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The Economics and Logistics of Horse-drawn Armies

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ABSTRACT
The capabilities of horse-drawn armies were recorded by contemporary observers and by later historians, nonetheless there has been a continuing debate regarding the capacity and workings of these forces, particularly once they were integrated with and then superseded by, newer forms of transport such as railways and motor vehicles. This paper argues that little attention has been paid to the wider economic environment in which these armies operated, and in turn the supply of these armies can be considered as an economic system in its own right.

Introduction

The horse was so ubiquitous in military life that they became almost invisible to contemporary writers. As a result, there are fewer written accounts of how they were used than one might expect, especially during campaigns. Yet their usage is key to our understanding of military operations. This article aims to use civilian accounts to understand how transportation was operated in the wider economy and the scope of trading links across Europe. It uses military accounts to understand how horse-drawn armies functioned, how they integrated with the civilian economy and how this changed over time. This allows the creation of a model incorporating the fundamental factors that affected horse-drawn armies between 1618 and 1945.

The most coherent account of the operation of a horse-drawn army was given by Géza Perjés in his 1970 paper on the last quarter of the seventeenth century.[1] This was used by Martin van Creveld as his principal source in his canonical 1977 book *Supplying War*. It formed the basis for van Creveld's theory that most horse-drawn

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[1]Géza Perjés, 'Army Provisioning, Logistics and Strategy in the Second Half of the 17th Century', *Acta Historica Academiae Scientiarum Hungaricae* 16 (1970), pp. 7–51.

armies drew on the local area for supply, and only resorted to magazine supply to conduct siege warfare. This view was challenged by John Lynn in *Feeding Mars* in 1993[2]. Believing that some of van Creveld's calculations were misleading, he claimed that the limitations on local supply had been ignored. The number of local ovens and mills were only sufficient to feed the local population and so Lynn shifted the emphasis back towards magazine supply. In the second edition of *Supplying War* in 2004, van Creveld addressed some of the gaps in the first edition, such as the American Civil War, but chose to ignore Lynn's challenge.[3]

This article seeks to widen Perjés viewpoint beyond the last quarter of the seventeenth century. Contending that while the viewpoint of both van Creveld and Lynn have their merits, neither adequately explain that horse-drawn armies represented a fine balance between competing factors and these in turn had an impact on the mobility of such armies. Similarly, armies represented a complex micro-economy, balancing their demand against a variety of available supply inputs. Nor have previous accounts taken into consideration the extent to which these armies were influenced and impacted by the economic landscape that each operated across. Finally, it is argued that this was not a static situation, as this landscape changed considerably between the seventeen and twentieth centuries as a result of wider technological and social evolution.

In order to understand these themes, this paper will examine three interconnected factors: *supply*, *demand* and *transport,* and how the relationships between them combined into a single output; *mobility*. Moreover, each factor represented a complex interaction between a variety of different elements, in the case of *supply* between elements such as population density, local trade networks and international merchants.

Theories on supply and mobility

Central to the debate as to whether armies supplied themselves from the local area or from distant magazines is the determination of the agricultural production of a region. Measuring agricultural production has always been a challenging problem for historians and the usual solution has been to use population density for pre-industrial societies.[4]

[2]John A. Lynn, *Feeding Mars: Logistics in Western Warfare from the Middle Ages to the Present* (Boulder, CO: Westview Press, 1993).

[3]Martin van Creveld, *Supplying War: Logistics from Wallenstein to Patton (2nd Edition)*, (Cambridge: Cambridge University Press, 2004), p. 307 note 10.

[4]E. A. Wrigley, 'Urban Gowth and Agricultural Change: England and the Continent in the Early Modern Period.', *Journal of Interdisciplinay History* 15, no. 4 (1985): p. 684.

This is not a new idea. Perjés cites Georg Kankrin's book *Über die Militairökonomie im Frieden und Krieg und ihr Wechselverhältniss zu den Operationen* from 1820[5]. Kankrin used his experience as an Intendant in the Russian Army during the Napoleonic Wars to establish that a 30,000 strong corps, could maintain itself from a local area for one to two days so long as the population density was greater than 35 inhabitants per km^2. From this Perjés concluded that for the second half of the seventeenth century, most of Europe outside of France and the Low Countries could not support armies without the use of magazines, because the population density of these countries was too low. In reality Kankrin adopted a more nuanced approach, as he considered that local supply did not cease, rather the shortfall was met by supply inputs from other sources: requisition across a wider area supplemented by transport from magazines and distant sources. Kankrin's ideas surrounding population density are given in Table 1 below.

Table 1: Kankrin's estimate of population density and supply methods

Type	Countries	Population density: Head per Q Meile in 1820[6]	Converted into head per km sq	Supply methods
Highly cultivated, food rich, great natural resources, roads and towns	Prussia, Silesia, Bohemia, Moravia, Germany, France, Belgium, Holland, northern Italy	1500-2000	36 – 27	Requisition from local area and quartering
Medium cultivation	Poland east of Vistula, Posen, Galicia, greater part of Hungary	1000	18	Mix of requisition, quartering with the aid of some supplies from a wider area or magazines
Medium cultivation, wealthy population but little grazing	Switzerland, central and lower Italy, Spain and Portugal and the mountains in France & Germany. North America and East India	1000	18	
Little cultivation, thinly populated	Very poor on the whole: Sweden, Finland, Belorussia.	< 1000	< 18	Magazines and supply

[5]Egor F. Kankrin, *Über Die Militairökonomie Im Frieden Und Krieg Und Ihr Wechselverhältniss Zu Den Operationen - Drei Band [On the Military Economy in Peace and War and Their Relationship to Operations - in Three Volumes]*, 3 vols (St Petersburg: 1820), http://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10526340_00005.html.

[6]A "Meile" was a Prussian unit of length equal to approximately 7.5 km and a Q[uarter] Meile was a measure of area equivalent to approximately 57 km sq.

or lacking grazing and grain production.	Better: Lithuanian, Liefland, Kurland			transport required to sustain armies which must not be too large
	Quite good: Russia, Greater and Lesser (Ukraine quite good) Vltava, Wallachia, parts of Bulgaria. South America, Anatolia in Turkey and Romania			
Semi desert, thinly populated with mountains or steppes	Norway, northern part of Russia, cultivated part of Siberia, Astrakhan, Caucasia, Georgia, large part of European Turkey, Bulgarian mountains, Persia and Western China	300	6	Unsuitable for large armies
Desert with few inhabitants but with little or no arable land, mainly nomadic herders	Lapland, greater part of Siberia, Kyrgyz steppe, Caucasian mountains around Mount Ararat. High mountains of Switzerland, Scotland, Pyrenees, greater part of Africa, North Africa.	< 300	< 6	Impossible to travel long distances but short distances or small corps can find the means.

Using this model, we come to a much more complex approach, as armies utilise numerous methods of supply that might change with time, circumstances, seasons or cost. The analogy with an economy is clear as an army's daily demand is met from a range of sources and via different routes. Determining factors might be availability, or cost, or physical effort, that is, a measure of moving one tonne a distance of one kilometre.

