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Weapons and Wealth: Economic Effects of the Lucca's War in Florentine Arms and Armour Production (1429–1433)

Summary: In traditional historiography, the wartime context is often judged to have had a uniformly negative impact on medieval economies. While this assessment holds in many respects, it has overlooked the specific sector of arms and armour production and trade, owing to a longstanding lack of focused study. This historiographical gap has thereby distorted our understanding of the period's economic reality. The present research, grounded in the payment mandates preserved by the *Dieci di Balìa*, the Florentine war office, during the War of Lucca (1429–1433), seeks to fill that void by offering a concrete appraisal of the arms and armour economy.

By examining every recorded expenditure on artillery and firearms with their accompanying gunpowder and bullets, on crossbows and the accessories required for their operation, on polearms, and on defensive armour, the study harnesses the richness and precision of archival evidence to reconstruct quantities purchased, total outlays, production locations and the identities of individual suppliers. Repeated spikes in spending correspond closely with the most intense phases of the campaign, demonstrating that demand for weaponry generated a marked, localised surge in economic activity. Notably, rural hamlets such as Montefioralle and La Trappola emerged as specialised centres for crossbow bolt manufacture, while a Florentine apothecary came to dominate the gunpowder supply.

Contrary to the prevailing view that war uniformly depressed Florentine economic life, the conflict with Lucca functioned as a powerful stimulus for sectoral growth, furnishing blacksmiths, carpenters, barrel makers and arms dealers with exceptional earning opportunities. By mapping the supply chains behind every cannon, bolt and spear and by correlating expenditure peaks with the military chronology, this study demonstrates that late-medieval warfare could serve

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as a positive-sum catalyst, anticipating the organised armaments industries of later centuries and calling for a substantial revision of traditional narratives about the economic impact of war.
Keywords: Military Labour, Renaissance Florence, Renaissance Warfare, Renaissance War, Siege of Lucca

Introduction: An Unsuccessful War (1429–1433)

For the Republic of Florence, the conquest of Lucca meant acquiring the last important part of the north of Tuscany, thus unifying almost the entire region, with the sole exclusion of the Sienese territories. In December 1429, Florence besieged the city.[1] After one year from the start of the war, Genoa sent the mercenary chief Niccolò Piccinino, who defeated the Florentine army.

Concerned that the Duke of Milan would take advantage of the situation to conquer the northern territories of Tuscany, Venice and Pope Eugene IV re-established the alliance with Florence. At the beginning of January 1431, hostilities also began in northern Italy. The first four months of 1431 were really difficult for the Florentines: Piccinino conquered many localities, and Lucca made further alliances with Milan and Siena. After Niccolò Piccinino's return to North Italy, the Florentine army managed to regain the lost territories. The clashes also continued at sea, and at the end of August of that year, the Venetians and Florentines defeated the Visconti-Genoese fleet in the battle of Rapallo.

At the beginning of June 1432, the Florentines defeated the army of Lucca, Siena and part of the Milanese in the battle of San Romano. From this moment, Florence maintained a defensive position, without incurring new important clashes. In northern Italy, the conflicts continued until November, when the Visconti army defeated the Venetians in the battle of Delebio. In December, the parties began to seek an acceptable agreement. After months of negotiations, they signed a peace treaty in Ferrara on April 1433.

Armaments

Purchasing ammunition was one of the most logistically demanding tasks for the Florentine office of war, the *Dieci di Balìa*.[2] Indeed, they had to purchase a considerable and disparate number of weapons and ammunition from multiple manufacturers

1 For a more accurate reconstruction of the conflict see: Picchianti S. 2024c chapter first.

2 Some of the late 15th century records produced by the *Dieci di balìa* have already been the subject of analysis. See: Ansani F. 2016; Ansani F. 2017a; Ansani F. 2017b; Ansani F. 2018; Ansani F. 2019; Ansani F. 2021a; Ansani F. 2021b; Ansani F. 2021c; Picchianti S. 2024a.

and then send these materials where needed.[3] These armaments can be divided into macro groups: artillery and handgonnes/bullets, gunpowder and barrels; crossbows, bows and spanning Devices spanning/crossbow bolts, arrows and crates, polearms, defensive armaments; finally, a miscellaneous group of useful tools for military camps.

Artillery and Handgonnes, Bullets, Gunpowder and Barrels

Artillery is generically defined by the documentation as bombards (*bombarde*), but in some cases, they have additional descriptions. By analysing the terminology used and comparing it with their relative weights in pounds (lb),[4] it was possible to divide them into three categories: great bombards (*bombarde grosse*); medium bombards (*bombarde mezane* or *bombardelle*); finally, small bombards (*bombarde piccole* or *bombardette*).[5] These bombards were made exclusively from cast iron (*ferro di getto*); no examples of bronze artillery are recorded.[6] The price of artillery was a function of its weight (*soldi* 6 a lb of cast iron).[7] During the first year of the war, purchases were not many, just 16 pieces. In all probability, the artillery needed for the siege of Lucca was already present at the *Camera dell'Arme*.[8] From the first half of 1431, all armament purchases will increase to arm each locality to defend against enemy attacks. Artillery, too, was not excluded. In fact, 182 were commissioned, with a total value of more than 6,000 *L*. In the following semesters, however, requests stabilised again at around 8–12 pieces.

