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The Military Rise of China: The Real Defence Budget Over Two Decades

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ABSTRACT

Despite growing tensions over China's military build-up and modernization, there is little understanding of China's defense budget. Published estimates vary implausibly from one quarter of the USA's defense budget to near parity, and there are very few attempts to understand how its size or composition has changed over time. This paper uses index number techniques to quantify China's real defense spending over time and relative to the USA. I construct price deflators and show that overall growth has been slower than thought, but also that there has been extremely rapid growth in real military equipment spending that has transformed China's defense forces. China's real defense purchasing power is also found to be 60% larger than commonly used market exchange rate estimates and equal to 59% of the USA's defense budget in 2021. Notwithstanding the rapid growth in equipment, the high relative purchasing power mostly reflects China's far larger number of active personnel.

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Introduction

China's military rise and modernization is causing concern over its capabilities and strategic intentions[1]. In addition to having the world's largest army and, by some measures, the largest navy, China has advanced capabilities and may have a technological edge in some advanced defense technologies (Achcar 2023; Allison and Glick-Unterman 2021; Eaglan 2023; Maizland 2020; Mazarr, Fredrick, and Crane 2022; U.S. Department of Defense 2022). These changes, along with China's territorial claims, have aggravated security tensions, and spawned new security alliances (Allison and Glick-Unterman 2021; The Economist 2021; Gerwitz 2023; Taffer and Wallsh 2023). In the U.S.A. in particular, the changing security environment has resulted in reassessments of global security commitments and disquiet over whether its defense budget is fit for purpose (Bartels 2020; Beckley et al. 2023; Eaglan 2023; Mearsheimer 2021; Rodrik and Walt 2022; The Wall Street Journal 2023).

Despite these claims, some argue that China's defense spending is still dwarfed by the U.S. A., which is argued to be larger than the next 10 countries combined (Beinart 2021; Korb 2021; Obama 2016; Zakaria 2021).[2] Their claims are supported by an extensive literature that compares China's spending to US dollars using market exchange rates (IISS 2022a, 2022b; SIPRI 2022).

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In response, senior US figures, including US Senator Inhofe and the Joint Chiefs of Staff Chair, General Milley, point out that the standard reporting of China's defense budget does not adjust for China's lower local costs, so China's defense budget goes much further (House Armed Services Committee 2021; Inhofe 2021; U.S. Senate 2018, 2021).[3]

Despite a strong history of economic analyses of Soviet defense spending by the US defence and security establishment, no defense department or statistical agency anywhere currently produces estimates of China's defense-sector price deflators or defense-sector purchasing power that might validate these opposing claims.[4] The lack of economic analysis of real spending and the subsequent widely varying range of military spending estimates adds to the political uncertainty in decision-making and hence also to security tensions (The Economist 2023; The Wall Street Journal 2023).[5]

This paper, therefore, aims to clarify the relative size, growth and composition of China's defense budget over the last two decades. Broad components of the defense budget are used to impute a defense-sector unit cost deflator and a military purchasing power parity (PPP) exchange rate, in order to make comparisons of real trends and spending levels. The results extend and update the earlier studies by Liff and Erickson (2013) and Robertson and Sin (2017), as well as providing the first analysis of China's defense spending in defense-sector PPP terms across time and first decomposition of China's defense budget in PPP terms.[6]

The results suggest that a realistic picture of China's rise lies somewhere in between the various accounts described above. In terms of current spending levels, China's 2021 defense budget, in real terms, is much (60%) larger than market exchange rate valuations. This equates to real spending of $US 476 billion, or 59% of the USA's defense budget.[7] Nevertheless, I also show that China's defense sector is still very 'labour intensive' relative to the USA.[8] The larger real size of China's defense budget, when local costs are accounted for, thus mostly reflects the revaluation of labour costs. If we focus only on military equipment spending, China's real spending is only 37% of the USA's level.

Second, in terms of growth rates, I show that China's real military spending growth is far slower than nominal growth rates and also significantly slower than GDP growth, at 5.7% per annum since 2000, compared to GDP growth of 8.6% per annum over the same period. This slower real growth reflects a decline in personal levels over the last two decades.

Nevertheless, China's real military Equipment spending has been extraordinarily rapid, growing at 10.2% per annum over 2000–2021 - six percentage points per annum faster than the U.S.A.. Over the last decade, the rate of China's military Equipment spending catch-up has been even faster, growing 8.6 percentage points per annum relative to the USA.

The remainder of the paper is organised as follows. Section 2 examines Chinese defense budget data over time in local currency using civilian price indices for machinery and estimated defense-sector unit-personnel costs to derive defense unit cost deflators. The resulting real growth rates of these components of defense spending are then compared with the U.S.A.. Section 3 compares the levels of military sending in China and the USA. For this purpose, we need to construct measures of real relative spending levels. Section 3 therefore also discusses relative defense-sector price levels in each country and constructs military purchasing power parity exchange rates. Section 4 summarises the results and concludes.

China's Real Defense-sector Growth

Real and Nominal Defense Spending

Figure 1 shows the defense budgets of China and the U.S.A., in current renminbi and US dollars, respectively, as reported by the Stockholm International Peace Research Institute (SIPRI). China's military spending in 2021 was estimated to be RMB 1.89 trillion, growing from less than RMB 200 billion in 2000. This represents a 'double digit' nominal growth rate of 11.7% per annum.

The figure also shows the shares of each component of spending, based on data provided by UN (2022), as shown in Table A1 in Appendix 2. Some caution is warranted in interpreting these divisions because they are obtained by dividing SIPRI's adjusted defense spending value by the defense budget shares from the official reported budget.[9]

Consistent with other discussions, such as Bartels (2020) and CSIS (2023), the data show little change in the overall composition of nominal spending for China or the USA. To understand what this implies in real terms, however, we need to adjust the nominal spending data for price changes or 'defense-sector inflation'. Ideally for our purposes, we would use a defense-sector cost deflator that measures the average cost of defense-sector inputs. Unfortunately, China, like many other countries, does not publish defense-sector prices.[10] In the absence of defense-sector-specific deflators, some studies have deflated China's defense spending by the GDP deflator or by the CPI (Liff and Erickson 2013; SIPRI 2022).[11]

For reference, Figure 1 therefore also shows China's defense spending deflated by the GDP deflator, in constant 2015 renminbi, using the World Bank World Development Indicators implicit GDP deflator (World Bank 2023). By this measure, which implicitly assumes that the rate of inflation in the defense sector is the same as the economy-wide average, the real growth rate of defense spending was 8.1% per annum over 2000-21. By comparison, nominal defense spending in the USA grew at 4.5% per annum or 2.2% per annum in real terms when deflated using the implicit defense price deflator from U.S. Bureau of Economic Analysis (2023).

