loayza 2002). Therefore, we would expect negative income shocks to lead to an increased motivation to purchase weapons for the purposes of crime or conflict.[6]

In the estimated model the coefficient on lagged income growth is not statistically different from zero (columns 1 and 2). The inconclusiveness of this parameter estimate may be the result of competing effects in the small arms market during economic downturns. While one expects the demand for weapons (for crime and conflict) to drive weapon prices up, it is conceivable that there is an even stronger supply effect. Agents on the margin of the legal labour market become unemployed in an economic downturn and a fraction of those unemployed take on employment in the black market (including arms trade), which is profitable relative to no work at all. The extra (illicit) employment in arms trade creates a more competitive arms market and the increase in supply may more than offsets the increase in demand. Since the results for lagged income growth are so insignificant it is not possible to determine whether the supply or demand effect dominates. A rationalisation for the observed parameter estimate of zero is that the illicit weapons market adapts extremely well to changes in economic conditions so that the effect on weapon price of economic shocks is neutralised.

A range of other variables were additionally tested in an effort to capture the motivation to purchase weapons. The proportion of young men (the demographic group most likely to purchase weapons); the proportion of young men interacted with income growth, and schooling (it is hypothesised that uneducated young men and those who experience negative income shocks are prime candidates for seeking weapons); finally, the average rate of homicide as an approximate measure for the underlying proclivity towards violence in a country was tested. However, all of these measures for motivation proved insignificant in explaining weapon price. This is not to conclude that motivation is unimportant in determining weapon price. Rather, it may indicate that better measures of preferences for purchasing weapons are required, and that decomposing motivation effects is not something that can

[6]It is implicitly assumed that illicitly-traded weapons are Giffen goods whose income effect is negatively related to demand. Unlike normal durable goods, when income falls, demand for a Giffen good rises.

be achieved in the simple framework currently under analysis.

Regulatory Effectiveness

Almost all countries have legislation designed to control the trade and possession of small arms. What differs is the ability of governments to enforce these laws. We expect that the more effective a government is at upholding its law, the greater will be the cost to trade weapons, legal or otherwise. The regulatory variable is intended to capture the height of the trade barriers that must be overcome in order to sell a weapon.

A number of measures of regulatory effectiveness (R) are used and all indicate that better enforceability of laws and regulations raises the price of weapons. The World Bank's government effectiveness variable which measures the competence of the bureaucracy is everywhere positive and significant (see Kaufmann et al. (2005) for a full description of how government effectiveness is calculated). Data from the International Country Risk Guide (ICRG 2005) confirms the importance of regulatory capacity as a determinant of weapon price. Democratic accountability measures are significant suggesting that checks on different levels of government and public services are also important in enforcing law in relation to illicit weapons (column 7).

ICRG's law and order variable is intended to proxy the on-the-ground ability of police to enforce the law and prosecute weapons violations. The parameter estimate is positive, but less convincing than expected (column 8). This may be explained by a demand-effect at very low levels of law and order. Households and groups are acutely aware when internal security forces are ineffective and may attempt to fill a security vacuum with their own weapons acquisition, whether for self-defense, crime or conflict. The lesser significance of the ICRG variables may be due to their reduced coverage relative to the World Bank's variables. As a check for whether the effect of varying sample sizes are significant, regressions were run with the World Bank governance data on the sample for which there was ICRG data. The results were not significantly different in the smaller samples.

The variables we use to proxy regulatory effectiveness (R) are all ordinal indicators. Since these variables are not cardinal, the effect of a change from -1 to 0 is not necessarily commensurate with an improvement from 0 to +1. As such, the parameter estimates cannot be interpreted in the standard linear fashion. In order to verify that the ordinal dimension of these variables is not biasing estimation, we pool the segments of the governance variables. Dummy variables for each third of the government effectiveness distribution are generated and included in the weapon price regression. In the first

instance, the bottom third of countries is included, and the Africa dummy is excluded . The bottom third governance indicator variable is independently significant (column 12), but when Africa is again included (column 14) the Africa dummy maintains its significance and yields a similar parameter estimate, while the segmented governance dummy becomes somewhat less significant ($\rho = 0.12$). This procedure was also undertaken for the 20^{th} and 25^{th} percentile segments of the distribution with similar results. Since the remaining parameters are not affected by re-specification, it may be concluded that the ordinal properties of the governance variables do not systematically bias the estimates.

