Small Arms Survey 2011: Annexe 1.3

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Methodology

This annexe provides supplementary information on the methodology used in Chapter 1 of the *Small Arms Survey 2011*—'Larger but Less Known: Authorized Light Weapons Transfers'—to calculate the average value estimate of USD 1.1 billion for annual authorized international transfers of light weapons. The estimate, and the process by which it was derived, is part of a multi-year effort to reassess the Small Arms Survey's previous estimate of USD 4 billion for the annual authorized international trade in small arms and light weapons, and their parts, accessories, and ammunition.

As described in Chapter 1, the method used to generate the USD 1.1 billion estimate is based on the basic assumption that if the values of light weapons transfers of a representative sample of states are known, it is possible to use this data as a basis from which to make reasonable estimates of the values of transfers of other states. This annexe describes in more detail the four stages that were followed in order to produce a global estimate: a) generating a representative sample of the documented trade; b) identifying the factors that best account for variations in spending on light weapons among states; c) deriving estimated import values for states outside the sample; and d) calculating final totals.

A) Selecting sample countries

The first stage in generating the global estimate of USD 1.1 billion was to identify 'sample countries'. A sample country was a country for which the authors were able to gather reasonably complete data on imports (by value or quantity) of light weapons over a number of years. Import data (rather than export data) was used as the basis for estimating transfers because little or no export data is available for a number of states believed to be significant exporters of light weapons. It was judged, therefore, that using import data would capture a greater proportion of the global trade.

Import data was obtained directly from governments, the Arms Transfers Database of the Stockholm International Peace Research Institute (SIPRI), and the UN Register of Conventional Arms (UN Register). Data was gathered for all available countries, but data on a given country was included in the study (that is, as a sample country) only if it met two criteria: first, if import data was sufficiently clear, disaggregated by weapon type, and complete; second, if the number of years of available data met minimum thresholds set by the authors.

Thresholds of minimum years of data were used to strike a balance between two aims. The first aim was to have data representative of typical annual procurement of the

state in question (import data averaged over a greater number of years better accounts for peaks and troughs in weapons procurement cycles). The second aim was to yield a sample as large and diverse as possible to be representative as possible of countries for which no import data was available.

Because data over a long time period was not available for most countries, a trade-off was made between these two aims. Data was available over more years for man-portable air defence systems (MANPADS) than for anti-tank guided weapons (ATGWs), and even less long-term data was available for non-guided light weapons.[1] To make maximum use of the available data, the authors therefore used different thresholds (and, hence, different sets of sample countries) for each of these three types of light weapons. A minimum threshold of four consecutive years[2] of data was set for MANPADS, three years of data for ATGWs, and two years of data for non-guided light weapons.[3] Employing these data requirements yielded a sample of 73 countries for MANPADS, 25 countries for ATGWs, and 26 countries for non-guided light weapons.

As noted above, and in Chapter 1, the methodology used in the study is based on the assumption of a *representative* sample of countries. The chances of having a truly representative sample would be augmented by having a sample of countries that is both large and random. The samples used in this study are quite large. Yet since the selection of sample countries is not random, but rather based on availability of national data on light weapons imports, and because there could be a link between transparency and light weapons import behaviour, it is possible that the samples contain a bias that could artificially deflate or inflate the global estimate of USD 1.1 billion. The likelihood of a significant bias is reduced by the large degree of *variation* within the sets of sample countries, namely variation according to the factors identified by the authors to account for levels of spending on light weapons imports.[4] Nonetheless, the possibility of a bias cannot be ruled out.

B) Explaining variation

Although the study used different samples for MANPADS, ATGWs, and non-guided light weapons, an analysis of the documented trade suggests that for each of these types the same four factors best account for variation in annual import value among states:

1. the size of its armed forces. As the size of an armed force increases, so does the number of light weapons required to equip it.

[1] This is the result of a) reporting of MANPADS imports to UNROCA before other light weapon types, and b) the unavailability of data on non-guided light weapons in the SIPRI database.
[2] Or five or more total years.
[3] Thresholds were determined on the basis of analysis of the number of sample countries that would be lost or gained by lowering or raising the threshold. For example, raising the threshold for non-guided light weapons to four years would cut the sample size from 26 to ten countries (while still not covering the likely procurement cycle for these kinds of weapons).
[4] Armed force size, military expenditure per soldier, conflict status, and domestic production capacity. See Chapter 1 (p. 20) and 'Explaining variation' in this annexe.

2. the value of a state's military expenditure per member of its armed forces. The more a state spends on its soldiers generally, the more likely its soldiers are to be equipped with greater quantities of light weapons and with higher-value types and models.

3. the extent to which a state is involved in armed conflict. Troops in active combat are more likely to be equipped with more (and higher-value) light weapons than troops that are engaged solely in peacetime actions. Moreover, weapons are likely to be used more frequently in armed conflict settings and will therefore have to be replaced more quickly.

4. the availability of domestically produced light weapons. The capacity to produce light weapons domestically reduces the need for, and acquisition of, imported weapons.