The use of a single deflator, however, does not allow us to see how real defense spending on the broad components, Equipment, Operations and Personnel, has changed relative to each other and hence how the structure of China's defense budget may have changed. To understand these real structural changes within the defense budget, I therefore consider price deflators for each input separately.

With respect to Personnel, we can observe the real inputs directly using data on active armed forces personnel numbers. Figure 2, panel (i) shows the number of active military personnel in China, as reported by the International Institute for Security Studies (IISS) (World Bank 2023). This definition includes all active-duty military personnel, including some paramilitary forces, insofar as they can be used to support or replace regular military forces.

The number of armed forces personnel in China has fallen over two decades from nearly 4 million in 2000 to 2.7 million today. Figure 2, panel (i), also reports active personnel adjusted by a human capital index for the Chinese labour force. This index, from the Penn World Table, is based on the estimated effective productivity from increases in the average years of schooling in the population (Feenstra, Inklaar, and Timmer 2015).[12] Although the skill index has increased significantly over time, by 16%, the efficiency adjusted series still shows a strong downward trend.

Given data on expenditure and the volume of skill adjusted personnel inputs, it is straightforward to construct a unit-personnel cost index for China's defense forces, by dividing the nominal

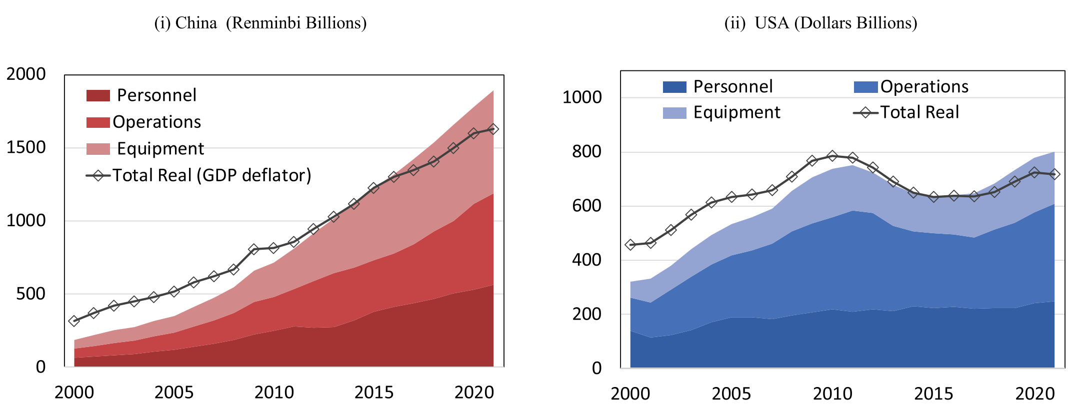

Figure 1. Nominal and Real Military Spending (Local Currency). Notes: Data are based on SIPRI (2022) military expenditure and UN budget shares (United Nations 2022) as described in Appendix 2 Table A1. The "Total Real" index is deflated by the GDP deflator for China (Gerwitz 2023) and by the national defense implicit price deflator for the U.S.A. (U.S. Bureau of Economic Analysis 2023). See text for discussion.

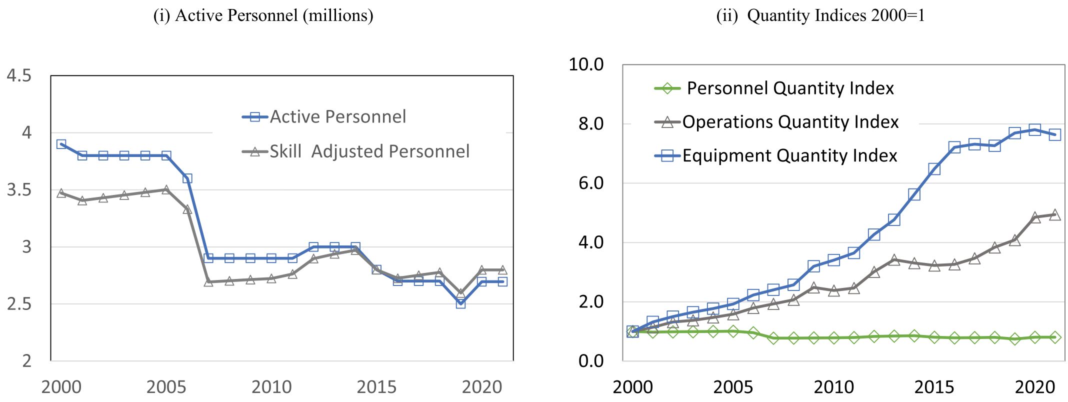

Figure 2. Active Personnel and Quanity Indices.

personnel budget by the number of effective (skill adjusted) active personnel. The growth in the implicit personnel unit cost index far exceeds the GDP deflator. Personnel costs rise at a little over 12% per annum, compared to the GDP deflator which only grows at 2% per annum. This growth in unit costs simply reflects the growing salaries needed to match private sector wage growth due to labour productivity in China's economy. Thus, the real personnel input index, shown in panel (ii), also declines and, by construction, follows the trend in real personnel inputs in panel (i).

Next, I consider spending on military Equipment. There is no real price index or price data available for military equipment. Hence, nominal Equipment expenditure is deflated using the economy-wide implicit gross fixed investment (GFI) deflator, calculated as the ratio of nominal to real GFI from the World Bank (2023). The GFI price deflator has risen more slowly than the GDP deflator, implying that real Equipment spending has grown faster than the rate implied by using the GDP deflator, as shown in Figure 2, panel (ii). For Operations spending, there is, likewise, no equivalent price index, but since it is a broad-brush mix of services and construction, fuel and labour costs, Operations spending is simply deflated using the GDP deflator, as before.

Figure 2 panel (ii) shows the real (deflated) growth of Personnel, Operations and Equipment spending, each indexed to 1 in 2000. While Personnel input levels have declined, Operations and Equipment spending have grown rapidly in constant price terms. Real Equipment spending grew at 10% per annum over 20 years, much faster than other inputs.

Thus, the deflated data reveal a rapid transformation and increase in capital intensity of China's armed forces. This can be seen in Figure 3 (i) which adds up each real component in constant 2015 dollars. Comparing Figures 1 and 3 shows that China's military rise has indeed included a large increase in Equipment relative to Personnel.

The implied constant price growth of overall real spending, in constant 2015 prices, is just 4%. Constant price indices, however, suffer from substitution bias (Gerschenkron 1947; Diewert 1996; Moulton 1996). To mitigate this bias, I also use a chained Fisher quantity index, as also shown in Figure 3, which gives a real growth rate of 5.7%.[13] Both figures are significantly lower than the nominal growth rate of 11.7% and the 8.1% per annum growth rate obtained using the GDP deflator. This indicates that the GDP deflator significantly understates defense-sector inflation in China. Specifically, rapid wage growth meant that defense-sector costs increased more rapidly than other sectors.