Previous authors have concentrated on the weight of cargo without considering the effort required to move it to the place of consumption. For instance, Lynn estimates the amount of horse fodder consumed daily per horse as 25kg of cut wet grass.[7] However Perjés is quite clear that green fodder was only fed from May to August and that for the remainder of the campaigning season, September to December, dry fodder of oats, hay and straw weighing 10kg was used.[8] By using his constant, Lynn overstates

[7]Lynn, *Feeding Mars,* p26 note 9. Compare with Prince de Ligne, *Military prejudices [and fantasies] by an Austrian officer [ie. the Prince de Ligne]. Volume 1,* (Brussels: A. Kralovelhota, 1780), p. 20, https://neptun.unamur.be/s/neptun/item/2112. Accessed 1 July 2020. Using his experiences during the Seven Years War the Prince gave the cut grass ration as 48kg (100 livres) and dry fodder ration as 3kg oats, 2.7kg hay and 4.5kg straw while others suggested a 12kg ration.

[8]Perjés, *'Army Provisioning'* p.15; see also Lee B. Kennett, *The French Armies in the Seven Years' War: A Study in Military Organization and Administration,* (Durham, NC: Duke University Press, 1967), p. 106.

the demand of the army horses for half of the campaigning season. If the effort required to deliver the forage to the army is considered, a different picture emerges. Cut grass, harvested within 10km and eaten within two days before it turned to compost: 0.05 tonne weight X 10 km = 0.5 tonne km. Dry forage carried the maximum distance: 0.01 X 140 km = 1.4 tonne km. Even when using the Prince de Ligne's heavier figure for green fodder, it can be seen that the effort required to provide dry forage required three times greater effort than collecting it locally.

It is probable that Clausewitz had read Kankrin's book and used it as the basis for his ideas on linking population density to the number of troops supported.[9] He assumed a unit would march three Prussian miles a day (23km) taking eight to ten hours or ten to twelve hours in hilly country and that it lost 1/150th of its strength daily from straggling. Clausewitz identified four methods of subsistence; subsisting on the inhabitants, contributions levied by the troops, general contributions and magazines, 'All of which were applied together, one generally prevailing more than the others'.[10]

For 'Subsistence on the inhabitants', the army used a 'system of subsisting troops by compulsory demands for provisions on the spot'.[11] 'Therefore in quarters which have never been occupied there is no difficulty in subsisting troops three or four times the number of the inhabitants for several days.' This he calculated at 2,000 inhabitants per Prussian *meile* square (57km^2) or 36 inhabitants km^2 with a corps of 30,000 men spread over four square *meile* (225 km^2 or an area with sides of 15km) holding 8,000 inhabitants, not including any large towns. Three corps spread out across 45km frontage could thus be supported with a second wave following on behind making the total force supported 150,000 men in total. Clausewitz notes that 'Forage for the horses occasions still less difficulty … only the deliveries of forage should certainly be demanded from the community at large'. In case of a halt in the march, the troops

[9]Kankrin's book, written in German, was published in 1820, the period when Clausewitz was doing his most intensive work on 'On war'. It cannot be definitely established that his book was available to Clausewitz at the Prussian *Kreigsakademie* but it was certainly held by other libraries across Germany. Kankrin was well known as he was the Russian army's chief intendant and had presented the report on the war to the Czar, together with his sponsor, Barclay de Tolly. See Dominic Lieven, *'Russia Against Napoleon'* (London: Penguin Book, 2016) p. 143, p. 544 n.14

[10]Carl von Clausewitz, 'On War. trans. Colonel J.J. Graham (London: Nicholas Trübner, 1873), Book 5, Chapter 14 "Subsistence"', online at https://www.clausewitzstudies.org/readings/OnWar1873/BK5ch14.html#a. Accessed 9 April 2019.

[11]Clausewitz, 'On War'", Ch. 11, 'Marches', https://www.clausewitzstudies.org/readings/OnWar1873/BK5ch11.html#a . Accessed 9 April 2019.

could feed themselves from the four days rations that they carried and then an additional four days' rations from the baggage train. Here, Clausewitz is providing a mathematical rationale for Kankrin's rule of thumb of linking population density to the size of military force and the area it forages. Similarly, Clausewitz's figures can by compared with Turenne and Montecuccoli's views from the middle of the seventeenth century, who considered 30,000 man armies to be the maximum sustainable size.[12]

Clausewitz stated that the ration of a horse weighed about ten times that of a man, that horses accounted for one third the number of men and therefore the total weight of forage required is 'three, four or five times as much as that of the soldiers' rations', so this requirement was met by local foraging expeditions. Although more modern scholarship puts the ratio at a lower minimum of 1 horse per 7 men the principle still applies.[13] Clausewitz notes that forage

> …is the most difficult supply to procure from a distance, on account of its bulk, and the horse feels the effect of low feeding much sooner than the man. For this reason, an over-numerous cavalry and artillery may become a real burden, and an element of weakness to an army.[14]

In his 1960 paper John G. Moore considered the transport implications for distant supply by comparing a *supply train* with an *expedition.*[15] He defined a *supply train* as columns of wagons moving supplies from a magazine to the army and then returning. Whereas an *expedition* saw the army and transport marching together from a railhead, using the wagons as a rolling depot. He showed that a typical army of the American Civil War, using 4,105 wagons, could be supplied at five days march or 160km by a *supply train* and the same army conducting an *expedition* could march for 14.3 days or 280km. So, an *expedition* could cover almost double the distance using the same amount of transport, simply due to its greater efficiency. However, the operational risk increased as the army had to reconnect with a source of supply at the end of its march or risk ruin. Moore's work was used by Edward Hagerman in his study of the American Civil War, particularly in his study of horse numbers.[16] He showed that

[12]David Parrott, *The Business of War: Military Enterprise and Military Revolution in Early Modern Europe* (Cambridge: Cambridge University Press, 2012), p. 184.
[13]Jean-François Brun, 'Le cheval dans la Grande Armée', *Revue historique des armées*, no. 249 (15 December 2007).
[14]Clausewitz, 'On War. Book 5, Chapter 14 "Subsistence"'.
[15]John G. Moore, 'Mobility and Strategy in the Civil War', *Military Affairs* 24, no. 2 (1960), pp.113.
[16]Edward Hagerman, *The American Civil War and the Origins of Modern Warfare: Ideas, Organization, and Field Command,* (Bloomington IN: Indiana University Press, 1988), pp.44 & 279.

armies in the West remained mobile despite seemingly large numbers of horses with ratios often as high as 1 horse per 2 men and 52 wagons per thousand men, because baggage remained light with most horses used for re-supply. In the east, the Army of the Potomac struggled to move at all, with a ratio of 1 horse per 5 men and 45 wagons per thousand due to its mountains of baggage.

The Triangular Model

By considering the army in the field as an economic unit, it can be seen to possess three interrelated fundamental factors: *demand*, *supply* and *transport* all influencing the output of *mobility*.