Many of the masters who produced artillery were also active in making handgonnes (*scoppietti*).[9] These are not distinguished by model or designation but solely by the material of their barrels – iron, brass, or bronze. They weigh between roughly 8.3 lb and 18.7 lb, and their unit prices reflect this composition: brass barrels fetched 9 *s* 9 *d*, bronze 8 *s* 11 *d*, and iron 6 *s* 11 *d*. In a few instances, the records note special features – such as a trumpet-shaped muzzle, fitted wooden stocks, or painted decoration – that increased the standard price.

3 The data presented regarding armaments and manufacturers were taken from some records produced by the Florentine war office. ASFi DB M 1–4.

4 One Florentine pound in the Quattrocento corresponds today to 339.5 g.

5 As can be seen, there is an overlap in the weights of small bombards with medium bombards. It is possible that in addition to weight other aesthetic characteristics qualified them in one group over another.

6 Surviving artillery from the period is very scarce. On the subject we refer to: Smith R.D., Rhynas Brown R. 1989; Smith R.D., DeVries K. 2005; Mauro M. 2008; Mauro M. 2009; Leduc A. 2016; Davies J. 2019; de Crouy-Chanel E. 2020.

7 The unit of account used by the Republic of Florence during this period was a combination of the *florin* and the *lira*: 1 *florin* (*f*) equaled 4 *lire* (*L*); 1 L was divided into 20 *soldi* (*s*) or 240 *denari* (*d*); and 1 *s* corresponded to 12 *d*.

8 The *Camera dell'Arme*, located in Florence, was the main arsenal of the Republic.

9 On this topic see: McLachlan S. 2010.

Table 1. Purchases of Crossbows, Bows and Spanning devices (1429–1433)

Category	Type	Quantity	Total
Crossbows	Crossbows *da gamba*	17	**1.361**
	Crossbows *a girella*	212	
	Crossbows *a mulinello*	273	
	Crossbows *a manetta*	172	
	Crossbows (generic)	416	
	Great Crossbows *a mulinello*	13	
	Great Crossbows *ad arganello*	36	
	Crossbows *ad arganello*	151	
	Crossbows *a passerino*	18	
	Great Crossbows (generic)	30	
	Crossbows *da panca*	22	
	Great Crossbows *da panca*	1	
Bows	Bows	151	**151**
Spanning devices	Gaffle or Belts-and-claw system (*a manetta*)	280	**1.238**
	Cord-and-pulley system (*a girella*)	518	
	Windlass (*mulinello* or *arganello*)	440	

As in the case of artillery, purchases in the first part of the conflict were meagre. In the first half of the year, none were purchased; in the second half of 1430, 85 were bought and then jumped to 675 in the first part of 1431. In the next two years, only 90 were purchased for a total of 850 during the war.

For both bombards and handgonnes, the documentation defines their projectiles as bullets. Those for handgonnes were made from iron or lead, while those for artillery from large or small stone.

From the documentation, it is possible to derive the weights of these bullets with their price: in iron, they were found from 0.15 lb up to 0.82 lb; in lead, from 0.50 lb up to 0.87 lb. As for those in stone, these were produced, in most cases, locally. The bullets found in the documentation are those of proof, as those produced by the flag-stone

worker (*lastraiuolo*) Giovanni di Piero dei Tornaquinci.[10] The production of bullets at army camps or strongholds became an established practice from the second half of 1431 onwards, as demonstrated by the fact that they no longer appear among the purchases made, while, as we have seen, specialised workers were sent directly to produce this ammunition. For this reason, it was not possible to quantify the production of such ammunition.

Another key element for the operation of artillery and firearms was gunpowder. Especially, the artillery needed large quantities of material to operate. During the conflict, a large quantity of 476.96 tons was purchased by the Republic.

Purchases related to bombard powder then include barrels suitable for containing it. These were produced by coopers and directly sent to powder manufacturers. Barrels differed in capacity between small (*bariletti*) and big (*bariglioni*).

Crossbows, Bows, Spanning devices, Crossbow Bolts, Arrows and Crates

Crossbows, their accessories and crossbow bolts were among the highest expenses of ammunition. There were several types of crossbows, classified according to size or spanning mode (Table 1).[11]

The most common, called simply crossbows (in some cases referred to as *balestre da gamba* or *a manetta*), correspond to more than ⅓ of all those purchased, amounting to 541 pieces. Their spanning was done using a lever, gaffle (*crocco a piede di capra*) or a belt-and-claw (or spanning hook) system, attached to a belt that the crossbowman wore around his waist, defined in this case as belts with *manette* or *a manetta*. The term *a gamba* (leg) indicated how it was necessary to insert the foot into the front stirrup of the crossbow in order to anchor it to the ground before tensioning the string with the gaffle or the belt-and-claw system. The crossbows *a girella* were the most convenient to use because of their rope-pulling system. The cord-and-pulley system consisted of a pulley, which allowed, through its rotation, to tension the rope. Then there were the crossbows *a mulinello* (reel). Their size and strength were greater than the other two models of hand crossbows, reason why they needed a windlass to be able to place the rope in traction. Their use was defensive. Finally, some large models could only be used by resting them on a stand. These could be a *mulinello* or *da panca* (bench). A total of 1,371 pieces will be purchased during the conflict, with a peak in the first half of 1431 of 736.