We can compare this growth with the USA, as shown in Tables 1 and 2 and Figure 3. Over the period 2000–2021, the USA's real defense budget, when calculated by aggregating these deflated components in constant 2015 dollars, grew at 2.0% per annum if we measure growth in 2015 dollars, or at 2.2% per annum using the Fisher chained index. Thus, aggregating components this way does not significantly affect the estimate of defense-sector growth in the USA but has a more significant effect on the estimate of China's real defense-sector growth. It suggests that China's defense sector

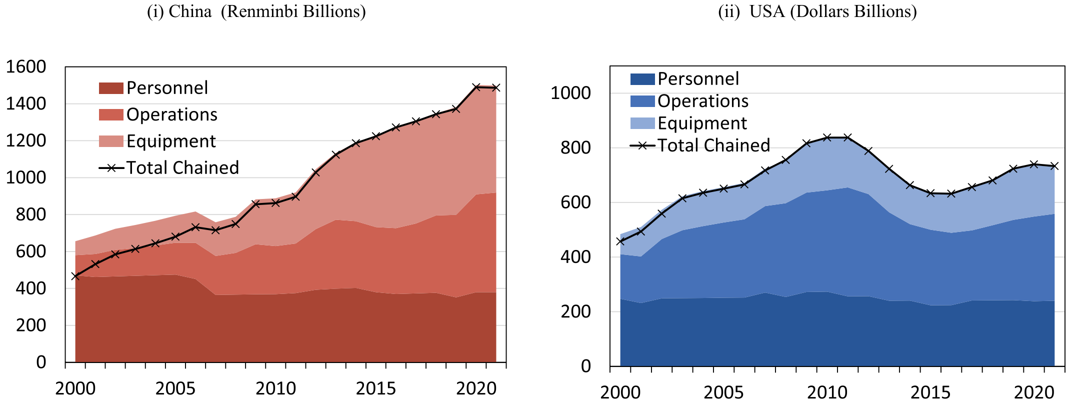

Figure 3. Real Military Spending by component (Local currency). Notes: Data are based on SIPRI (2022) military expenditure and UN budget shares (United Nations 2022) and component deflators as described in text. Components are in constant 2015 renminbi.

Table 1. Real Military Expenditure Growth China (RMB Billion).

Year	GDP (current prices)	GDP constant prices	Mil Exp. current prices	Personnel constant 2015=100	Operations constant prices	Equip. constant prices	Mil Exp. constant prices	Mil Exp. Fisher Chain index
2000	10,028	17,251	184	470	109	76	656	466
2010	41,212	47,043	714	369	260	259	888	862
2021	114,367	98,406	1,893	379	540	580	1,499	1,487
Growth 2000-21	12.3	8.6	11.7	−1.0	7.9	10.2	4.0	5.7
Growth 2010-21	9.7	6.9	9.3	0.2	6.9	7.6	4.9	5.1

Table 2. Real Military Expenditure Growth U.S.A. ($US Billion).

Year	GDP (current prices)	GDP constant prices	Mil Exp. current prices	Personnel constant prices	Operations constant prices	Equip. constant prices	Mil Exp. constant prices	Mil Exp. Fisher Chain index
2000	10,251	13,754	320	247	163	73	484	457
2010	15,049	16,383	738	273	371	191	836	724
2021	23,315	20,529	801	240	318	172	730	772
Growth 2000-21	4.0	1.9	4.5	−0.1	3.2	4.1	2.0	2.3
Growth 2010-21	4.1	2.1	0.7	−1.2	−1.4	−0.9	−1.2	−1.2.

has been growing at 5.7% per annum relative to the USA's 2.3% per annum, and so only catching up with the USA at a relatively modest 3.4% points per annum.

The relatively modest real growth of China's overall defense sector reflects the decline in personnel numbers. If we compare the relative rates of Equipment spending, however, we see that China's 10.2% growth rate of military Equipment is 6.1 percentage points per annum faster than the USA's real Equipment spending of 4.1%. Over the last decade, 2010-21, moreover, Equipment spending in the USA fell by 0.9% per annum, while China's Equipment spending grew at 7.6% per annum. Hence, China's real military Equipment procurement has been growing 8.6 percentage points per annum faster than the U.S.A. over the last decade.

Thus, despite China's apparently static nominal defense budget shares, the price adjusted data show that China's real military growth, over 20 years, has been characterized by rapid structural change, with declining personnel numbers and a massive increase in Equipment per person.

Comparing Real Levels of Military Spending

The preceding section examined the change in China's defense spending over time. This section therefore complements Section 2's analysis of growth rates in local currencies, to see how China's defense budget in Yuan has closed the gap relative to the USA.

To compare China's defense budget with USA, however, we need a common unit of account. By far the most common approach to comparing defense budgets across countries, is to convert local spending into US dollars using market exchange rates. While this may appear to provide a common basis of comparison, market exchange rates only indicate how much a budget would procure if it is spent in another country's currency, for example, through imports. This, however, is not necessarily equivalent to its what the budget procures, since most countries' defense budgets are mainly spent at home in the local currency.

The only meaningful way to compare two budgets that involve different relative and absolute prices is to compare the real resources that each budget purchases – its purchasing power. This means that to compare spending levels across countries we need a purchasing-power parity (PPP) exchange rate that indicates the relative unit costs of defense in each country. That is, we need a military PPP exchange rate (Brzoska 1995; Robertson 2022; Smith 2011). Dividing the ratio of country's defense budgets by the military PPP exchange rate or unit cost ratio (also in local currencies) gives the desired real quantity index of real relative defense inputs in each country.

This point is well established in defense economics. The construction of a ruble-dollar military purchasing power parity exchange rate was one of the key aims of the CIA when it was established in 1947 and tasked by the National Security Council to assess the capabilities and potential of the Soviet Economy (Holzman, 1980, 1989; Firth and Noren 1998; Maddison 1998). Today, however, there are no statistical agencies that produce data on military purchasing power exchange rates and the concept is not widely recognised in defense policy circles.[14]

Other academic studies that have considered military purchasing-power concepts include United Nations (1986), Fontanel (1986), Cars and Fontanel (1987) and Heston and Aten (1993). Despite this initial work, interest in the area fell away with the end of the Cold War and in the face of criticism of the US Department of Defense projects (Firth and Noren 1998).