Demand is a largely a function of the size and composition of the army, multiplied by the scale of rations. It varies because some armies were frugal and efficient, carrying minimal baggage and having optimal artillery and cavalry numbers, while others had excessive baggage, artillery, cavalry, rations, and medical care. Clausewitz noted 'Generally the diminution of baggage tends more to a saving of power than to the acceleration of movement.'[17] Horse numbers alone were not a good indicator, as some horses were consumers waiting in camp to be fed (artillery, baggage and heavy cavalry,) while others were net contributors, providing supplies (foraging light cavalry and horses pulling supply wagons).[18]

Supply represents the available stock of a wide range of commodities needed by the army and can be divided into three categories. The army train carried the army's baggage, equipment, stock of rations, munitions and repair materials in the wagons and caissons of the army. Close supply was the sustenance drawn from the local agricultural networks in the foraging area of the army, plus whatever additional supplies can be gathered by local officials using networks across the province. While distant supply represented commodities carried to the army by its own transport or contactors from a depot or magazine. In turn, these depots had been filled using strategic transport routes such as rivers or railways or sea to carry the commodities from distant agricultural markets by merchants or government agencies.[19]

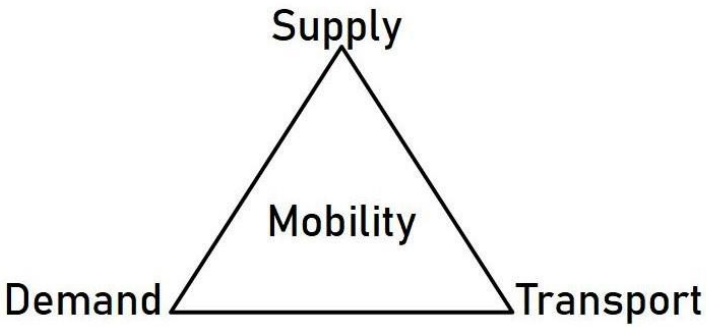
Transport moderated the available supply and was divided into an operational transport fleet provided by military, conscripted or civilian contractors which operated at both the close and distant supply levels providing the convoys linking the army with its magazines and depots. These depots were filled by the strategic transport fleet which was usually provided by civilian or conscripted contractors who delivered the distant supply from national and international markets. Operational transport had limited

[17]Clausewitz, 'On War'. Book 5, Chapter 11 "Marches".
[18]Kennett, *The French Armies in the Seven Years' War*, p. 67.
[19]Ibid., p. 99.

carrying capacity, short range and travelled slowly while strategic transport carried greater loads, more quickly and over much longer distances.

The outcome of the interaction of these three factors was mobility, and since horse-drawn armies varied little in the distance they could travel in a day's marching, (usually under 30km,) this was expressed as the number of days a week the army could march. The highest mobility was seen in a frugal corps, unencumbered by excess cavalry or artillery or baggage, marching through a well-populated landscape, drawing its supplies from the immediate area. The number of marching days was reduced as more effort was required in collecting supplies and friction increased once supplies needed to be delivered by convoys from afar and by excess baggage and horses.

Figure 1. The logistics triangle



Using Kankrin's threshold of thirty-five inhabitants per km^2 in Clausewitz's foraging zone of 230 km^2 (8,000 inhabitants) supporting a corps of 30,000 men, a table can be produced plotting national population density over time, which shows when countries became viable for self-supporting corps, as shown in Table 2.

Table 2: Population density by period

	Numbers of inhabitants per km²				
	1600	1700	1820	1850	1900
Great Britain	20	28	68	87	132
Netherlands	20	25	31	41	68
Belgium	52	66	112	146	220
France	39	46	66	77	86
Spain	16	18	24	30	37
Portugal	12	22	36	41	59
Italy	44	45	68	83	114
Switzerland	24	29	48	84	80
Germany	22	21	35	47	76
Poland	16	19	32	40	77
Austria	30	30	40	47	71
Hungary	13	16	45	55	77
Russia	5	7	14	19	31
Europe	19	21	35	44	62
United States				7.9	
Confederacy				4.6	

Shaded cells denote population density higher than the 35 inhabitants km² threshold for local supply of military forces of 30,000 men

Source: 'Maddison Historical Statistics | Historical Development | University of Groningen'. Accessed 15 October 2019. https://www.rug.nl/ggdc/historicaldevelopment/maddison/.

This only applies to a frugal, well-balanced force with a typical horse to men ratio of 1:7 which might have a demand of 146 tonnes a day (30,000 x 2kg + 4,300 x 20kg). By contrast, the Grande Armee of 1812 had a ratio of 1:4 which might translate into a demand of 210t (30,000 x 2kg + 7,500 x 20kg) or 40% greater.[20] Similarly the technique of 'marching divided, fighting united' in corps, only came into widespread use during

[20]Brun, 'Le cheval dans la Grande Armée', p.2.

the French Revolutionary Wars under General Moreau. Although the earliest example of splitting an army into 'corps' to reduce the burden on local supply was done by Peter I of Russia, the practice did not become widespread and eighteenth century armies generally marched in several columns ready to deploy into their battle formation. So individual armies must be assessed for their overall demand in relation to the standard and adjusted accordingly. When making these assessments, the model utilises fundamental factors that apply to all horse-drawn armies across the time period. There are other cultural factors arising from military custom, the ruler's whims or societal pressures which may influence a particular nation's armies for a number of years.

Supply: Economic Landscape

Central to Kankrin's theory is the link between agricultural production and population density which he measured in 1820. However, this did not remain constant, as the Agricultural Revolution raised productivity levels by a series of improvements in animal husbandry, crop varieties and agricultural machinery. These reforms were not uniformly carried out across Europe, with the greatest impact found in England, Belgium and the Netherlands, with middling performance in France, Germany and Italy and the weakest in Spain.[21] The rise in agricultural output per worker rose from a factor of 1.00 in 1500 to 1.15 in 1700 to 1.43 in 1800 in England yet the overall rise in agricultural production was less due to urbanisation and the reduction in the agricultural workforce. Increased availability of food allowed country dwellers to move into towns to pursue manufacturing and trade instead of agriculture so production per capita fell, in England from 0.85 in 1700 and 0.68 in 1800, while France remained steady at 0.65 throughout the period and the Netherlands went from 0.7 to 0.8 between 1700 and 1800 (England 1500 = 1.00). Overall the effect was that it was harder, or at best the same, to support an army from local supplies in 1700 than in 1800 for any given population density.

Care needs to be taken not to apply these factors in isolation since international trade was delivering foodstuffs by water from Eastern Europe to the cities of Western Europe as early as 1550. By 1670s Amsterdam was known as 'the granary of Europe'[22] and by 1750 Great Britain was a net importer of grain, with Polish grain being traded in the markets of London and Antwerp. This trend grew with the introduction of trans-oceanic steamships in 1819, followed by the mass importation of grain into

[21]Robert C. Allen, 'Economic Structure and Agricultural Productivity in Europe, 1300–1800', *European Review of Economic History* 4, no. 1 (April 2000): p. 16, https://doi.org/10.1017/S1361491600000125. Accessed 7 April 2019.