The regulatory effectiveness variable (*R*) is concerned with the effective height of the trade barriers that need to be overcome in order to trade a Kalashnikov. The empirical governance variables considered so far account for the relative freedom of *within*-country trade. Arguably, however, *between*-country trade barriers are at least as important as within-country barriers. The ideal variable would be some measure of the porousness of a country's border since the vast majority of cross-border small arms transactions are likely to be illicit. Since no such data currently exist it is proposed to use a dummy variable for African countries. Africa provides a natural experiment as its countries on average possess a higher number of neighbours than the rest of the world (3.4 versus 2.1), that are considered to have more porous borders than the rest of the world (CIA 2005).

Even controlling for income, government effectiveness, war legacy and supply cost variables, being located in an African country makes purchasing an assault rifle on average over US$200 cheaper than elsewhere. It is postulated that this staggering Africa-discount (see Table and Figure 1) is predominantly driven by porous borders. Since borders are more porous than elsewhere, the trade in assault rifles across the African continent approaches a deregulated market in which prices converge and there are only negligible trade barriers that arms supply must overcome to meet demand. At any one time, only a few African countries have very high demand for weapons. This demand profile across the continent changes over time as localised tensions rise and recede. Porous borders enable the entire supply of weapons on the African continent to meet whichever country currently has high weapons demand.

Supply Costs

The supply costs variable (*S*) in the small arms market model is designed to capture the intrinsic non-regulatory costs involved with supplying arms. A range of empirical variables are used to represent the key factors that affect the underlying cost of supplying assault rifles.

The supply cost variable that proves most robust is neighbours' average military expenditure. This variable measures the average of neighbouring countries' annual government military expenditure as a share of GDP. It is theorised that the strong negative correlation between neighbours' military expenditure and weapon price is driven by spillovers and leakages. *Spillovers* arise where some fraction of a country's military spending is allocated to supplying arms directly to anti-government forces in rival neighbouring countries. The exact reasons for governments supplying foreign rebel forces with arms are not considered here, but one may conjecture that such supply involves some strategic decision designed to destabilise or divert the attention of a threatening neighbour's regime.

The *leakage* effect arises not from a conscious effort by neighbours, but from misappropriation of official weapons stocks by arms dealers and rebels. Such acquisition is typically facilitated by unauthorised sales by defense force personnel (i.e. corruption) or the forcible seizure of weapons stocks during combat or raids on arsenals, which are then sold across borders.

Surprisingly, own-country military expenditure was not a satisfactory explanator of weapon price. Indeed, it had the opposite sign to neighbours' military expenditure (column 9). An explanation for this result is that most illicit purchases of weapons will not be from officials to non-government agents of the same nationality. In general, defence forces would not wish to destablise their own regime by facilitating arms trade with domestic rebels. Even at lower levels within the military, the private incentives of soldiers making some extra money from unauthorised sales to domestic rebels is likely to be outweighed by the expected cost of being caught and dealt corporal or capital punishment. Moreover, there is a deterrent effect of own military expenditure on the feasibility of weapons trade. Where a country has a strong military presence (as proxied by a high level of military expenditure), it would be imprudent for non-government entities to openly trade or parade about with large quantities of conflict-grade weapons.