With the rise of China there has been a renewed policy interest in appropriate international comparisons of real military spending (Bitzinger 2003; Brzoska 1995; Ward 2006). Nevertheless, practical problems arose in deriving appropriate defense-sector-specific PPP exchange rates, and the use of GDP-PPP exchange rates was rightly argued to be questionable (IISS 2012, 215–216; SIPRI 2020; Ward 2006) Studies thus attempted to find solutions subject to the limited data availability. For example, Crane et al (2005) tried to adjust China's defense budget for tradable versus non-tradable inputs and Gilboy and Heginbotham (2012) similarly evaluated Indian and Chinese defense budgets using adjusted equipment prices. Kofman and Connolly (2019) and IISS (2022a) also revived interest using GDP-PPP exchange rates to emphasise the potential errors involved with the conventional market exchange rate comparisons.

The approach to developing military-PPP exchange rates used in this section follows the method used in Robertson and Sin (2017) and Robertson (2022) who introduced index number concepts to develop military PPP measures based on defense-sector unit costs functions and hence are consistent with economic theory and hence also allow for substitution bias.[15]

These previous studies, however, have not considered the trend in PPP adjusted defense budgets over time, or the trends in country's defense spending components. This part of the present study therefore extends this literature by showing how China's defense budget has grown relative to the USA in real terms. Thus, for the first time, it quantifies China's real military 'catch-up' with the USA.

Comparing Spending Components

The importance of allowing for price differences across countries is readily seen by considering China's military personnel costs. Converting the Chinese military personnel budget using the market exchange rate gives a figure in US dollars that is less than half of the U.S.A.'s personnel budget. But, according to IISS data, the total number of active military personnel in China in 2021 is nearly twice as many as the U.S.A. – 2.70 million compared to 1.39 million. Clearly, therefore, the market exchange rate is vastly understating the purchasing power of China's personnel budget relative to the USA.

This occurs because the relative price of labour is much cheaper in China, and market exchange rates tend to equate the prices of traded goods, whereas labour costs can vary substantially across countries. For example, at market exchange rates, the base pay for a truck driver is RMB 54,480 which converts to $US 7,800. This is five times smaller than U.S.A. where salaries start at $US40,000.16 This means that, on average, an employer only needs one-fifth of the market exchange rate (1.39 renminbi per dollar rather than around six or seven renminbi per dollar) to employ the same number of truck drivers in China as in the U.S.A. Similarly, according to the Penn Word Table, labour incomes in China across the whole economy, for labour of similar skill levels, are approximately one-fifth of the USA.[17]

Consequently, when comparing the purchasing power of defense personnel budgets, we need to compare the cost of employing a similarly skilled service person in each country.

To calculate the relative cost of military personnel in China relative to the USA we can again use the data on active personnel numbers and relative skill levels. Dividing the personnel budget in each country by the number of skill-adjusted personnel gives the average unit cost per effective person in each country.[18] This gives a ratio of total cost per person for China relative to the USA of 1.62 renminbi per dollar in 2021, which is 3.98 times lower than the market exchange rate. So, on this basis, China's military personnel are paid approximately 4 times less than U.S.A. military personnel.[19]

Hence, the purchasing power of China's personnel budget terms is approximately 4 times larger than the exchange rate value of $87 billion, which equates to $356 billion in current $US for 2021. Note that the value of this single component is already larger than the market exchange rate value of the entire Chinese defense budget. Appendix 2, Table A3 summarises these data for all years, 2000–2021.

Comparing the number of active-duty personnel is obviously an imperfect measure of 'personnel inputs', and there is room for debate about comparative skills and training. Careful documentation by defense experts with better quality disaggregated data could likely make significant improvements in these estimates, as was done the CIA and US Department of Defense during the Cold War. However, if these personnel headcount numbers are even approximately correct, they illustrate the vast distortionary effect of using market exchange rates to compare real spending levels between China and the USA.

Estimates of the relative prices of Equipment and Operations can also be used to infer the relative quantities of these inputs in China and the USA. To infer differences in military Equipment prices I use the World Bank's International Comparisons Project (ICP) data on civilian Equipment prices in China relative to the USA (World Bank 2020). The ICP provide this data for three base years, 2005, 2011 and 2017. To compute prices for intermediate years, I again use growth rates of the implicit investment price deflator for China from the World Bank WDI (World Bank 2023). Third, the GDP-PPP exchange rate from the Penn World Table is again used as the relative price of Operations.

The resulting real, or 'PPP', exchange rates, for Personnel, Equipment and Operations, are shown in Figure 4. As discussed, the relative price of Personnel is much lower than the market exchange rate, reflecting the very low cost of labour in China relative to USA. It increased from 0.26 RMB per dollar in 2000 to 1.62 RMB per dollar in 2021. Conversely, the relative price of Equipment is higher than the market exchange rate, ranging between 9 and 10 renminbi per dollar.

These price ratios, or PPP exchange rates, can then be used to deflate the nominal spending ratios in each category into real relative quantity indices to obtain the relative real purchasing power of each country's defense budget by each category of spending. The resulting real quantity indices for Personnel, Operations and Equipment are shown in Figure 5.

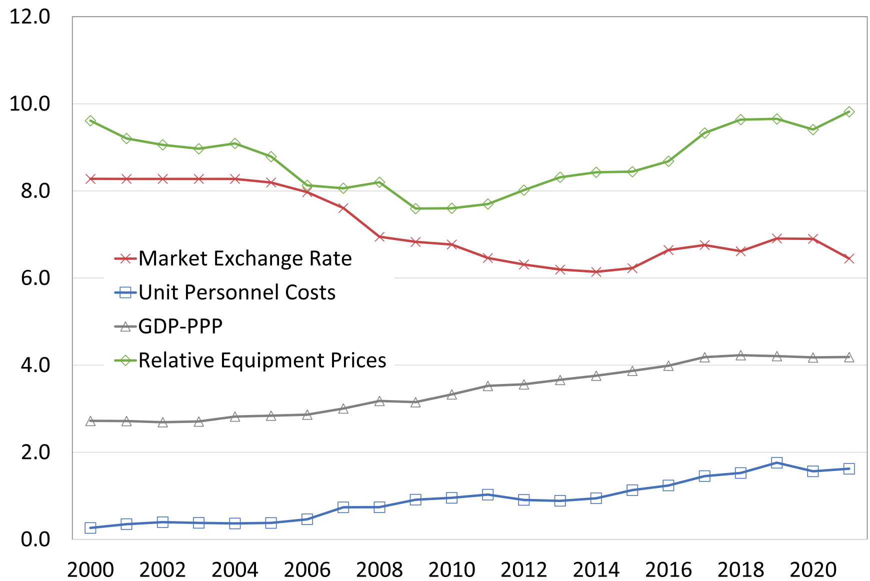

Figure 4. Exchange Rates and Price Ratios (Renmibi per Dollar).