[22]O. Van Nimwegen, *De subsistentie van het leger: Logistiek en strategie van het Geallieerde en met name het Staatse leger tijdens de Spaanse Successieoorlog in de Nederlanden en het Heilige Roomse Rijk (1701-1712)* (Amsterdam: De Bataafsche Leeuw, 1995), p. 34.

Europe from North America from 1860s and this began to uncouple the relationship between population density and agricultural production.

For seventeenth century armies, Perjes proposed a cultural factor in that the number of mills was only sufficient to produce flour for a local population and could not meet the demand of a far larger army.[23] This seems unlikely for centres of the grain trade such as the Dutch Republic, which would have needed extra milling capacity. A problematic argument as agriculture was a surge activity, the entire harvest appeared in August and had to be processed for storage in the three months before November with sufficient flour ground to cover consumption over the next six months. Yet windmills only run for a third of the year, around 3,000 hours due to adverse wind conditions, too light in summer and too fierce in winter. When conditions are right they can process a 9kg bag of flour in 10 minutes, giving an annual production of approximately 150 tonnes per mill. Where watermills were used they suffer fewer restrictions, however they were limited by low water levels in summer and icing of ponds and damp conditions worked against milling flour in winter. At their height in 1850 there were 200,000 windmills and 500,000 watermills (many of these powered industrial processes such as forges and sawmills) across Europe.[24] Given these factors, a high proportion of the grain harvest was quickly turned into flour in the autumn and the balance in the spring and stored, available for the campaigning season. Magazines stored no more than a third of its stocks as grain because it was subject to mould and had to be changed every three years while the balance was stored as flour since this kept almost indefinitely.

In a similar vein, Lynn proposed another cultural factor during the wars of Louis XIV - the time it took to build of ovens constructed of bricks cemented with mortar.[25] These ovens took anything from two days to two weeks to build and so encouraged bread supply direct from magazines. In these circumstances the armies of Louis XIV managed to march less than 500 km in a campaign season, even though marching across some of the most productive farmland in Europe possessing a good infrastructure of roads and canals. However, the 'oven cultural factor' is challenged by events at the other end of Europe, as Charles XII's Swedish army marched up to 1,500 km in a campaign season between 1700 and 1709 and Peter I of Russia's army was not much slower. Moreover, their campaigning area had a lower population and far less developed infrastructure. How, then, did these armies march so far and fast when they

[23]Perjés, *'Army Provisioning',* pp. 7-9

[24]Kris De Decker, 'Wind Powered Factories: History (and Future) of Industrial Windmills', *Low-Tech Magazine,* Vol. 2009, Iss. 10, (October 2009). https://www.lowtechmagazine.com/2009/10/history-of-industrial-windmills.html. Accessed 3 May 2020.

[25]Lynn, '*Feeding Mars',* p. 20

should have been constrained by their ovens in a similar way as the French? In reality these armies were small enough to live off local supply and so avoided the need to draw supplies from magazines and build ovens.

As noted above, Peter went one step further by marching his army in separate bodies, so that it was spread out across a wider area. By comparison the armies of Louis XIV had a greater demand due to their larger numbers of soldiers, cavalry and artillery, extensive baggage train and numerous camp followers. This level of demand exceeded local supply and necessitated distant supply and ovens. The fundamental factor at work here was the size of armies in relation to the ability of the local area to support them. Large armies' problems with ovens may have been a contributory factor in making them slower, however the introduction of iron-hooped ovens in the 1740s, capable of being built in a day, did not increase French mobility significantly. It is interesting that Perjes in an earlier work states:

> The leaders of the Revolution and Napoleon were able to turn away from the magazine system because, in contrast to earlier times, the number of people in Europe increased, the population density increased and the productivity of agriculture increased. The armies found more food in the theatres of war, making the magazines superfluous. However, in those areas where the population density was just as high around the turn of the 18th to the 19th century, as in Western Europe in the 17th and 18th centuries, the magazines were still indispensable.[26]

Supply: State Agents, Entrepreneurs and the Contractor State

In 1988 John Brewer conceived the idea of the 'Fiscal-Military State' with its emphasis on nation state administration enacting effective fiscal policies so as to produce monetary resources to enable the waging of war sustainably.[27] This evolved through the work of Sanchez after 2004, into the concept of the 'Contractor State' where state administration worked with existing commercial supply chains, both domestic and international to deliver the resources of war.[28]

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[26]Géza Perjes, 'Die Frage der Verpflegung im Feldzuge Napoleons gegen Rußland [The question of supply in Napoleon's campaign in Russia.]', *Militärgeschichtliche Mitteilungen.* 1968, no. 2 (1968): p. 35. Author's translation.

[27]John Brewer, *The Sinews of Power: War, Money and the English State, 1688-1783* (Routledge: London, 1994).

[28]Rafael Torres Sánchez, *War, State and Development: Fiscal-Military States in the Eighteenth Century* (EUNSA: Pamplona, 2008). See also Richard Herring and Sergio Solbes Ferri (eds.), Contractor State Group. International Congress (4°. 2011. Las Palmas de Gran Canaria), The contractor state and its implications, 1659-1815, (Las

From this perspective, an army in the field was sitting at the centre of a web of pre-existing commercial flows of material and finance of the agricultural economy, that linked producers such as peasant farmers to distant consumers in towns and cities, through a series of merchants and hauliers. It can be seen that these flows had their own geography and were not uniformly spread across the landscape. So, while the army's own foraging and collection activities in the local area are important, it must be recognised that its own buying power pulled in goods and commodities from local peasants, regional merchants and through sutlers activities. Yet for some commodities such as flour, oats and meat, the demand was so large that the state had to contract with international markets to deliver these goods either to local magazines or, as was more common in the earlier period, direct to the army in the field. In contrast, the need for smaller amounts of commodities, such as firewood, candles, iron, wheels, cloth and spare parts, could be met from suppliers province-wide for use by the army's craftsmen (gunsmiths, blacksmiths, farriers, tailors, cobblers, wheelwrights and saddlers.)

This viewpoint provides an important explanation to the phenomenon of two armies in the same theatre of war, one of which had adequate supply while the other did not. With the theatre divided, so were the areas of production and trade networks which had to re-order themselves in order to keep functioning. Inevitably this gave one army an advantage in *supply,* yet the scale of that advantage depended on the efficiency of the armies in terms of contemporary military customs of organisation and operation. A frugal and efficient army could counter a disadvantageous supply position while one which had an inherently heavy demand might find itself in dire straits.

An example of these networks can be seen in the Combined Army in Germany in 1758-62 when the British government paid for an army of 100,000 men, of whom no more than 22,000 were British troops.[29] It employed '…British commissaries and contractors, and also Germans – as commissaries and other army employees, contractors, merchants, shippers and farmers….'[30] Supplies were drawn from Russia, the merchants of the Dutch Republic and Germany and even British farmers sent grain, even though Britain was a net importer. Local Bremen merchants such as *Schröder, Behrens and Wetzlar* handled contracts to obtain 500 tonnes (5,000 sacks or a week's supply for the army) of rye meal. These commodities were warehoused at Bremen,

Palmas de Gran Canaria: Universidad de Las Palmas de Gran Canaria, Servicio de Publicaciones, 2012) p. 13.