As far as bows were concerned, the purchases of the *Dieci di Balìa* were directed at strengthening the depots of the fortified localities. During the conflict, 151 bows were purchased from the same artisans who also supplied crossbows. This relatively

10 ASFi DB M 1, c. 115v.

11 Regarding the bows and crossbows of this period see: Biscarini P. 2018; De Luca D., Farinelli R. 2018; Corbie L. 2018. Recently published on the history of the crossbow see: Ellis-Gorman S. 2022.

limited number suggests that bows held a significantly less prominent role in warfare compared to crossbows. At the time, crossbows had not yet become widely adopted for hunting, unlike bows, which were still commonly used across all social strata. However, effective use of the bow required extensive training over several months, in contrast to the crossbow, which could be mastered more quickly. As a result, bows were likely issued only to those who were already proficient in their use.

Spanning devices varied in price depending on complexity and size, and were always sold already attached to belts. The total number of items purchased is slightly less than the total number of crossbows.

Crossbow bolts were definitely the item most purchased by the Republic of Florence, corresponding to over 46,000 *L* in expenditures (Table 2).[12] Their use was indeed massive on the battlefield, but at the same time, every fortified place had to have large quantities of them in order to withstand a hypothetical siege. Crossbow bolts comprised three principal components – the head, the shaft, and the fletching – and during the War of Lucca, five distinct varieties were produced. The smallest, known as *verrettoni da gamba*, were intended for hand-loaded crossbows, while the medium-sized *verrettoni da cianfogna* were used with winch-operated weapons. *Passatoi* featured particularly sharp, round-sectioned heads designed for precision penetration, whereas *quadrelli* (or quarrels) were distinguished by their square-sectioned points and exceptional penetrating power. Finally, the largest type, the *cianfognoni da galea*, shared the form of the *verrettoni da cianfogna* but exceeded them in length and were employed specifically in naval engagements.[13] During the war years, more than 1,246,300 crossbow bolt heads and 1,610,800 shafts were purchased, among the many types.

The volume of arrows purchased, while significantly less than that of crossbow bolts, shows us that the use of these was not totally insignificant: in fact, the arrowheads alone number just under 70,000. The cost of arrows was, on the other hand, significantly higher than that of most crossbow bolt heads (the most common ones cost 30–50 *L* per 1,000 units). The high price of such ammunition was given mainly by the cost of assembly and feathering, amounting to 80 *L* per 1,000 units. The sources, in this case, allow us to understand why this price was so high: the fletches were not made of birds' feathers but of silk.[14] This was purchased directly from assemblers and consequently resulted in higher prices than crossbow bolts that had wooden or leather fletches.

As in the case of powder barrels, the darts needed crates so that they could be sent where they were needed. The crates were standard in size as they could hold 500 pieces each. Specific crates were produced by the same craftsmen for arrows used with bows. In this case, these could hold up to 600 units each.

12 The production and trade in Florence of crossbow darts during the period 1430–1433 has been the subject of analysis in Picchianti S. 2024a.

13 ASFi DB M, 2, cc. 34v, 37v and 38r.

14 ASFi DB M, 2, c. 86r.

Table 2. Purchases of Crossbow Bolts and Arrows (1429–1433)

Category	Type	Quantity	Total
Bolt Heads	*Gamba*	809.670	**1.246.379**
	Cianfogna	424.554	
	Passatoi	6.555	
	Quadrelli	300	
	Galley *Cianfognoni*	5.300	
Shafts	*Gamba*	572.172	**1.610.872**
	Cianfogna	394.200	
	Passatoi	25.200	
	Quadrelli	100	
	Galley *Cianfognoni*	2.700	
	Generic Shafts	616.500	
Arrows	Complete Arrows	19.575	**121.680**
	Arrowheads	69.555	
	Shafts	32.550	

Table 3. Purchases of Polearms (1429–1433)

Category	Type	Quantity	Total
Polearms	Lances for Horsemen	5.895	**19.765**
	Spears for Infantrymen	7.493	
	Small Spears (*chiaverine*)	139	
	Galleys Spears	1.126	
	Galley Darts	5.112	

Polearms

Another of the categories of armaments found among the ammunition is polearms (Table 3).[15] These were produced primarily by combining the labour of two categories of craftsmen, blacksmiths and spear makers. The former produced the weapon heads, the latter the shaft and did the assembly.