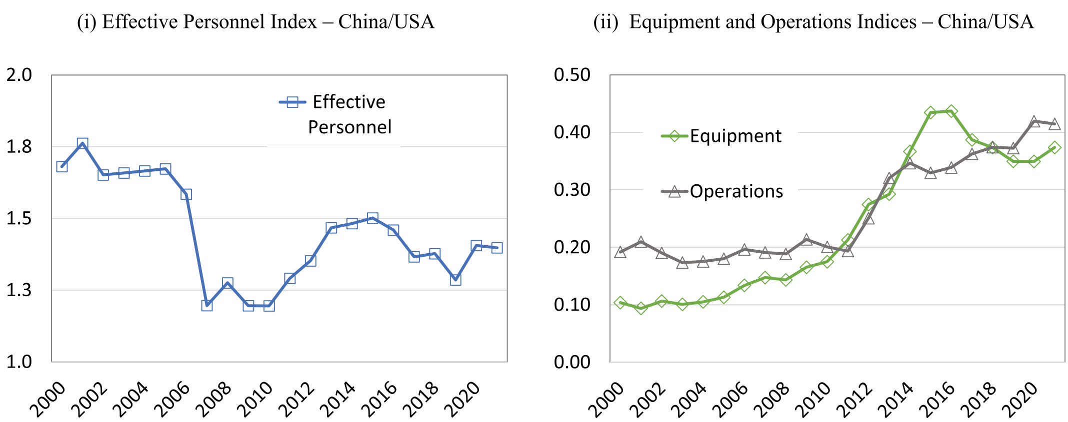

Figure 5. Quantity Ratios for Defense Inputs - China/U.S.A..

The real quantity index for Personnel measures the ratio of skill adjusted personnel in each country. This has declined over time, reflecting the decline in China's active military personnel, but was still 1.4 times larger than the USA in 2021. The real quantity of Operations spending in China, however, was only 41% of the USA in 2021 (compared to the market exchange rate value of 27%). This has doubled relative to the USA, from just 20% of the USA in 2012.[20]

The real quantity index for Equipment has caught up even faster. Specifically, real relative Equipment spending in China was only 10% of the USA in 2000 and 17% of the USA in 2010, but rose to 37% of the USA by 2021. This is smaller than the ratio implied by market exchange rates (56% of the USA) however, since the Equipment price index is higher than the exchange rate.

Figure 5 thus shows that China's real military Equipment and Operations spending is rapidly closing the gap relative to the USA. The figure likewise shows that China's defense budget procures 1.4 times more skill adjusted personnel than the USA, but Equipment and Operations input levels are, respectively, only 37% and 41% of the USA's budget. Thus, China's defense forces are far more labour intensive than the USA.

Comparing Total Spending

While Figures 4 and 5 provide a clear view of the size of the components of China's defense sector relative to the USA, political and economic discussion necessarily focuses on aggregate figures, under the assumption that the composition of spending reflects military decisions over a country's best use of various types of assets and personnel.[21]

An overall index will necessarily be a weighted average of the three quantity indices in Figure 5, where the weights will depend on the relative price of each input. A seemingly intuitive approach is to evaluate China's real defense inputs in Figure 5, using USA relative prices and add them to get an overall measure in US dollars. This counterfactual value can then be compared with the overall US nominal budget to get an overall measure of China's defense purchasing power relative to the USA. This approach is intuitive and often adopted in policy discussions in international relations.

An alternative and equally valid approach is to compare the U.S.A.'s and China's defense budgets by evaluating the USA's input quantities at Chinese prices and comparing this counterfactual U.S. A. budget in renminbi with actual Chinese spending in renminbi.

Unfortunately, these two approaches give very different answers, and neither is more correct than the other. Specifically, the first approach (evaluating China's inputs at USA prices) is a Laspeyres quantity index of Chinese spending relative to the USA. It yields a dollar value China's defense budget equal to 71% of the USA (see Appendix 1). The second approach (evaluating USA inputs at Chinese prices) is a Paasche quantity index of China's defense budget, and this yields a value of just 50% of the USA. The difference is an example of the 'Paasche-Laspeyres spread' and arises because the choice of base prices – USA or China – will affect how each quantity is weighted when aggregating the overall budget.[22]

The economic solution to this index number problem, which mitigates this substitution bias, is to evaluate each county's inputs at common intermediate prices and approximate the shift in relative input mixes that each country would choose at these counterfactual intermediate prices, for a given budget (Eurostat and OECD 2004). Specifically, we can use a superlative price index such as the Fisher, Törnqvist or Walsh price indices that are exact for specific flexible functional forms of the production function or cost function (Eurostat and OECD 2004, Chap 15, 17; Diewert 2021). Dividing the ratio of nominal expenditure by the any of these superlative price indices give a real quantity index that, again, is an exact quantity ratio for a flexible functional form of the production function. Thus, each price index is also a military PPP exchange rate.[23]

Figure 6 panel (i) thus shows the aggregate military – PPP exchange rate using all three price indices. It can be verified that there is very little difference among these alternative approaches. Each is an approximation to the true but unknown unit cost of defense in each country, expressed in local currencies (Diewert 1976; Eurostat and OECD 2004, Chap. 17).

Figure 6 (i) shows that implied military PPP exchange rate, by any of the three measures, is well below the market exchange rate (shown in Figure 4) and rises from around 1.5-2.0 two decades ago to a ratio of 4 today. The growth in the price ratio reflects the growth in the individual price ratios in Figure 4, which in turn reflects growing costs relative to the USA, particularly due to wage growth and increasing Equipment prices over the last decade.[24]

The implied real relative quantity of aggregate defense inputs in each country, obtained by dividing the ratio of nominal spending in each country by respective price index, is shown in panel (ii) of Figure 6. These are effectively price-weighted averages of the component quantity indices in Figure 5. Thus, it is useful to (i) compare Figures 5 and 6 (ii) to understand how Personnel, Operations, and Equipment growth add up to give the overall trend in relative overall defense inputs.