The supply cost variable that seeks to proxy the stock of weapons in circulation is a variable called civil war legacy. The *legacy* variable is generated using the cumulative civil war battle-deaths since 1960. Since the majority of battle deaths are caused by weapons, the number of battle deaths may be considered a suitable proxy for the quantity of active weapons in a country. In the same way as the magnitude of a war 30 years ago matters proportionately less than an equivalent-sized battle last year, the weapons used to prosecute the war depreciate over time. A discount rate of 5% is applied to recognise depreciation, consistent with a Kalashnikov's life expectancy of up to 50 years.

As an approximation of the number of active weapons, the legacy variable is reasonably robust to various model specifications. Its parameter estimate is generally negative significant conforming with elementary price theory which predicts that, all else equal, the more plentiful is a commodity, the cheaper it will be.

It is commonly believed that the collapse of the Soviet Union released inestimable stocks of weapons onto the world market. This view has been popularised in a recent Hollywood film, *Lord of War*, where Nicholas Cage plays a Ukrainian arms dealer who profitably liquidates the former Soviet state's military arsenal. According to conventional wisdom, weapons trade during the Cold War was based on political affiliation, but since the collapse of communism it has been driven by profit-seekers. Another way of conceiving this hypothesised transition is in terms of industrial organistion: until 1991 there was a duopoly in the weapons market (USA and USSR). Since then the global market has been effectively deregulated with numerous agents operating in a competitive market.

Was the collapse of the Soviet Union a significant supply shock for the illicit weapons market? Regression results suggest not. At the very least, it is not as important as previously believed. When controlling for other factors, the coefficient on the dummy for the post-Soviet collapse period is not significant at conventional levels (column 6). This result suggests that the historical case for a structural break in the global market for small arms has been overstated. An explanation for this finding is to be found in the role of secondary markets. Since weapons are durable goods they can, like shares in a firm, be repeatedly sold from agent to agent. During the Cold War, even though the superpowers thought they were giving or selling weapons to their political allies, these weapons were regularly - and profitably - sold on to secondary (or black) markets which had no regard for the political stripe of the initial source of the weapon. Two caveats to this finding should be acknowledged, however. Firstly, there is only one observation period (1986-1990) before the Soviet collapse. Secondly, there are only 46 observations for the pre-collapse period, whereas there are more than 80 for each of the three subsequent periods (see Table 2 on Page 7).

While the collapse of the Soviet Union did not in itself appear to be a significant supply shock for the small arms market, the role of the Soviet Union and its successor states as sources of weapons does yield significant parameter estimates. Distance from Moscow is adopted as a proxy for the transport costs of getting weapons (in this case Kalashnikovs) from their initial source to the secondary

markets on which they are traded.[7] The distance from Moscow variable is positively correlated with weapon prices for all model specifications indicating, as one would expect, that transport costs matter in determining the price of weapons.

[7]Thanks to Kristian Gledistch for providing this distance data, see also (Gleditsch and Ward 2001)

5. Conclusions

This paper has quantitatively investigated the nature of the small arms market. With the benefit of newly collected cross-country time-series data on the price of AK-47 assault rifles it has been possible to generate empirical findings on previously hypothesised aspects of the small arms market.

The model for the small arms market developed in Section Three is theorised to be driven by four factors - income, motivation, regulation, and supply costs. Estimation of the reduced form version of the model finds that regulation and supply costs are significant determinants of weapon price. This result is robust to various proxies for the concepts. The effective height of trade barriers for weapons, both within and between countries is consistently significant in weapon price determination. Surprisingly, when controlling for other factors, the collapse of the Soviet Union does not have as large an impact on weapon prices as is generally believed. The significance of neighbourhood effects, as proxied by neighbours' military expenditure and an Africa dummy (as a measure of border porousness) indicates that regional trade is at least as important as global weapons trade.

On the demand side, there is some evidence that, for a given level government effectiveness, increasing income raises the price of weapons as a wealth mark-up for a partially non-tradable good. Proxies for the motivation to acquire weapons: lagged income growth, homicide rate, and share of young men do not perform as well as expected. This may suggest that the historic focus on the supply side is justified. More likely, however, it indicates that better modelling and operationalisation of the preferences for purchasing weapons is required. A further qualification to the demand side results is that the price data collected are predominantly for the AK-47. By focusing on the AK-47, the most basic assault rifle, we are possibly ignoring substitution effects as buyers substitute into other, better weapon types as income rises.