As is explained below, the study did not assume that the affect of these four factors (or 'variables') was the same across all three types of light weapons. However, the steps taken to generate global import value estimates for all three samples did proceed from the same methodological principles:

1. The military expenditure (Mil X) per solider[5] and the size of a given country's armed forces affect the value of light weapons that the country imports in a *non-linear* fashion. That is, these two variables cannot simply be used to scale up or down the value of light weapons imports by sample states to generate estimates for all countries.

2. Nevertheless, provided that differences in conflict status and domestic production capacity are taken into account, within specific ranges of Mil X per soldier and armed force size, countries will spend, on average, a similar amount on light weapons imports per soldier per year. Therefore, countries can be categorized according to ranges of these variables; *within these categories* it is possible to extrapolate from data on sample countries to an estimated dollar value for light weapons imports for each of the other countries in the same category.[6]

The next section describes in detail the methods used to estimate import values for non-sample countries according to these methodological principles.

C) Estimating imports

For each of the three categories of light weapons, five main steps were involved in generating import estimates for non-sample countries. First, where necessary, import quantities were converted to dollar values. Second, countries were categorized according to Mil X per solider and armed force size. Third, for each category (see step

[5] In this study, the term 'soldier' is used to refer to any member of a state's armed forces, rather than exclusively to a member of the land component of those forces.
[6] This methodology does not demand accuracy in predicted values for individual countries. Rather, it assumes that overall (aggregate) value of each of the nine country groups (see Table 1.2) will be fairly accurate.

1, below) 'composite countries' were created from sample countries, representing typical import value per soldier. Fourth, these import values per soldier were scaled up (according to armed force size) to generate provisional estimates for non-sample countries. Fifth, the resulting estimates were modified to account for states' conflict status and capacity to produce light weapons domestically. Below are descriptions of each step.

Step 1. Converting import quantities to dollar values

Because much of the data on light weapons imports by sample countries only specifies the quantity of transfers rather than the value, it was necessary to convert data on quantities of imported weapons into estimated values. This was done using unit prices for particular types (and, where possible, models) of light weapons. Three principle sources of data on unit prices were used in this exercise: pricing data extracted from the documented trade (principally budget data, and data on light weapons imports provided directly to Small Arms Survey by individual governments); UN reimbursement prices for mortars and recoilless guns used in peacekeeping operations (UN, 2008); and unit prices for various MANPADS and ATGWs reported by Forecast International (Forecast International, 2007a; 2007b).

Step 2. Categorizing countries according to Mil X per solider and armed force size

This step consisted of placing all countries in the world into categories according to the size of their armed forces and their military spending per soldier.[7] Each country was placed into one of three ranges (high, medium, or low) for each variable, resulting in nine categories of countries.

Table 1.2 Parameters for light weapons import country categories

Country group		Thresholds	
		Military expenditure (USD) per active service person	**Armed force size (personnel)**
1	High–large	> 100,000	> 1,000,000
2	High–medium	> 100,000	27,000–1,000,000
3	High–small	> 100,000	< 27,000
4	Medium–large	20,000–100,000	> 1,000,000
5	Medium–medium	20,000–100,000	27,000–1,000,000
6	Medium–small	20,000–100,000	< 27,000
7	Low–large	< 20,000	> 1,000,000
8	Low–medium	< 20,000	27,000–1,000,000
9	Low–small	< 20,000	< 27,000

Step 3. Creating composite countries

One way to generate import estimates for non-sample countries would have been to take averages of import values for sample countries within each country category, as was done in estimating a value for the global trade in light weapons *ammunition*.[8]

[7] The sources for data on these variables were SIPRI (2009), IISS (2009), and CIA (n.d.).
[8] See Herron et al. (2010).

However, procurement cycles for light weapons themselves are often significantly longer than the time periods for which national import data were available. Average import values for each sample country could not, therefore, be individually taken as 'typical' (because of the distorting effect of procurement peaks and troughs). It was assumed, however, that peaks and troughs in the procurement cycle would even out across several sample countries. Thus, for each of the nine country categories, a 'composite' country was created from corresponding sample countries. These composite countries were assigned figures for armed force size, domestic procurement capacity, conflict status, and import value. These figures were calculated from averages of values for the same variables for sample countries within each country group (that is, the value for armed force size for the composite country for the MANPADS medium–medium category was an average of the armed force sizes for the sample countries in the MANPADS medium–medium category).

Where necessary, composite import values were adjusted downwards to account for the conflict status of composite countries, and upwards to account for domestic production capacity.[9] The adjusted import values for each composite country in each light weapons model was then divided by the number of soldiers in each composite country's armed force size. This generated a typical import value per soldier for each country category.

These steps were carried out separately (but in the same way) for all three weapon categories analysed (that is, MANPADS, ATGWs, and non-guided light weapons). For all three samples, there were two country categories for which no sample data was available: medium–large and low–large (see Table 1.2). However, research suggests that all of the countries in these two categories (China, India, and the Russian Federation in the medium–large category, and North Korea, the only country in the low–large category) obtain the vast majority of their light weapons from domestic production. As such, all of these countries were assigned a 'nil' value for light weapons imports.