It can be seen that China's real defense output is estimated to be just under 60% of the USA by all measures. For the Fischer index, for example, China's real defense budget is equivalent to 59% of

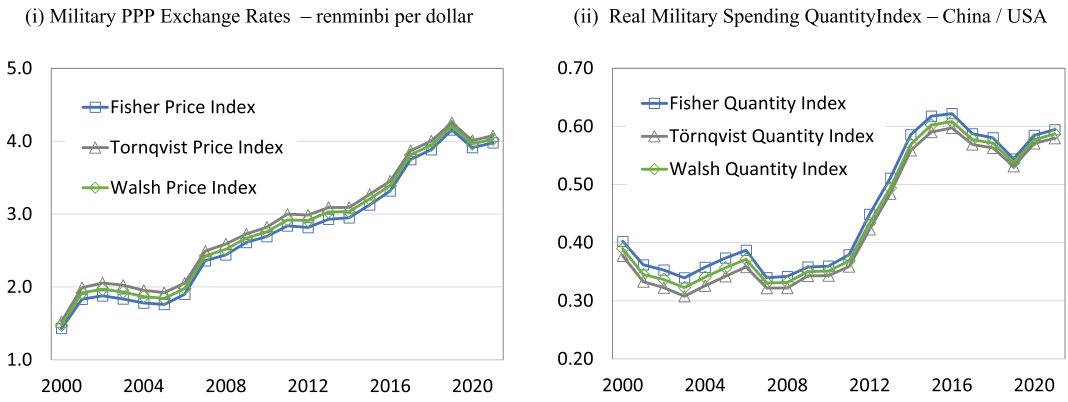

Figure 6. China's Military Spending Relative to the U.S.A..

USA in 2021, rising rapidly from 35% in 2010.[25] There was particularly rapid catch-up in the 5-year period 2011–2016, which as we show below reflects the USA demobilisation rather than an acceleration in China's spending. The ratio also appears to have stabilised since around 2016 as USA spending increased.

This relative pattern can be more easily understood in Figure 7 (i) which compares the relative spending levels. It shows the level of China's real military spending, expressed in US dollars at military PPP (Fisher) prices, obtained by multiplying the Fisher quantity index by nominal current US defense spending. This is compared to the USA's nominal spending in current prices and the market exchange rate value of China's defense budget. China's 2021 defense budget in military PPP terms (Fisher) equates to $US 476 billion, compared to the market exchange rate value of $US 293 billion and the USA's budget of $801 billion.[26]

Figure 7 also shows that the rapid catch up of China's defense spending relative to the USA over the period 2011–2016 (as seen in Figure 6) reflects the dynamics of the USA budget. The cycle in US defense spending reflects the Afghan war. China's spending growth by contrast was fairly smooth over the whole two decades. As noted in Section 2, all of the catch-up shown in Figure 7 is driven by increased military Equipment and Operations spending in China.

While China's overall defense budget is catching the USA and is approximately 59% of the USA's budget, we also saw in Figure 5 that input mix is very different with China having more personnel than the USA but less real volumes of Equipment and Operations. It is therefore useful to see how

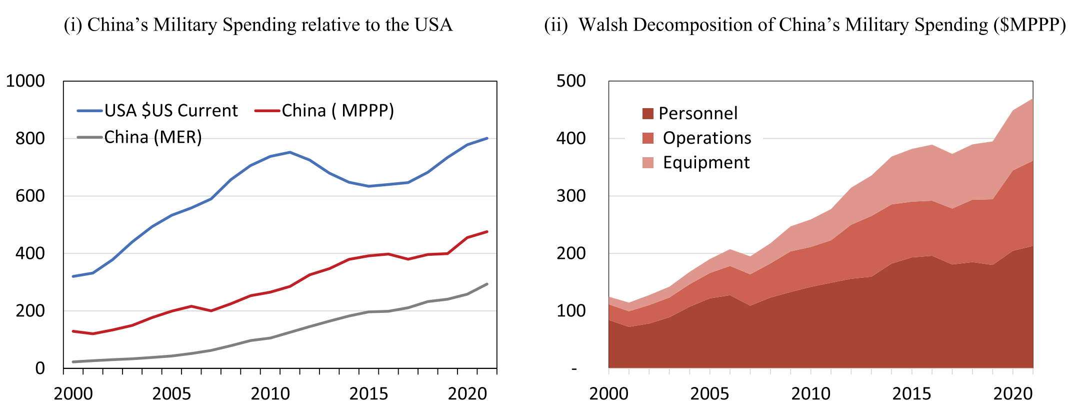

Figure 7. Chinese and US Military Relative Spending 2000-2021 ($US billions.

these components contribute to China's overall budget in military PPP terms. Specifically, when China's real inputs are evaluated at PPP prices the expenditure shares in the budget will also change.

To illustrate this, I decompose defense spending into the implied expenditure shares evaluated at the common intermediate prices using the Walsh index.[27] The Walsh index can be expressed as

$$Q^W = \frac{\sum_i q_i^c \tilde{p}_i}{\sum_i q_i^u \tilde{p}_i}$$

where subscripts denote the inputs, Personnel, Operations and Equipment, indexed by i and the superscripts c and u denote China and the USA respectively and $\tilde{p}_i = \sqrt{p_i^u p_i^c}$. Thus, the Walsh quantity index is an expenditure ratio where each countries inputs, q_i^c and q_i^u are evaluated at the common intermediate price ratio, the geometric average of Chinese and USA input prices, $\tilde{p}_i = \sqrt{p_i^u p_i^c}$.

Figure 7 panel (ii) thus shows the value of Chinese military spending over time broken down by each input value $q_i^c \sqrt{p_i^u p_i^c}$. It can be seen that, compared to Figure 1, the Personnel share is a much larger fraction of spending in PPP terms and accounts for 45% of China's military spending in 2021 compared to 29.7% of the actual nominal budget and compared to 19% of the USA's spending at Walsh military PPP prices. So, while in fact both countries spend approximately 30% of their defense budget on personnel at local prices, at common average prices China's estimated personnel share is more than double the USA's – which reflects the quantity ratios from Figure 6. Conversely, China's equipment share at Walsh PPP prices is much lower than its actual Equipment budget share (at local prices) of 37%.[28]

Thus, the extra spending power observed when we evaluate China's defense budget in military PPP terms mostly reflects the re-evaluation of Personnel spending. It can also be seen, however that, over time, the relative share of sending on Equipment and Operations has increased, while the importance of the Personnel contribution has diminished. Thus, it remains the case that the catch-up relative to the USA is mainly due to growth in China's real Equipment and Operations inputs.

The data thus show that there is significant catch up in overall military spending which is driven by rapid growth in real Equipment spending. Nevertheless, China's defense input choices remain much more labour intensive than the USA's. This difference in composition may reflect different operational needs or simply an incomplete modernization programme and legacy issues.[29] Irrespective, it is important to recognize that the composition of the USA and Chinese defense budgets differ substantially, which may have implications for any inferences regarding military capabilities.