Further Research

The burgeoning field of small arms research has produced a sizeable quantity of survey work. Compiling this growing wealth of survey information into a format amenable to statistical analysis has the potential to provide insights in addition to those garnered from close investigation of single cases. As the first statistical analysis of small arms, this study has uncovered many new empirical questions to consider and illuminated numerous avenues for future research.

Table 6: Priorities for Small Arms Data Collection

Variable	Collection Method	Benefits
Weapon price	Targeted surveys	Extend time horizon of sample; Annual data
Ammunition price	Targeted surveys	Examine role of the most important weapon complement
Quantity (stocks)	Currently collected by Aaron Karp	Measure extent of small arms proliferation
Quantity (flows)	Take a multiple or fraction of legal flows from customs data	Enable estimation of simultaneous equation small arms market model; follow trends in illicit weapons trade
Border porousness	$\frac{\text{Number of police}}{\text{Length of border}}$	Measure ease of between-country illicit trade; also applicable for studies in drug trade and people smuggling

Data collection

This study has begun the task of systematically collecting weapon price data and is intended to be an ongoing project. It is envisioned that the small arms research community will allocate responsibility for collecting statistically useful data in the areas of weapon flows, stockpiles, ammunition price, and border porousness, as outlined in Table 6. Collecting these data will be necessary in order to make further quantitative approaches to small arms research possible.

In the absence of a better measure, border porousness was proxied in this study with an Africa dummy variable. A possible method to generate a more robust border porousness variable would take the number of Police (border police would be rather too optimistic a level of disaggregation) divided by the length of a country's land borders.

Empirical Analysis

Cross-country, time-series data on weapon prices will facilitate the testing of hypotheses on the relationship between small arms and civil conflict. For example, does the availability of small arms affect the probability of civil war onset? Does it lead to longer war? Does it result in higher conflict intensity in terms of battle deaths? Investigation of the role of weapons in civil war would seek to evaluate their differential impact on probability of conflict onset, conflict intensity, conflict duration, and post-conflict legacy. Empirical answers to these and other questions will be of direct relevance in

generating constructive policy recommendations.

Does the availability of small arms increase the probability of civil war? A stylised fact which may be gleaned from Figure 1 on page 8 is that weapon prices in peaceful countries have increased relative to those which have experienced civil war in the last 20 years. But are cheap weapons a cause or consequence of civil conflict? Investigation of the relationship between weapon prices and war would need to isolate the role of weapons in the onset of civil war by using a range of methods to control for the suspected endogeneity of weapon price in the conflict process.

In low- to medium-intensity modern civil conflict, assault rifles are an indispensable piece of military equipment. Assault rifles may therefore be considered a proxy for the cost of specific capital required to mount a rebel movement. A conceptual production function for civil war, which includes a specific capital input may look thus:

$$War = f(Labour, Capital, Weapons) \tag{8}$$

Existing approaches which seek to quantitatively explain conflict risk have adopted proxies for labour (the level and growth of income, which measure the labour opportunity cost of belonging to a rebel group) and capital (e.g. lootable resources and diaspora funding, which provide operating finance). Adding a measure of the specific capital input (AK-47 prices) may aid the explantory power of conflict regression models.

On the relationship between of weapons availability and conflict intensity (as proxied by battle deaths), either a positive or negative sign on the weapon price coefficient in a conflict intensity regression is *a priori* rationalisable. On the one hand, cheap weapons may increase the extent to which rebels are armed and thus the number of battle deaths when a conflict arises. On the other, it is possible that, conditional on a civil conflict being observed, cheap weapons have a countervailing deterrent effect. If government forces know that rebels are well armed, they are perhaps less likely to launch costly frontal assaults on rebel positions.