[29]Stephen Conway, 'Provisioning the Combined Army in Germany 1758-1762: Who Benefited?', in Harding and Ferri (eds.), *The Contractor State and Its Implications*, pp. 77–98.

[30]Ibid., p. 79

then shipped down the Weser by German bargemen to a magazine at Hameln, where the flour was baked into bread and then transported to the army in locally hired German wagons, by British contractors such as Lawrence Dundas and Richard Oswald. This meant that the army commander, Prince Ferdinand of Brunswick-Lunëburg, was reliant on a supply chain stretching a distance of 415km from Bremen to his headquarters at Dulmen, with 250km transported by water as far as Hameln, then 135km by road to the forward magazine at Munster, which forwarded them the last 30km to Dulmen.[31]

In terms of overall costs subsistence represented the major expenditure. For instance, the Austro-Hungarian Army of 1758 spent 56% of its 37,320,000 florin budget on a daily supply of 214,011 bread rations, 76,786 fodder rations and 700 oxen a week driven from Hungary and Poland.[32] Similar figures for the French army in 1741, showed that meat and bread supply accounted for 38%, transport 20%, pay 15%, clothing 14%, fodder 8% and recruiting 5% of expenditure.[33]

For all this effort and expenditure, the reality was that supply often failed with soldiers and horses going hungry for long periods, as a French Napoleonic cavalryman, De Brack commented 'I made eight campaigns in the time of the Empire and always with the outposts; I did not see during all that time one single *'commissaire des guerres';* I did not receive a single ration from the army's depots.'[34] These depots need closer consideration at this point.

Supply: Magazines and depots

The creation of major magazines is usually attributed to the work of François-Michel Le Tellier, Marquis de Louvois, in 1660s, and the development of the French magazine system certainly accompanied and facilitated a somewhat unexpected expansion of the French army. Magazines represented a considerable, sustained effort in terms of planning and finance. By 1752 Frederick II of Prussia had acquired 43,300 tonnes (53,000 bushels) of flour and grain stored at Berlin, Stettin, Magdeburg and Breslau,

[31]Reginald Savory, *His Britannic Majesty's Army in Germany during the Seven Years War,* (Oxford: Oxford University Press, 1966), p. 101.
[32]Christopher Duffy, *Instrument of War: The Austrian Army in the Seven Years War,* (Rosemont IL: Emperor's Press, 2000), pp. 101, 323.
[33]Jöel Félix, 'Victualling Louis XV's Armies. The Munitionnaire Des Vivres de Flandres at d'Allemagne and the Military Supply System.' in Harding and Ferri (eds.), *The Contractor State and Its Implications,* pp. 101.
[34]John R. Elting, *Swords around a Throne: Napoleon's Grande Armée* (London: Orion, 1999), p. 554.

sufficient to supply an army of 60,000 men for two years.[35] On this basis, each magazine could supply the field army for around 6 months. He built a fleet of thirty barges carrying around 4,000 tonnes to move this cargo on its 400km journey along the canals and river Oder to Breslau and from there it was hauled by wagon 55km to the forward magazine at Schweidnitz.[36]

Acting as the link between long distance transport and the army in the field, magazines were usually placed in large, fortified towns on navigable rivers or canals with a good road infrastructure. This allowed them to forward supplies to the field army by wagon convoys, or to act as depots by armies that were conducting an expedition. The local civil administration was often involved in the collection of supplies from the surrounding province while the state sent supplies from further afield. They often formed victualling and rest points for *etappen*, the fixed routes of march for reinforcements or drafts of recruits, the most famous example of which was the Spanish Road linking Lombardy with the army in Flanders.[37]

By the end of the eighteenth century, agricultural production had grown sufficiently to allow armies to support themselves by requisition, albeit at the cost of constant movement. This transition period saw a number of examples of magazine supplied armies facing requisition supplied armies such as the British campaign on the Portuguese-Spanish border between 1809-1813.[38] Sir Arthur Wellesley's frugal army contained limited cavalry, artillery and baggage and was supplied by river transport which filled a chain of inland magazines, 65km apart using bullock carts travelling six km a day. The link between magazines, army and transport for the train was provided by columns of mules marching 22km a day carrying 100kg per mule. This antiquated transport system not only supported a force of 50,000 men but also sustained a number of sieges of frontier towns. By contrast French forces were larger, like Masséna's Army of Portugal of 65,000 men, contained greater numbers of horses and artillery and struggled to maintain themselves in the country using requisition. Two logistical systems therefore produced different tactical forces with varying levels of

[35]Christopher Duffy, *The Army of Frederick the Great*, (Newton Abbot: David & Charles, 1974), p. 134.
[36]Neil Cogswell, *Zweybrücken in Command*, *The Reichsarmee in the Campaign of 1758*, (Warwick: Helion, 2019), *p.* 21.
[37]Geoffrey Parker, *The Army of Flanders and the Spanish Road, 1567-1659: The Logistics of Spanish Victory and Defeat in the Low Countries' Wars* (Cambridge: Cambridge University Press, 2004), pp. 45.
[38]Troy Kirby, 'The Duke of Wellington and the Supply System During the Peninsula War', master's thesis, US Army Command and General Staff College: Fort Leavenworth, KN, 2011. https://apps.dtic.mil/dtic/tr/fulltext/u2/a547395.pdf. Accessed 1 July 2019

mobility for the generals to use in theatre according to their abilities. These forces would make varying demands on resources, reflecting their tactical and operational needs and their composition.

Demand

Armies were in large part a product of their society and their composition was based more on what could be raised than a rational balancing of weapon and troop types. Army commanders attempted to exert some level of control over the number of horses and baggage carried yet these attempts were quite limited in scope, as armies attracted large numbers of servants, sutlers and camp followers who provided both food and entertainment for the officers and men. The benefits and the penalties of excess baggage were clearly understood by contemporary writers:

> Since the wars of the French Revolution, armies have completely done away with the tents on account of the encumbrance they cause. Partly it is found better for an army of 100,000 men to have, in place of 6,000 tent horses, 5,000 additional cavalry, or a couple of hundred extra guns, partly it has been found that in great and rapid operations a load of tents is a hindrance, and of little use. But this change is attended with two drawbacks, viz., an increase of casualties in the force, and greater wasting of the country.[39]

Similarly, a British Army instruction of 1789 correctly identified baggage and artillery as the main culprits,

> In opposing the enemy in this manner, everything depends on the Alertness of the troops, on the Lightness of their equipment, and being free from every Incumbrance of Baggage and Carriages and even the Artillery employed should neither be numerous or heavy.[40]

In this case each regiment was restricted to bread wagons each carrying 1,200kg (1,600 rations of 0.7kg each,) four wagons and two sutlers carts with 35 bat-horses carrying tents, officers baggage and the surgeons chest.[41]