By the second year of the conflict, just under 20,000 polearms were purchased by the *Dieci di Balìa*. The main types were spears for foot soldiers and lances for mounted combat, but there were also specific ones for naval clashes. Added to these were two types of throwing weapons: the small spears similar to javelins, and the galley darts. The latter appears similar to a spear, but was equipped with a lance that allowed for better propulsion when thrown from the coffins of vessels. In some cases, it could also be fitted with hind fletches in order to stabilise its flight and thus improve its accuracy.[16]

The peak purchase of these occurred in the second half of 1431. In those months, the Florentine fleet was in fact being strengthened, and it was the only period in which galley spears (1,126) and darts (5,112) were purchased, all from the same seller, the peddler Berto di Giovanni from Pistoia.[17]

Defensive Armaments

Every mercenary or soldier of the Republic deputed to the defence of a locality had to have his own defensive armament so as not to incur the penalties commensurate with the lack of some element.[18] For this reason, defensive armaments were not normally part of the War Office's purchases. Instead, the situation of extraordinary insecurity faced by the *Dieci di Balìa* during the years of the War of Lucca led to a change in direction. If, in fact, in the first year of the war the purchases were minimal, during 1431, coinciding with the most difficult period of the conflict, they acquired a certain importance.

The defensive armaments present can be divided into three categories: shields, defensive armaments for the torso, and head protection (Table 4).[19]

15 Polearms have never generated much interest among researchers of arms and armour. The most relevant contributions are: Boccia L.G. 1967; Enlart C.P. 1976; Monelli N. 1977, Troso M. 1988 and a volume devoted to throwing darts, Troso M. 2014. As for the Florentine production Picchianti S. 2018b. Some references on the production of polearms in the 15th century in Pistoia can be found in Herlihy D. 1972, 199–200.

16 See: Troso M. 2014.

17 ASFi DB M, 2, cc. 251r and 317r.

18 Picchianti S. 2024b, 528–529.

19 Regarding Florentine production of defensive armaments: Boccia L.G. 1970; Boccia L.G. 1973a; Boccia L.G. 1973b; Frangioni L. 1985; Frangioni 1987; Frangioni L. 2005; Picchianti S. 2017; Picchianti S. 2018a; Picchianti S. 2020a; Picchianti S. 2020b; Picchianti S. 2023; Scalini M. 1982; Scalini M. 1990.

Table 4. Purchases of Shields, Armour Cuirasses and Head Protection (1429–1433)

Category	Type	Quantity	Total
Shields	Shields (*Targoni*)	374	**483**
	Galley Pavises	78	
	Great Pavises	9	
	Round Shields (*Rotelle*)	22	
Armour Cuirasses	Cuirasses	228	**283**
	Half Cuirasses (*mezze corazze)*	15	
	Breastplates	39	
	Plackart	1	
Head Protection	Small semicircular caps (*coppi*)	166	**225**
	Baucchi (a type of helmet)	216	
	Sallets (*celate*)	93	
	Ribalde (a type of Sallet)	6	
	Bacinets (*bacinetti*)	115	
	Helmets	11	

The shields mentioned fall into four distinct categories, each corresponding to a specific type and use: round shields (*rotelle*) were small, circular defensive arms typically used in hand-to-hand combat or ceremonial contexts; great shields (*targoni*) were larger and more elongated, offering greater protection and often employed by infantry; galley pavises (*palvesetti da galea*) were medium-sized, portable shields specifically designed for use aboard galleys, providing cover for rowers and soldiers during naval engagements; finally, great pavises (*pavesi*) were tall, rectangular shields used primarily in siege warfare to protect crossbowmen and archers while reloading. These, like other defensive armaments, were purchased massively on the Florentine market, even buying old models or those in less than excellent condition. The large shields were crafted from plain wood or faced with donkey or sheepskin and often bore the municipal insignia — either the lily or the Marzocco (Florence's lion emblem).[20]

20 ASFi DB M, 2, c. 315r. All shields were to be painted, as indicated by specific expenditures to wooden board makers (*tavolacciai*) or painters, such as Bonaiuto di Giovanni or Stefano di Lorenzo (ASFi DB M 2, cc. 315v-316r).

The peak time for the purchase of such armaments was the second half of 1431, during the arming of the Florentine fleet, which, as has already been seen for the arms in the auction, involved an increase for some types of ammunition.

Defensive armaments for the torso are divided into two categories. The first includes cuirasses (*corazze*) and half cuirasses (*mezze corazze*), which provided broad protection and were typically constructed from layered materials or reinforced fabric.[21] Among these armoured pieces — composed of steel plates fastened with leather straps — there are a total of 243 items, usually covered with fabric and occasionally with hides such as chamois.[22] The second category consists of individual plate armour. Notably, the only standalone pieces of armour present are 40 breastplates.

Head protection are of multiple types. There were: small semicircular caps (*coppi*); *baucchi* (a type of helmet); sallets (*celate*); *ribalde* (a type of sallet); bacinets (*bacinetti*); unspecified helmets.[23] The craftsmen devoted to this type of production were the same as those involved in the production of armour. Among the 607 pieces, purchased in the largest number, we find *baucchi*, followed by *coppi* and *ribalde*.