Conclusion

Despite growing concerns over China's military build-up and suggestions of a new Cold War, there have been few attempts to understand how fast China's defense budget has grown, how large China's defense spending is in real terms, or how the composition of China's defense sector has changed. Programmes run by the CIA and the US Department of Defense to estimate Soviet military spending were disbanded after the Cold War ended and, currently, no security agencies or defense departments have undertaken international comparisons of real defense spending that considers variations in local country defense input costs. Thus, the vast literature on China's military modernization, capabilities and catch-up with the U.S.A., is almost entirely absent of any economic analysis of real military spending.

Having clarity over the real relative size of China's defense sector, however, is critical to informed public debate and political decision-making over defense department requests. In this paper, I address this issue by constructing defense-sector price deflators and purchasing power parity exchange rates for defense spending in China. I find that, in 2021, China's real defense budget is 60% larger than the widely used exchange rate values and is the equivalent of $US 476 billion – compared to the exchange rate value of $US 293 billion. While the composition of the defense budget differs from the U.S.A.'s defense budget, China's budget in purchasing power terms it nevertheless equates to about 59% of the U.S.A.'s defense budget of just over $800 billion – compared to the market exchange rate value of 36.6% of the U.S.A..

I further show, however, that the composition of the Chinese and US defense forces is very different. Specifically, China's military is still significantly more labour intensive than the U.S.A., with observed military equipment spending that is only 37% of the U.S.A.'s equipment budget. In these terms, China's defense sector remains well behind the USA

The most notable feature of China's defense budget over time, however, is the growth in real military Equipment spending. This averaged over 10% per annum since 2000, in real constant renminbi terms, and real military Equipment spending per person has averaged over 11% per annum. This observed rapid increase in the capital intensity of China's defense forces aligns with more hawkish descriptions of China's catch-up and military modernization.

Naturally, the results are subject to the limitations of the data, and China's defense budget is notoriously opaque. However, based on the available data, especially SIPRI estimates and information on local prices, it appears that China's modernization has already substantially transformed its armed forces in terms of equipment per person. While China's military remains relatively labour intensive compared to the US, its overall spending now rivals the U.S.A. and is rapidly closing the gap in military equipment.

Notes

1. Economics Department, The University of Western Australia, Perth WA. 6009, peter.robertson@uwa.edu.au. I am grateful to Hoi Chu for his research assistance. I am indebted to discussions ideas and hospitality of with many people but notably Fred Bartels, Wilson Beaver, Lucie Beraud-Sudreau, Jack Detch, Mackenzie Eaglan, Kelvin Giang, Robert Hill, James Laurenceson, Fenella McGerty, Chas Morrison, Veerle Nouwens, Ron Smith, Cole Spiller, Maseh Zarif, seminar participants at: *The Heritage Foundation*, 26th July 2023; *The American Enterprise Institute*, 27th July 2023; a presentation to Congressional Staff for *The House Select Committee on China*, 28th July 2023, the *IISS* Conference, 'Military Expenditure: Transparency, Defense Inflation and Purchasing Power Parity' 20th December 2022, and; the Australia–China Relations Institute, 7 March 2024.
2. See also Freedberg (2018), Tirpak (2021), Lofgren (2021), Cato Institute (2023).
3. Similarly, US Senator Sullivan claims, citing Department of Defense confidential sources, that China's defense budget is as much as $700 billion. This figure puts it almost on parity with the U.S.A. and many times larger than the official value of $209 billion (U.S. Senate 2021; The Wall Street Journal 2023).
4. The IISS recently commenced reporting military expenditure for China, the U.S.A. and Russia but only using GDP-PPP exchange rates. Robertson (2022) shows that estimates of military-PPP exchange rates differ substantially from GDP-PPP exchange rates in many countries. The U.S.A. Department of Defense's Annual Report on China's Military Developments (U.S Department of Defense 2022) only discusses China's defense budget in nominal terms and only compares China's defense budget to the U.S.A. using market exchange rates. The US Department of State produced a series of military spending comparisons, including an ad-hoc approach to measuring military purchasing power parity exchange rates, but this was discontinued in 2021. It is available at https://www.state.gov/world-military-expenditures-and-arms-transfers/. See Firth and Noren (1998) and Maddison (1998) on the US Defense Department's economic analysis of Soviet military spending
5. This concern has culminated a new bipartisan bill, *The China Defense Spending Transparency Act*, June 2023. This requires the US Department of Defense to produce a report to Congress on the comparative size of China's defense budget, including assessments based on unit cost differences across countries and differences in defense budget purchasing power (Romney 2022, 2023; Sullivan 2023; The Wall Street Journal 2023). The Act requires the department of defense to 'provide the people of the United States with an accurate comparison of the defense spending of the People's Republic of China and the United States' . . . and to 'consider the effects of purchasing power parity'.
6. Liff and Erickson don't consider PPP values and their analysis only extends to 2012. Robertson and Sin (2017) introduced purchasing power concepts to the defense spending literature, but their data was limited to two years, 2000 and 2010.
7. This is based on based on SIPRI's definition of defense spending.
8. I use the term 'labour intensive' in the colloquial sense to refer generally to the composition of the input bundle, which may differ due to input price differences, rather than the shape of the isoquant map specifically.