The effect of controlling demand on logistics can be seen at the end of the horse-drawn period, when the standard model of European armies in the Second World War, was of an army comprising a small armoured/motorised force with the bulk rifle-

[39]Clausewitz, On War, Ch. 9 "Camps".
[40]Sir William Fawcett, *Instructions Relative to the Baggage and Marches of the Army* (War Office: London, 1798), p. 7, http://archive.org/details/instructionsrela1798grea. Accessed 1 July 2019.
[41]Ibid.

armed infantry supported by heavy artillery, little different from that of the First World War. Mobilisation, strategic and operational movement was conducted by rail while tactical movement was horse-drawn. Motor vehicles supported armoured forces, pulled the heavy artillery and provided the supply link between the rail-head and the armies. The wartime Red Army was no different, fielding 6,750,149 men, 366,959 vehicles (268,428 cargo,) and 791,611 horses (or roughly 9:1, men : horse) in the operational army on 1 January 1945 and, even with Lend Lease vehicles, was no more motorised in 1945 than it had been in 1941.[42] In order to reduce the demand on long-distance transportation, these types of armies still drew large amounts of sustenance for both men and horses from their local areas with the Red Army drawing 65% of its food supplies locally.[43]

The fundamental change in demand was for the large amounts of artillery ammunition which now exceeded all other types of supply combined. Soviet military science demonstrated that the main demand for ammunition came in breaking through the enemy lines and that further fighting during the pursuit or in encounter battles was relatively modest. Typically the plan for conducting a fifteen day army operation used 2-3 *boekomplekt* (ammunition loads or 9,000 tonnes) for the breakthrough battle, 0.5 *boekomplekt* a day (1,500t) for further fighting and 0.25 a day (750t) for the pursuit.[44] So long as the breakthrough battle could be fought from depots established just behind the front line and close to a railway, the rest of the munitions demand could be met by horse-drawn transport conducting an expedition and was of a similar order of magnitude to previous eras.

Typically, in the mid-war period a Combined-Arms Army fielded 55,000 men, 3,000 vehicles and 9,000 horses and relied for its supplies on railways. The Rifle Divisions were horse-drawn leaving the bulk of motor transport to draw heavy artillery guns, leaving just 300 supply vehicles (700t) sufficient to meet day to day needs, carrying supplies 75km from the nearest rail-head. In order to gather stocks behind the front line to sustain the offensive, most of the army's vehicles had to be stripped from the combat units and used for hauling supplies. The build-up lasted two weeks then motor

[42]H. G. W. Davie, 'Logistics of the Combined-Arms Army – Motor Transport', *The Journal of Slavic Military Studies* 31, no. 4 (2 October 2018): pp. 474–501, https://doi.org/10.1080/13518046.2018.1521360. Accessed 1 July 2019

[43]Wendy Goldman & Donald Filtzer, *Hunger and War: Food Provisioning in the Soviet Union during World War II* (Indiana IN: Indiana University Press, 2015), p.104 note.19.

[44]G.E. Peredel'skiĭ, A.I. Tokmakov, and G.T. Khoroshilov, *Artilleriia͡ v Boiu͡ i Operatsii͡ : (Po Opytu Velikoĭ Otechestvennoĭ Voĭny) [Artilllery in Battles and Operations]* (Moskva: Voenizdat, 1980), Ch. 2 Artillery Offensive authors calculations, http://militera.lib.ru/science/peredelsky_ge/index.html. Accessed 1 July 2019.

vehicles returned to their units. Once the offensive started, the army relied for the bulk of its supplies for the next 12 days on the stocks carried in the horse-drawn transport marching alongside the infantry, motor vehicles pulling the heavy artillery and motor transport shuttling between the depots on the old front line and the advancing troops. This depended on the Rifle Divisions having a light cargo weight and minimising demand to just rations, fuel and ammunition during the period of the advance to ensure maximum horse-drawn mobility. It should be obvious that an understanding of mobility requires an exploration of the different modes of transportation available.

Transport

> A broad-wheeled waggon, attended by two men, and drawn by eight horses, in about six weeks time, carries and brings back between London and Edinburgh near four ton weight of goods. In about the same time a ship navigated by six or eight men, and sailing between the ports of London and Leith, frequently carries and brings back two hundred ton weight of goods. Six or eight men, therefore, by the help of water-carriage, can carry and bring back, in the same time, the same quantity of goods between London and Edinburgh as fifty broad-wheeled waggons, attended by a hundred men, and drawn by four hundred horses. [45]

In the above, Adam Smith succinctly demonstrated the 50:1 ratio of costs of moving across the landscape by land or water and further calculated that the land needed to graze one horse could feed eight men. As a result of these costs, towns were built close to waterways, trading routes followed rivers and coastal patterns and roads were fewer, expensive and limited the type of goods it was economic to carry. The sole advantage of road travel was that it was faster, keeping to time compared to wind powered shipping. The result was that the main means of moving low value, bulk industrial and agricultural commodities such as coal and wheat was by river or coastal shipping, while long distance road transport was reserved for high value, finished goods, such as textiles or perishables like fish or butter which warranted the extra expense. This is what Braudel meant when he coined the phrase 'The tyranny of distance.'[46] Yet as Onorato, et al have shown in the case of France, transport was the main determinant of the size of armies and railways made mass armies possible by changing the dynamics of mass mobilisation rather than affecting the ability to supply them.[47]

[45]Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (London: A. Strahan & T. Cadell, 1793), p. 31, http://online.canadiana.ca/view/oocihm.49748 Accessed 1 November 2020

[46]Fernand Braudel, *Civilization and Capitalism: 15th-18th Century* (London: Collins, 1985).

[47]Massimiliano Gaetano Onorato, Kenneth Scheve, and David Stasavage,

Consequently military, strategic long distance travel was often easier by water and later by railways, which could carry large amounts, cheaply and speedily, though across a limited network. Meanwhile, travel at the operational level by road was expensive, slow and difficult. For the military establishment this posed a particular problem as its main cargo was bulky materials such as flour, oats, hay and straw. In civilian life, these commodities would normally be carried by water or turned into finished products shipped by road. In this sense, the standard military cargo was an unusual cargo for land transport.

There were three types of road conveyance, packhorses, two wheeled carts and four wheeled wagons, with the first two being used from medieval times and the wagon appearing around the 1560 from the Low Countries and gradually superseding carts by 1630.[48] Carts might use up to five horses pulling a one tonne load while wagons might use up to eight horses in file pulling four tonnes. Packhorses could cover up to 60km in a day or 240km in a week and waggons 200km but the speed began to increase from the 1690s in England, as roads improved along major routes, with a second increase in the 1790s with the introduction of new designs of lighter wagons and the use of relays of horses in "stages" along the route. A stage system saw the wagon and load moving continuously throughout a 24 hour period while the horses and drivers are changed every six to eight hours. The service from Southampton to London, 130km away, took sixty hours in the 1770s along the turnpike, but had dropped to thirty-six hours by 1820 by using stages and fly-wagons. Furthermore, between the early 17th century and 1820 horses doubled the load they could pull, while at the same time the amount of provender (fodder and grain) was reduced by a quarter. This is borne out by calculations on the efficiency of working horses in 1924, which showed horses pulled 1.5 tonne 32km a day or heavy horses pulled 5 tonnes, 15km a day, producing 380 tonne-km a week which was three times the work generated by carrier's horses in 1816.[49] This greater efficiency was achieved largely through road improvements, by reducing gradients and through developing better and stronger breeds of horses.