Goods Useful in Army Camps

Outside these macro-categories of goods are additional expenditures for special equipment purchased in small numbers. For example, a whole range of useful tools at the army camps, such as lanterns, iron picks, axes, two-handed axes and iron mallets, supplied by ironworkers, peddlers or blacksmiths; ladders, ropes, food bags for grain, the latter made by the linen products makers.[24] To be sent to some fortresses, bands, latches, drawbridge chains, keys, patches, created by blacksmiths and key makers.[25] More than 120 flags of different shapes and decorated with the lily, the *Marzocco* or the Commune coats of arms were requested from the flag makers.[26] Besides these, also some tents and flagpoles. Probably to carry out some undercover naval operations, flags with Genoese coats of arms were commissioned.[27]

21 Regarding cuirasses and their specific classification, see: Vignola M. 2008. On Italian armour in the 15th century, see: Boccia L.G., Coelho E.T. 1967; Scalini M. 1980; Boccia L.G. 1982a; Boccia L.G. 1982b; Williams A.R. 1987; Oakeshott E. 2000; Williams A.R. 2004. See: Moffat R. 2024.

22 ASFi DB M 2, c. 236.

23 On the specific differences between the various head protectors (perhaps simply 'helmets'). See: Picchianti S. 2023, 254–258.

24 ASFi DB M 1, cc. 41r–41v, 58r.

25 ASFi DB M 1, c. 51r.

26 ASFi DB M 2, cc. 288r–289r.

27 ASFi DB M 2, c. 288r.

Producers and Economic Intermediaries

The wide variety of armaments and ammunition that were purchased by the *Dieci di Balìa* were produced by artisans and marketed by them or by economic intermediaries (Table 5).

Table 5. Craftsman/Seller and Related Goods Produced

Profession	Artilleries	Firearms	Gunpowder	Bullets	Barrels	Crossbows	Spanning devices	Bolts	Crates	Polearms	Shields	Armour	Flags, tents	Ladders, ropes, bags	Latches, chains, keys	Lanterns, axes, etc.
Blacksmith (*fabbro*)	x	x						x							x	x
Ironworker (*ferraiuolo*)	x	x										x				
Bombard maker (*bombardiere*)	x															
Firearms maker (*scoppiettiere*)		x		x												
Flag-stone worker (*lastraiuolo*)				x												
Seller of spices (*speziale*)			x													
Barrels maker (*bottaio*)					x	x	x									
Crossbow maker (*balestriere*)						x	x									
Peddler (*merciaio*)						x	x				x					x
Secondhand dealer (*rigattiere*)						x	x									
Dealer in old iron (*ferravecchio*)						x	x				x					x
Carpenter (*legnaiolo*)								x	x	x						
Bowl-maker (*scodellaio*)										x						

Table 5. cont.

Profession	Artilleries	Firearms	Gunpowder	Bullets	Barrels	Crossbows	Spanning devices	Bolts	Crates	Polearms	Shields	Armour	Flags, tents	Ladders, ropes, bags	Latches, chains, keys	Lanterns, axes, etc.
Spear maker (*lanciaio*)										x						
Wooden board maker (*tavolacciaio*)											x	x				
Armour maker (*corazzaio*)												x				
Arms dealer (*armaiolo*)										x	x	x				
Linen products maker (*linaiuolo*)														x		
Keymaker (*chiavaiuolo*)															x	
Flags maker (*bandieraio*)													x			

The artillery purchased by the office of war was produced by various artisans: blacksmiths, ironworkers, or bombard makers. The number of manufacturers is small, but one must consider the size of their workshops, which was undoubtedly not limited to just a few workers. Indeed, if one considers the six months of highest demand for armaments, it becomes clear how two of them managed to fulfil a substantial number of orders. Out of a total of 182 pieces, the blacksmith Tinaccio di Piero, along with the craftsmen working in his workshop, produced as many as 40 bombards, while Simone di Michele di Jacopo delle Volte was responsible for as many as 78 of various types. These included large, medium, and small bombards, indicating a diversified output. Given approximately six months, or about 180 days, this suggests that one bombard was completed roughly every five days in Tinaccio's workshop. Such a remarkable rate of production can only be explained by a highly organised system of labour and the involvement of a substantial number of workers specialised in cast-iron founding.