The dynamic relationship between weapon prices and civil war over the course of the conflict cycle also warrants investigation. With a longer horizon of observations it may be possible to empirically estimate whether some countries fall into weapons trap. That is, do high levels of weapons availability prevent a country from breaking out of a conflict trap, independent of other conflict risk factors? Inspection of the data indicate that weapon prices on average rise in the first period of civil war. By

contrast, in the model for weapon price determination, it was found that during the 5 to 10 years post-conflict prices on average fall. Thorough investigation of the role of weapons through the conflict cycle will help inform strategies for managing post-conflict societies.

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Table 7: Descriptive Summary Statistics

Variable	**Obs**	**Mean**	**Std Dev**	**Min**	**Max**
Weapon Price (current US$)	334	511.36	660.84	12	6000
Weapon Price (current US$) $_{t-1}$	234	494.57	651.07	12	6000
Weapon Price (constant 2000$)	334	515.30	662.37	12.4	6000
War Start (Gleditsch)	770	0.06	0.24	0	1
GDP per capita (PPP 2000$)	668	8360.66	8646.46	499.8	60536
GDP per capita (constant 2000$)	711	5492.38	8143.59	80.3	46191
GDP per capita Growth	706	1.41	5.28	-43.7	32.9
Military Expenditure (% of GDP)	547	3.24	3.94	0	44.7
Neighbours's Avg. Military Expenditure	536	3.48	3.21	0	22.6
Post-Soviet collapse period	824	0.25	0.43	0	1
Ln Population	785	15.21	2.12	9.9	21.0
Africa	824	0.22	0.41	0	1
Civil War Legacy	785	538.60	1836.66	0	20672
Government Effectiveness	808	0.03	0.97	-2.3	2.4
Ln Distance from Moscow	692	8.44	0.80	4.3	9.7
Law and Order	522	3.75	1.46	0.6	6
Democratic Accountability	522	3.60	1.61	0	6
Young Men (15-29 % of population)	744	0.13	0.02	0.09	0.23
Homicide rate (per 100,000 deaths)	504	8.11	10.72	0.3	63.4

Table 8: Data Sources

Variable	**Measurement**	**Source**
Weapon Price, current $	Current US$	Killicoat
Weapon Price, constant $	Constant 2000$; deflate current prices by average US CPI	Killicoat, World Bank (2006)
War Start	1000 Battle Deaths in a given year of a 5 year period	Gleditsch (2004)
GDP per capita PPP	Purchasing Power Parity terms in 2000$	World Bank (2006)
GDP per capita constant	Constant 2000$	World Bank (2006)
GDP per capita Growth $_{t-1}$	Average annual growth lagged one period (5 years)	World Bank (2006)
GDP per capita Growth	Average annual growth	World Bank (2006)
Military Expenditure	Average annual government military expenditure as share of GDP	SIPRI (2004)
Neighbours's Avg. Military Expenditure	Average of neighbours' defence burden (as above)	SIPRI (2004)
Post-Soviet collapse period	Coded one for period 1990-1994, zero otherwise	
Ln Population	Natural log of average population over period	World Bank (2006)
Africa	Coded one if African country, zero otherwise	
Civil War Legacy	Log of Cumulative Battledeaths since 1960 with 5% annual discount, divided by log of population	Gleditsch et al (2002)
Government Effectiveness	Ordinal measure (-3 to 3) of government's regulatory capacity	Kaufmann et al (2005)
Ln Distance from Moscow	Log of minimum distance (km) from Moscow to country's capital	Gleditsch & Ward (2001)
Law & Order	Ordinal measure (0 to 6) of law enforcement capacity	ICRG (2005)
Democratic Accountability	Ordinal measure (0 to 6) of democratic accountability	ICRG (2005)
Neighbours	Number of neighbours; islands =0	
Young Men	Men aged 15-29 as share of population	UN (2005)
Homicide rate	Homicides per 100,000 deaths	Fajnzylber et al (2002)