The characteristics of different types of waggons are given below in table three and examples of mid eighteenth century vehicles are illustrated in *"Die Österreichische Armee im Siebenjährigen Krieg"*[50]

'Technology and the Era of the Mass Army', *The Journal of Economic History* 74, no. 2 (June 2014): p. 473, https://doi.org/10.1017/S0022050714000321. Accessed 1 July 2019

[48]Dorien Gerhold, *Road Transport in the Horse-Drawn Era,* (Aldershot: Scolar, 1996).

[49]Ibid., p. 221.

[50]Lars-Holger Thümmler, *Die Österreichische Armee im Siebenjährigen Krieg*, (Berlin: Brandenburgisches Verlagshaus, 1993), p. 101–8.

Table 3: Wagon characteristics from contemporary sources

Date	Name	Details	Draft horses	Weight of wagon	Load carrying (kg)	Days march (km)
1756	Commissariat wagon	Frederick the Great	4 horses in pairs		980 kg	29
1756	Company bread wagon	Frederick the Great			760 kg	29
1795	Wagon	British Commissary	4 horses in pairs		800 kg on unpaved roads	
1795	Wagon	British Commissary	4 horses in pairs		1360 kg on paved roads	
1812	Comtoise	Napoleon's light baggage wagon	4 horses in pairs		1000 kg	32
1812	Fourgon	Napoleon's heavy baggage wagon	4 oxen in pairs		1090 kg	
1813	Brandy wagon	Barrel wagon	single horses			
1813	Deckelwagen	Heavy baggage wagon	4 horses in pairs	25 Zentner or 1,250 kg	28-32 Zentner or 1,400-1,600 kg	
1813	Vorratswagen	Light baggage wagon	4 horses in pairs		20 Zentner or 1,000 kg	
1865	Escort wagon	Sherman	6 mules in pairs	907 kg	2,040 kg	45
1865	Escort wagon	Hollabird good roads + 5-10 days of horse grain ration	6 mules in pairs	907 kg	1,820 kg	45
1865	Escort wagon	Hollabird dirt roads + 5-10 days of horse grain ration	6 mules in pairs	907 kg	1,365 kg	34
1865	Escort wagon	Hollabird wild country + 5-10 days of horse grain ration	6 mules in pairs	907 kg	910 kg	34
1914	GS Wagon Mark IX	British Army First World War	4 horses in pairs	891 kg	1,224 kg	40
1940	leichte Heeresfeldwagen Hf.1	German Army Second World War light cargo wagon	2 horses in pairs	610 kg	750 kg	40
1940	schwerer Heeresfeldwagen Hf.2	German Army Second World War heavy cargo wagon	4 horses in pairs	800 kg	1,200 kg	40

Sources:
Duffy. *The Army of Frederick the Great.*
H. le Mesurier, *The British Commissary, in Two Parts. Part I. Part II.* (London, 1801).
Ségur, Philippe-Paul. *Histoire de Napoléon et de la Grande-Armée pendant l'année 1812. Tome I & II*, (Paris, 1824). https://www.gutenberg.org/ebooks/19972.
E.F. Kankrin, *Über Die Militairökonomie Im Frieden Und Krieg Und Ihr Wechselverhältniss Zu Den Operationen - Drei Band [On the Military Economy in Peace and War and Their Relationship to Operations - in Three Vols]*. (St Petersburg, 1820.)
http://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10526340_00005.html.
Edward Hagerman, *The American Civil War and the Origins of Modern Warfare: Ideas, Organization, and Field Command*, (Bloomington, IN: Indiana University Press, 1988)

War Office. *Field Service Pocket Book, 1914*. H.M. Stationery Office, (London 1914). This gives the average draw weight of a light draught horse of 1200lb (544kg) and a heavy draught horses of 1,600 (726kg) for 20 miles (32km) a day
Wolfgang Fleischer, *German Infantry Carts, Army Field Wagons, Army Sleds, 1900-1945*. (Atglen, PA: Schiffer, 2000.)

Yet enough waggons and beasts had to be found. An illustration of limited amount of transport available can be seen in a letter written by Prince Ferdinand of Brunswick to the Marquis of Granby during the Seven Years War.[51] He complained that he needed to support his army over a distance of 135km from its magazine at Kassel to Gleissen and that the main problem for the army was obtaining sufficient transport. The 30,000 daily rations were carried in 600 waggons with four stages covering the distance (each a day's travel of 30km between towns) which would require 2,400 waggons, with another 2,400 waggons to account for the return journeys. To sustain this operation, further horses were required to allow rest days, yet the entire Kingdom of Hesse could only provide 2,400 wagons in total. It was consequently far from easy to ensure mobility that was adequate for operational needs.

Mobility: frequency of marching or the tempo of operations

A good example of a commander benefiting from high mobility is King Frederick II of Prussia during the Seven Years War. The challenges he faced in 1757, at both strategic and theatre levels, virtually dictated a need for speed and endurance. The enemy forces ranged against him consisted of a French army in Hannover, a French force with the *Reichsarmee* in Franconia, Austrians in Saxony, the main Austrian army in Bohemia, Russian armies approaching Brandenburg and Swedes in Pomerania. Assembled to counter these threats were the Combined Army of German states in Hesse, Prince Henry's Prussian corps in Saxony and Frederick's main army moving between Prussia's southern and eastern provinces. In such circumstances, Frederick needed to fight a series of decisive battles to destroy the enemy armies one after the other, and to avoid long sieges.

However, things did not go according to plan, and by June 1757 Frederick had been forced out of Bohemia and the Franco-Austrian armies were threatening to converge in overwhelming numbers on Silesia. In order to forestall this, Frederick conducted three marches between theatres. From 25 August to 15 September he marched from Lobau in Upper Lusatia to Gotha in Thuringia, a distance of 320km. Then he conducted a second march from 11 to 19 October from Thuringia towards Berlin in pursuit of Count Hadik's raid, a distance of 170km. Then following the defeat of Soubise and the *Reichsarmee* at Rossbach, Frederick marched from 13 to 28 November between

[51]John Manners, Marquis of Granby, *A Letter to the Most Noble John Manners, Marquis of Granby, Commander in Chief of the British Forces under Prince Ferdinand of Brunswick* (London: Printed for J. Pridden, 1760).

Leipzig to Parchwitz in Bohemia, a distance of 310km before winning a victory at Leuthen on 5 December 1757.

He conducted these marches by taking a core army (18 battalions and 23 squadrons of cavalry around 12,000 strong[52]) then reinforcing it at the destination with local troops. Loading the train with eighteen days supplies so that he could conduct an *expedition* and drawing further supplies from towns along his route of march. The importance of this is shown during his return march through an already denuded Bautzen, as he sent a supply column from Leipzig to re-stock it before his arrival.