The geographical origin of such masters is varied. In addition to locations in the domains, one is found from the famous Brescian firearms production area (northern Italy), the Garza Valley, another from Germany, one from Perugia (central Italy),

and yet another from the Venetian locality of Cologna.[28] Workshop locations are not always recorded; where they are specified, however, they invariably lie adjacent to waterways, allowing smiths to harness hydraulic power for hammers or bellows. For instance, Tinuccio's forge stood near Porta San Niccolò on the banks of the Arno, Antonio di Domenico operated in Ponte a Grassina by the Sieve tributary, and Bindo di Nanni's workshop in Castelfiorentino was similarly sited on the Elsa River.[29]

Blacksmiths and ironworkers constituted the principal producers of handgonnes, their broad metallurgical expertise encompassing not only ironworking but also — and by implication — bronze casting operations, even though founders are not explicitly named in the sources. It is reasonable to infer that casting of bronze and other copper alloys was carried out under the aegis of these workshops. Alongside them operated a handful of highly specialised firearm makers (*maestri di scoppietti*), whose very title attests to their distinctive skill in fabricating portable gunpowder weapons. Among the named artisans, Simone di Michele di Jacopo delle Volte's workshop accounted for 219 handgonnes, Tinuccio di Piero's for 115, and the ironworker Lapo di Stefano da Greve for 102, reflecting the concentrated yet varied nature of gun barrel production in the Florentine domains.

The bullets were made by the same craftsmen dedicated to the production of firearms as Lapo di Stefano and Tinuccio di Piero.[30] They are also joined by the flagstone workers (*lastraioli*), the true specialists in the field, among whom Giovanni di Pierone stands out in terms of sales volume.[31]

Powder production was virtually monopolised by a single apothecary (*speziale*), Lorenzo di Stagio Barducci, whose workshop supplied over 82% of all recorded bombard powder — an amount exceeding 8,300 *ƒ* (approximately 33,200 *L*). Notably, Barducci and his peers were exclusively engaged in the procurement and refinement of gunpowder; they neither manufactured firearms nor cast artillery pieces. This clear division of labour highlights the early emergence of a specialised gunpowder economy, in which distinct artisan categories collaborated to sustain Florentine military logistics.[32]

28 Santi di Domenico (Garza Valley); Giovanni di Giovanni (Germany); Maso di Matteo (Perugia). ASFi DB M 1, cc. 50r, 118r, 102v; Matteo di Gherardo (Cologna). ASFi CC P SEU 42, c. 345v.

29 All in the domains of the Florentine republic. ASFi DB M 1, c. 41v; ASFi CC P SEU, 42, c. 344v; ASFi DB M 2, c. 237r.

30 ASFi DB M 1, cc. 88r, 116r.

31 ASFi DB M 1, c. 113v.

32 The only other producers mentioned were: Francesco di ser Antonio and Domenico di Lorenzo. ASFi DB M 1, c. 56r; the seller of spices Cambio di Giovanni. ASFi CC P SEU 42, c. 44v; Vannuccio d'Andrea Martignoni and Giano Bauzi. ASFi DB M 1, c. 144v; Bartolomeo di Masino del Tignoso from Pisa. ASFi DB M 1, c. 148r.

There were only three artisans who made barrels, and they were all Florentines: Giovanni di Corsellino, Giovanni di Filippo, and Neri di Francesco.[33] Regarding this type of goods, it is worth noting how they could be repurposed. For this reason, used barrels sent back to the powder manufacturers for reuse are shown, as was also the case with crates of crossbow bolts.[34]

Crossbows were chiefly produced by specialised crossbow makers, with barrel makers playing a smaller role; vendors included itinerant peddlers, secondhand dealers and merchants in scrap iron. Although many artisans in the records do not specify their place of origin, documentary evidence reveals that the majority were Florentine citizens. The most prolific workshop belonged to Nanni di Tingo, who supplied the Republic with over 250 crossbows in addition to ancillary components.

The staggering volume of bolt production further illustrates a proto-industrial organisation: between 1430 and 1433, more than 700,800 bolt heads from Montefioralle alone were delivered. Thanks to the rolls of the *Arte dei Fabbri* (the Florentine guild of blacksmiths) for the city and its contado, we can identify thirty-three master smiths active in Montefioralle during the Lucca War. Virtually all inherited their craft through family — only five were new entrants — underscoring the locality's entrenched tradition of blacksmithing. When compared with guild membership across the wider Florentine countryside, Montefioralle emerges as a remarkable centre of metalwork throughout the 15th century.[35]

Tax records from 1427 show that Montefioralle counted just seventy working-age men, of whom thirty-three were master smiths.[36] It is therefore reasonable to infer that the remaining adults were employed in workshops and that younger boys served as apprentices. Together, they maintained a semiannual average output of over 100,000 crossbow bolt heads — peaking at nearly 196,000 in a single six-month period — and supplied Florence with more than 700,800 heads between 1430 and 1433. The Republic's procurement of these vast quantities amounted to expenditures in excess of 18,600 lire throughout the war.

Meanwhile, the tiny hamlet of La Trappola, situated on the southwestern slopes of Pratomagno and home to roughly fifty inhabitants, became the principal source of wooden shafts. Local carpenters — members of Florence's gild of carpenters (*Arte dei Legnaiuoli*) — produced an estimated 983,000 shafts during the conflict, with a six-month high of 454,000 in early 1431.[37] Although guild rolls do not preserve the names

33 ASFi DB M 1, c. 39r; ASFi DB M 2, c. 29v; ASFi DB M 4, c. 34v.

34 Of crates for crossbow bolts were bought in fact a little less than 1.500, which could contain less than the half of the total of the darts purchased.