Step 4. Scaling according to armed force size

The next step was to calculate (for each of the three samples) a provisional estimated import value for every non-sample country. This consisted of multiplying each state's armed force size by the corresponding[10] composite import value per soldier.

[9] If one or several sample countries in a country category were involved in armed conflict, this would result in an inflation of the 'normal' (that is, non-conflict) import value of the composite country (and vice versa with respect to domestic production capacity). In order to compensate for this, a value for both conflict status and domestic production capacity was calculated for each composite country. These values were based on the conflict status and domestic production capacity of the sample countries that constituted it. Modifiers were then applied in accordance with these values. The modifiers used were the inverse of those applied to non-sample countries. See step 5.

[10] That is, the armed force size of a non-sample country in the high–medium category was multiplied by the composite import value per soldier for the high–medium country category.

Step 5. Modifying for conflict and domestic production

Provisional import estimates were then modified to take into account the effect of engagement in armed conflict. A list of countries experiencing armed conflict in their territories was developed using the PRIO–Uppsala conflict dataset.[11] These conflicts were ranked as either minor (more than 25 battle deaths) or major (more than 1,000 battle deaths). Second, a list of foreign troop deployments to conflict zones was compiled from *The Military Balance 2009* (IISS, 2009). These lists were used to identify every country involved in armed conflict between 2006 and 2009.

Different modifiers were then applied depending on the light weapons model in question. For the MANPADS sample, no conflict modifier was applied due to the infrequency of conflicts involving engagements with enemy aircraft in recent years. For ATGWs and non-guided light weapons, however, the following modifiers were applied:

- 33 per cent for every year between 2006 and 2009 that a state was involved in minor conflict within its territory;
- 130 per cent per year for major conflict within its territory; and
- 66 per cent for states with active foreign troop deployments.[12]

Because of a lack of data documenting light weapons imports both before and during conflict, it was difficult to judge the effect of conflict on light weapons import value. For this reason, the effect of conflict on light weapons ammunition procurement value was used as a proxy, and the conflict modifiers used in this study for ATGWs and non-guided light weapons were the same as those used for the Small Arms Survey's investigation into light weapons ammunition imports (Herron et al., 2010).[13]

Finally, the impact of domestic production was taken into account. For MANPADS, analysis of the documented trade suggests that where states have the capacity to produce MANPADS domestically, they procure the majority (but not all) of their MANPADS from domestic production. Consequently, the import value of any state with domestic MANPADS production capacity was reduced by 90 per cent.

For ATGWs, the modifier assigned to countries with production capacity varied depending on the sophistication of the systems those countries produce domestically. States that can produce the most up-to-date ATGWs were assigned a modifier of 100 per cent and estimated import values were reduced to USD 0. The import values of states with slightly older missile technology were reduced by 75 per cent, and those with older technology still by 50 per cent. These values are based on analysis of the documented trade and author assessments of the likely impact of domestic production capacity on import levels.

[11] See UCDP/PRIO (n.d.).

[12] Estimates for countries with very low levels of foreign deployment (below two per cent of total armed force size) were not modified on the assumption that such small deployments would not have a significant effect on levels of light weapons procurement.

[13] For an explanation of how these modifiers were generated, see the accompanying methodology annexe to that chapter in Small Arms Survey (2010).

For non-guided light weapons, analysis of the documented trade suggests that where states have the capacity to procure weapons systems domestically, they do so 85 per cent of the time (by value). Thus, an 85% domestic production modifier was used. However, this modifier was only applied to the percentage of types of non-guided light weapons for which a particular state had production capacity. Thus, if a state had the capacity to produce mortars but not grenade launchers, recoilless rifles, or RPGs, the 85 per cent production modifier was only applied to the portion of the provisional import value for mortars. Analysis of the documented trade suggests that recoilless rifles make up around 5 per cent of the value of that trade, mortars 16 per cent, grenade launchers 33 per cent, and RPGs 46 per cent. As a result, the production modifier of 85 per cent[14] was applied to the percentage of the provisional import value total in accordance these proportions. For example, 19 per cent of the provisional import value of a state that has the capacity to produce grenade launchers and RPGs was reduced by 85 per cent.

D) Final calculations

Completion of the steps identified above yielded estimated annual import values for each light weapon type (MANPADS, ATGWs, and non-guided light weapons) for nearly every country in the world. An estimated total for the annual undocumented trade in each of the three light weapons models was then calculated by subtracting the combined value of imports by the sample countries in each model from the total value of imports. For MANPADS, the estimated value of the undocumented annual global trade was USD 36 million. For ATGWs (Model 2) the estimate was USD 626 million, and for 'other light weapons' (Model 3) the estimate was USD 210 million. When combined, these figures yield an annual estimate for the total undocumented international trade in light weapons of USD 872 billion. When added to the documented trade of USD 242 million, the annual value of authorized transfers of light weapons rises to an estimated USD 1.1 billion.

[14] That is to say, reducing the provisional import value to 15 per cent of itself.

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