Importantly, once in theatre Frederick reverted to a system of weekly movements between fortified camps, supplied by convoys from magazines 'especially in Bohemia, where the country is but little better than a desert'.[53] The army drew some supplies locally since it had a large body of sutlers who performed a vital function in supplying food and other commodities.[54] By comparison Soubise's army that year had 12,000 camp followers for his army of 30,000 men, The official Prussian bread and meat ration were carried from some distance travelling down a western route carried by boats along the river Elbe, from the magazine at Torgau to Pirna at the border and then by a 140km *etappe* by a combination of road and water to Prague. For the eastern route, the starting point was Zittau, down the textile trade road to Reichenberg and then along the river Iser to Prague, a distance of 140km.[55]

This illustrates that Frederick's army was quite capable of rapid marches since it had a proper balance of cavalry and artillery with restrictions on its baggage train. Other armies such as the French, weighed themselves down with too many horses, too much baggage and large numbers of camp followers. It must be stressed that tactical considerations were the main inhibition to rapid movement, as Frederick having conducted his rapid march from Bohemia into Saxony, then spent a period of eight weeks, from 15 September to 4 November operating in this theatre from fortified camps supplied by magazines. He was waiting for the French and *Reichsarmee* to make

[52]Christopher Duffy, *Prussia's Glory: Rossbach and Leuthen 1757* (Helion: London, 2019), p. 43.

[53]King of Prussia, Frederick II and Thomas Foster, *Military Instruction from the Late King of Prussia to His Generals: Illustrated with Plates* (Sherborne: J. Cruttwell, 1818), p. 14, http://archive.org/details/militaryinstruc00prusgoog. Accessed 1 July 2019

[54]Thomas Cardoza, *Intrepid Women: Cantinières and Vivandières of the French Army* (Bloomington IN: Indiana University Press, 2010), p. 22.

[55]Grosser Generalstab. Kriegsgeschichtliche Abteilung II, *Die Kriege Friedrichs des Grossen.* (Berlin: Mittler, 1890), vols 3. Der Siebenjährige Krieg. 1756-1763., https://archive.org/details/diekriegefriedr00unkngoog2. Bd. Prag. Skizzie 12. Accessed 1 July 2019.

a mistake and allow the tactical opening that resulted in the battle of Rossbach. All through this period the Austrians were allowed free rein in Bohemia, so Frederick was under intense pressure to defeat the French and return there.

An equally illuminating pattern of mobility, but for an entire war, can be found several decades earlier. It is a shame that we do not know the identity of 'An Impartial Hand' since the source provides an excellent table showing the activities of the British Army during the Spanish War of Succession between 1701 and 1713.[56] These activities divided the year into Garrison and in the Field, how many days were marched and the distance. Of the 12 years and one week covered or 4,387 days, only 2,184 were spent in the field, of which 500 days were spent marching 8,864km. Essentially this shows that the army only marched every 4.4 days when in the field or 1.6 days a week and that these marches covered only 17km a day or 24km a week. Even allowing for lengthy sieges, this stately progression allowed plenty of time for supply convoys to deliver supplies from magazines over quite limited distances. However, as Perjés has observed, the regular cycle of army activity left little time for advancing into enemy territory.[57]

[56]Richard Kane, *A System of Camp-Discipline, Military Honours, Garrison-Duty, and Other Regulations for the Land Forces. Collected by a Gentleman of the Army. In Which Are Included, Kane's Discipline for a Battalion in Action; with a Map of the Seat of War, Lines and Plans of Battles, &c. To Which Is Added, Kane's Campaigns of King William and the Duke of Marlborough, from 1689 to 1712. Second Edition Continued ... to 1757. By an Impartial Hand.* 2 volumes, (London: Milian, 1757).
https://books.google.co.uk/books?id=YEEIAAAAQAAJ Accessed 1 July 2019

[57] Perjés, *'Army provisioning'*, p. 43-44

Table 4: Examples of changing tempo of operations

	Spanish Succession	Seven Years War		Napoleonic Wars	American Civil War
	1702-1712	1757		1812	1 Jan 1863 - 24 Mar1864
	Allied	Austrian	Prussian	French	Union
Garrison Days	178	131	107	192	115
Campaign Days	195	234	258	117	323
Marching Days	39	46	90	66	112
March Days in campaign	20.0%	19.7%	34.9%	56.4%	60.1%
Distance march (km)	706	600	1535	945	1826
March per day (km)	16	13.0	17.1	14.3	16.3
Days march/week	1.4	1.4	2.4	3.9	4.2
Distance/week (km)	22	18	42	57	69

Similar data can be collected for other periods using personal diaries such as the one kept by Horace St. Paul during the Seven Years War, or by Charles Wills during the American Civil War and in some cases there is sufficient detail from military histories to study King Frederick II's or Napoleon's movements during the 1812 campaign and these are given in Table 4 above.

This table shows that the tempo of operations steadily increased over time. Armies did not march significantly harder to increase the distances covered during their campaigns, rather they simply marched more often, spending less time in camp or tied down in sieges. This posed a problem for horse-drawn supply convoys since they only maintained a narrow advantage in speed over that of their army and they relied on it staying in camp for extended periods to catch up. Once these stays became shorter, different transport methods were needed if armies were not to become overstretched and burned out. Armies increasingly conducted expeditions from temporary depots provided by railways in preference to basing themselves on fixed magazines in frontier fortresses.

While Perjés sought to understand the mechanics of late seventeenth century horse-drawn armies, this paper widens that view including the whole period from 1618 to 1945. This facilitates a whole and different set of influences, incorporating Perjés earlier work on Napoleonic armies, the works of Moore and Hagerman on horse numbers in the American Civil War and Soviet ideas about the timing of demand. By considering this broader picture, a number of fundamental factors which were common to all horse-drawn armies emerged and the possibility to establish

relationships between these factors and their outputs. As we have seen, all horse-drawn armies lived within the landscape through which they travelled and this limit on *supply* imposed a restriction on both the size of armies and their ability to concentrate. Exceeding this limit required distant supply, which was very costly and restricted by the available *transport*. These two factors represented two sides of the *logistics triangle* and were to a great extent beyond the control of military commanders or their governments. Nonetheless they could control *demand*, the third side of the triangle, which was determined by societal factors and military custom, as in the composition of armies, number of horses, scale of rations, medical support and operational practice.

Within the framework imposed by *supply* and *transport* on horse-drawn armies, controlling *demand* determined whether they could reach the limits of mobility and logistics. Nor was this situation static, as population growth and economic improvement gradually provided more resources and improved transport infrastructure to armies. This military activity was maintained and supported by an invisible web of commerce and trade that linked the field armies to the wider economy through a number of mechanisms and agents, from the humble soldier's wife acting as a regimental sutler buying chickens from local farmers to resell as soup, right through to Amsterdam merchants laying out contracts to buy wheat in Poland and deliver it to soldiers a thousand kilometres away.