35 The main localities of the Florentine countryside for the presence of blacksmiths registered in the guild were: Castel Fiorentino; Figline Valdarno; Empoli; Poggibonsi, San Giovanni Valdarno; Montevarchi. Picchianti S. 2018a, 142.

36 Conti E. 1965, 294.

37 ASFi Arte dei Legnaiuoli 4, c. 6r.

of individual masters in La Trappola, the hamlet's small population makes it likely that almost every able-bodied male participated in shaft production during periods of peak demand. Together, these figures attest to a remarkably concentrated, proto-industrial organisation of armaments manufacture in Florence's rural domains.

Producing the polearms was the spear maker. Although logically, they would have belonged to the Arte dei Legnaiuoli, in 1384 the guild expelled all weapon makers, re-instating them later, except the spear makers.[38]

Artisans who professed this trade then had to register with the guild by indicating another trade: some that of carpenters, but most that of bowl maker (*scodellaio*).[39]

It is also noteworthy that the Florentine vendors from whom the *Dieci di Balìa* purchased polearms were, in most cases, economic intermediaries rather than direct manufacturers. Matteo di Benedetto, for instance, sold the Republic no fewer than 9,129 polearms — an amount that would have far exceeded the productive capacity of a single workshop, particularly one located in the centre of Florence. The intermediary nature of these figures is further confirmed by the case of Piero di Naldo, who died in September 1430. According to the post-mortem inventory of his workshop, compiled by the *Ufficiali dei Pupilli*, a Florentine magistracy responsible for overseeing testamentary estates in cases where the heirs were still minors at the time of the deceased's death, he held in storage 462 complete weapons and 856 weapon shafts, quantities far too large for a typical urban workshop to produce independently. Moreover, the lists of his debtors and creditors include, in addition to the *Dieci di Balìa*, numerous individuals from the city, the surrounding countryside, and even the mountainous areas of Pistoia — regions from which he evidently sourced arms for resale.[40]

Producing and marketing defensive armaments were different artisans/entrepreneurs from multiple guilds: the main ones were the armour maker (*corazzai*), part of the eponymous art (*Arte dei corazzai e spadai*); then there were the arms dealers (*armaioli*), registered in *Arte di Por Santa Maria*;[41] Finally, some members of the guild of key makers, ironworkers and coppersmiths (*Arte dei chiavaiuoli, ferraiuoli e calderai*) (but who could only market used or cold-processed products.[42] The largest number of purchases was made from the Florentine arms dealer Giovanni di ser Piero Centellini, from whom more than ⅗ of all armour was bought. Even in the case of helmets, about a hundred of them were bought from Centellini, while the remainder were sought in markets outside the city of Florence.

38 Picchianti S. 2018b, 44.

39 As well as Matteo di Benedetto, Marco di Giovanni, Piero d'Antonio. ASFi DB M 1, cc. 44r-44v, 96r.

40 Picchianti S. 2018b, 49.

41 The Arte di Por Santa Maria gathered among its members multiple artisans/sellers of luxury goods such as: silk merchants (*setaioli*); hat makers (*cappellai*); doublet makers (*farsettai*); shoemakers (*calzaioli*); mattress makers (*materassai*); goldsmiths (*orefici*).

42 As regards the specific activities carried out by these craftsmen, see: Picchianti S. 2023, 250–354. In this guild were present: key maker, dealer in old iron, and coppersmith.

Shields were made by wooden board makers, experts in woodworking, mainly from planks. Also, trading in such products are peddlers and dealers in old iron, all Florentine citizens. Here again, there is a favoured seller in purchases, the wooden board maker Bartolomeo di Domenico: out of the 483 shields purchased, he would provide 215.[43]

Conclusions

By analysing the trends in military expenditure, it becomes evident that, following the initial surge in spending during the early stages of the war, aimed at supplying the encampment stationed beneath the walls of Lucca — outlays on armaments and ammunition dropped sharply in the subsequent six months (Chart 1). The year 1431 marked the peak of military expenditure: in the first half, funds were directed toward equipping auxiliary troops and securing the republic's fortresses; in the second half, resources were allocated to outfitting the Florentine fleet. After these intense phases of procurement, military spending gradually declined until the conclusion of the conflict.