9. The division is based on the expenditure shares which are derived from the United Nations 'Milex' database (United Nations 2022) and various national defense white papers produced by China. Details of the budget shares are reported in the Appendix 2 Table A1. The adjustments made by SIPRI mostly relate to spending on: the People's Armed Police; the China Coast Guard; demobilized and retired soldiers, and additional estimates of research and development and military construction. These accounted for an additional 27 per cent of total estimated Chinese military spending in 2019, of which nearly all is due to R&D, pensions the People's Armed Police activities (Tian and Su 2021). It is difficult to apportion these categories into Operations, Equipment and Personnel. The approach adopted therefore just apportions these additional spending categories according to the overall official budget shares. It is also worth noting that research spending reported to the UN is included in Operations for the U.S.A. but is not reported for China. These adjustments by SIPRI however are applied consistently over time so will have a negligible effect on the expenditure trends.
10. SIPRI report their military expenditure data in several ways, including data in constant prices, deflated by the local country CPI (Stockholm International Peace Research Institute,2022, Sources and Methods). The use of the CPI gives a measure of the opportunity cost of the defense sector in terms of forgone consumption. This is appropriate for measuring the defense burden. More generally, the choice of deflator will differ depending on whether one is interested in measuring costs of consumption or production.
11. As noted above, SIPRI's definition of defense spending includes some paramilitary forces, research and Equipment procurement (Tian and Su 2021). However, Tian and Su (2021) also note that these figures are very conservative and do not include any items for which there is no concrete evidence. Eaglan (2023) for example has argued that there is very substantial additional 'off the books' spending through civil-military fusion.
12. The Penn World Table uses a Mincerian relationship between the effective units of labor h, and years of schooling, s, given by $h = e^{\varphi\, s}$, where φ is an estimated return to schooling, drawing on Barro and Lee (2013) and Cohen and Leker (2014). For further discussion see 'Human capital in the PWT 9.0' in the Penn World Table repository https://www.rug.nl/ggdc/docs/human_capital_in_pwt_90.pdf. In 2019 the human capital index in China relative to the U.S.A. was 0.71, compared to 0.64 in 2000.
13. Specifically, if prices have been growing rapidly in one input relative to others, latter year prices will assign too much weight to those inputs in the initial periods. A Fisher chain quantity index is defined as $Q_t^{FC} = \prod_{s=0}^{t} Q_s^F$, where $Q_s^F = \sqrt{Q_s^L Q_s^P}$, $Q_s^L = \frac{\sum p_{s-1} q_s}{\sum p_{s-1} q_{s-1}}$ is the one period Laspeyres quantity index and $Q_s^P = \frac{\sum p_s q_s}{\sum p_s q_s p_{s-1} q_s}$ is the one period Paasche quantity index, and p_s and q_s are the input prices and quantities of Personnel, Operations and Equipment in period s.
14. See for example the discussion in Tirpak (2021) or Korb (2021) who rejects the use of PPP valuations in response to Greenwalt (2021).
15. Substitution bias is the problem that emerges when one considers a bundle of goods at counterfactual prices, without taking into account the likelihood that, if prices change, the quantity demanded also changes. This discussed further in Section 3.2.
16. An entry salary for a truck driver in the U.S.A. is $40,000 but may rise to $89,855 per year, https://www.indeed.com/cmp/U.S.A.-Truck/salaries?job_category=driver. Likewise a truck driver in China earns between RMB 54,480 ($US 7,886) and RMB 164,400 ($US23,797) per year, http://www.salaryexplorer.com/salary-survey.php?loc=44&loctype=1&job=239&jobtype=3. Hence, at market exchange rates, truck driver in the U.S.A. earns 3.8 to 5 times more than those in China.
17. The average income received by labour in China in 2019 was RMB 72,720 which, at 2019 current market exchange rates of 6.9 RMB per dollar, is equal to $US10,526. The average labour income in the U.S.A. in 2019 was $US80,844. Skill levels in China's civilian labour force were 72% of skill levels in the U.S.A. in 2021. Thus, when adjusted for skill differences, labour earnings in the U.S.A. are 5.5 times higher than China.
18. For the U.S.A. this gives a Figure of $US178,000 per active person in 2021. Kapp and Torreon (2020) reported U.S.A. spending $100,000–$110,000 per year as the cost of an average active-duty service person, which includes cash, benefits, and contributions to retirement programs, as a conservative estimate. The larger figure obtained here, however, includes all salaries in the personnel budget, including some reserves and civilians that appear on the Department of Defense budget.
19. This value is reassuringly close to the 5 – fold civilian wage gap in the Penn World Tables. It is also very similar to other studies such as Bartels (2022) and Allison and Glick-Unterman (2021) who likewise try to compare the cost of military personnel and the U.S.A., as well as Robertson (2022).
20. The fact that the relative price of civilian equipment is higher than the exchange rates has been viewed with some scepticism when presenting this research. The value, however, is from the World bank's ICP data. One explanation is that it reflects protection of China's indigenous manufacturing sector and also border and internal taxes. If the relative price of equipment is too high, this would mean that our military PPP estimates understate China's real military spending relative to the U.S.A.. An alternative is to use the market exchange rate for the price of Equipment, although this has a negligible impact on the results.

21. In particular, Firth and Noren (1998), in discussing the CIA' programme of estimating of Soviet defense spending, argue that the defense budget is the only practical way to communicate magnitudes and trends in military programmes.
22. For a discussion of this issue in Defense economics and attempts to estimate Soviet military spending see Holzman (1980, 1989) and Firth and Noren (1998), 148-50.
23. The Fisher quantity index is $Q^F = \sqrt{Q^L Q^P}$, where $Q^L = \frac{\sum_i p_i^u p_i^c}{\sum_i p_i^u q_i^c}$ is a Laspeyres quantity index of China's spending relative to the U.S.A. and $Q^P = \frac{\sum_i p_i^c p_i^c}{\sum_i p_i^c q_i^u}$ is a Paasche quantity index of China's spending relative to the U.S.A., and where p_i^u and $q_i^u$are the input prices and quantities of $i \in$ (Personnel, Operations, Equipment) for the U.S.A. and p_i^c and q_i^crefer to these for China. Dividing expenditure by Q_i^F gives the Fisher price index, P_i^F. The Törnqvist price index is $P^T = \prod_i \left(\frac{p_i^c}{p_i^u}\right)^{\theta_i}$ where θ_i is the arithmetic average of the i'th input cost share in China and the U.S.A.. Dividing expenditure by P^T gives the implicit price index. The Walsh index is defined below. See also ILO et al (2004) Chap. 17.
24. The data suggest that defence costs have risen more rapidly than average prices which suggest that China is getting less real output for a given defense burden, particularly due to rising labour costs. This can be thought of an example of Baumol's cost disease. For a further discussion see Robertson (2015). The Chinese and U.S. A. defense burdens are compared in Appendix A3.
25. This is based on SIPRI defense spending estimates, which makes some adjustments to China's official defense budget but may well not capture all defense budget items such as civil military fusions in research. As noted in Appendix 3, if China spent the same fraction of its GDP as the U.S.A., its defense budget in military PPP terms would be around 30% larger than the U.S.A.
26. All measures of military spending are only measures of inputs. Military power or capability also depends on the effectiveness in which the inputs can be brought together and factors such as morale, which may be independent of the inputs. According to Firth and Noren (1998, 143-44) the tendency to interpret PPP estimates of spending as measures of economic power, despite many disclaimers, led to widespread misunderstanding and mistrust of the CIA's estimates of Soviet military spending.
27. Unlike the Fisher index, the Walsh index can be decomposed into it's the input components budget shares. I am grateful to Robert Hill for suggesting using the Walsh quantity index in this context. The corresponding Walsh price index, obtained by dividing expenditure by Q^W, is $P^W = \sum_i \theta_i^u \sqrt{\frac{p_i^c}{p_i^u}} / \sum_i \theta_i^c \sqrt{\frac{p_i^u}{p_i^c}}$, where θ_i^u and θ_i^c are the expenditure share for input i in the U.S.A. and China. For further discussion see ILO et al (2004), 322).
28. More detailed results for the Walsh shares are given in Appendix 2 Table A5.
29. This would imply either inefficiency or that the defense sector has multiple objectives that extend beyond defense-such as employment creation.

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