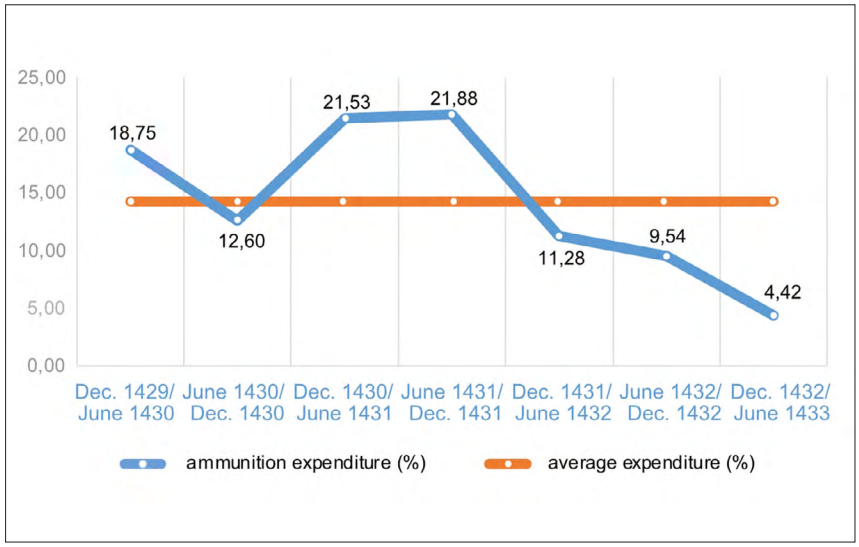

Chart 1. Percentage Breakdown by Semester of Total Expenditure on Ammunition during the War of Lucca (1429–1433)

43 The size of his workshop was large and it is not excluded that he could also play the role of dealer for other craftsmen.

Ammunition costs alone accounted for a significant portion of overall state expenditure and involved numerous craftsmen with highly specialised skills. A clear trend emerged to concentrate the largest contracts in the hands of a few economic intermediaries, effectively creating monopolistic or oligopolistic structures (Table 6). This pattern is exemplified by Lorenzo di Stagio Barducci's dominance in the gunpowder market; Giovanni di Berto's exclusive supply of galley darts and spears; Matteo di Benedetto's control over polearms; Nanni di Tiengo's provision of crossbows and related accessories; and the production of crossbow bolt heads and shafts from the artisanal centres of Montefioralle and La Trappola. In other instances, similar dynamics persisted, although the supplier in question was unable to fully dominate the market, managing instead to supply approximately half of the Dieci di Balìa's demand — as was the case with Bartolomeo di Domenico and the supply of shields.

Table 6. Artisans/Vendors & Produced Goods

Principal Producers	Profession	% on tot.	Goods
Tinaccio di Piero	Blacksmith	21,98	Artilleries
Simone di Michele di Jacopo delle Volte	Blacksmith	42,86	Artilleries
Simone di Michele di Jacopo delle Volte	Blacksmith	25,76	Firearms
Tinaccio di Piero	Blacksmith	13,53	Firearms
Lapo di Stefano from Greve	Blacksmith	12,00	Firearms
Lorenzo di Stagio Barducci	Seller of spices	82,00	Gunpowder
Artisans of Montefioralle (village)	Blacksmiths	56,23	Bolts (heads)
Artisans of La Trappola (village)	Carpenters	61,03	Bolts (shafts)
Nanni di Tingo	Crossbow maker	18,23	Crossbows
Berto di Giovanni	Peddler	100,00	Galley Spears and Darts
Matteo di Benedetto	Bowl-maker	67,49	Spears/Lances
Bartolomeo di Domenico	Wooden boards maker	44,51	Shields
Giovanni di ser Piero Centellini	Armour dealer	38,60	Cuirasses
Giovanni di ser Piero Centellini	Armour dealer	41,78	Helmets

In the field of firearms, although some artisans reached high production volumes, none focused exclusively on a single type of weapon. Instead, they typically specialised in multiple product lines: Tinuccio di Piero manufactured artillery, handgonnes, and bullets; Simone di Michele di Jacopo produced both artillery and bullets; and Lapo di Stefano specialised in handgonnes and bullets.

The economic benefits of wartime demand were not limited to arms manufacturers and merchants. The overall value of military contracts amounted to the remarkable sum of 181,785 *L*. In some cases, wartime needs spurred entire communities to specialise in the production of a single item, as occurred in two villages that became proto-industrial centres for the manufacture of crossbow bolts.

In peacetime, military expenditures in Florence were minimal, often approaching negligible levels. Following the conclusion of hostilities, the Republic systematically ensured that each fortress was adequately stocked with weapons and ammunition, while also replenishing the reserves maintained by the *Camera dell'Arme*. However, during wartime, the demand for armaments extended beyond the fortifications to include the continuous provisioning of the field army, resulting in a substantial and sustained increase in military expenditures. This surge in demand necessitated efficient organisational strategies in procurement. The observed monopolisation or oligopolization of supply contracts by a limited number of vendors can be understood as a pragmatic response aimed at fulfilling large-scale and urgent orders within compressed timeframes. Such concentration of military suppliers likely facilitated the rapid mobilisation and equipping of forces essential to wartime efforts. While similar supply dynamics may have occurred during peacetime, these would have depended on well-established and trusted relationships between vendors and Florentine authorities, underscoring the importance of long-term economic partnerships in the maintenance of the Republic's armaments infrastructure.

While it is undeniable that the war negatively impacted certain sectors of the economy, such as the wool trade, other categories of economic actors benefited significantly. The military sector, therefore, remained a powerful driver of economic growth during the medieval period for a wide range of artisans, not only those directly involved in weapons production but also those whose goods and services supported the broader logistics of war.

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