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Behind the Turkish War Machine: Gunpowder Technology and War Industry in the Ottoman Empire, 1450–1700

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Despite the slow incorporation of Ottoman history into world history during the latter half of the twentieth century, and despite the growing number of comparative studies on Ottoman and Islamic military history in Western historiography, some of the old fallacies about Ottoman military technology are still with us. Historians of the Eurocentric and Orientalist schools alike have a tendency to present a fixed and facile picture of Islamic backwardness in the early modern period. Too much emphasis is placed on the alleged inability of Islamic civilizations to adopt Western innovations in general and military technology and know-how in particular. Kenneth Setton, E. L. Jones, and Paul Kennedy fault the "extreme conservatism of Islam,"[1] the "military despotism" that "militated against the borrowing of western techniques and against native inventiveness,"[2] and "cultural and technological conservatism"[3] for the failure of Islamic civilizations to keep pace with Western military technology. The popularity of these generalizations is particularly surprising since it is well documented that the Ottomans, the Mamluks, the Mughals, and even the Timurids, the Akkoyunlus, and the Safavids have systematically used gunpowder and firearms. Because the available evidence, originally published in specialized scholarly journals and monographs, has recently been incorporated into some basic monographs on general military history,[4] there is no need to repeat them here.

Recent studies on military history offer a more global, though Eurocentric, interpretation. Acknowledging that the Ottomans successfully adopted Western military technology and know-how during the fifteenth and the sixteenth centuries, Geoffrey Parker argues that Western techniques of the so-called military revolution were only "imperfectly practiced" by even the most developed empires of the Islamic world. As a consequence, Ottoman military technology soon became relatively inferior as early as the late sixteenth or the early seventeenth century. Parker claims that the Ottomans "experienced

difficulty in mass-producing" and that their indigenous arms industry was weak and failed to meet the requirements of the empire from both quantitative and qualitative points of view. This technological inferiority was responsible for their military failures along the European frontier, and eventually led to their defeat and to Western military hegemony.[5] According to another hypothesis put forward by Keith Krause, the Ottoman Empire was a "third-tier producer" and "relied heavily on imported weapons and technologies."[6] Krause's Eurocentric views are repeated in Jonathan Grant's most recent study. Grant's main aim is to question the theory of Ottoman decline and to argue that the Ottoman military technology remained competitive in the regional context. Unfortunately, he had no access to Ottoman production data; that alone might have provided us with the necessary basis to challenge the received views about the supposed inferiority of the Ottoman arms industry. Basing his article on Krause's questionable model, Grant likewise argued that the Ottomans "remained a third-tier producer" throughout the period under discussion. He claimed that the Ottomans possessed capabilities comparable to "third-tier" rivals such as Hungary, Poland, and the medieval Balkan states.[7] In recent literature, only Jeremy Black significantly counters the above Eurocentric approach in his global and comparative narrative of warfare, which treats non-European armies and societies as autonomous participants in regional conflicts and questions the importance of technology for "the fate of the continents."[8]

In sharp contrast to Eurocentric historians, William McNeill and Marshall Hodgson emphasize the importance of gunpowder weapons in some of the Islamic civilizations, characterizing the Ottoman, Safavid, and Mughal states as "gunpowder empires."[9] Later historians of the Middle East have surpassed this characterization and have suggested that gunpowder weaponry played a crucial, if not determining, role in the military success of these empires.[10] Yet their interpretation exaggerates the importance of military technology. Neglecting other, equally important, factors of organized violence, they have displayed too much confidence in the decisiveness of gunpowder weaponry. Currently, however, there is a growing concern among European and Middle Eastern historians about technological determinism.[11] Rhoads Murphey has recently challenged the casual link between the rise of the Ottoman state and the use of gunpowder technology, on the one hand, and the decline of the empire and technological atrophy, on the other.[12]

The aim of this essay is not to present a simple counter-thesis to the Eurocentric views of Ottoman technological inferiority. Rather, it is to demonstrate the need for a more balanced and cautious approach in studying their military technology by broadening the scope of examination. The first section will comment on some of the questionable biases against Ottoman technology;

the second will concentrate on the Ottoman war industry and the supply of weaponry and ammunition.

The Introduction of Gunpowder Weapons in the Ottoman Empire

The date of the introduction of firearms into the Ottoman Empire remains debatable. The main problem, as with early Ottoman history in general, is the scarcity and questionable reliability of the sources. We hardly have any Ottoman sources contemporaneous with or close to the supposed time when firearms were introduced into the empire. It would be risky to base the argument solely on Ottoman chronicles dating from the late fifteenth and even the sixteenth centuries that are not confirmed by other independent sources, since chroniclers might have projected the terminology of their own times when referring to earlier events. Thus, in writing about fourteenth-century sieges and battles involving only mechanical artillery (e.g., trebuchet) or personal missile weapons (e.g., crossbows), Ottoman chroniclers might erroneously mention firearms, which were used regularly at the time they wrote their annals.

Terminology constitutes a major problem for the student of Islamic military technology. As with many European languages,[13] old terms were applied to new weapons. It is likely that to the east of the Ottomans, in the initially Samarkand-based Timurid Empire, the Arabic word *ra`d* (meaning "thunder") was used for a kind of mechanical artillery or missile weapon that hurled incendiaries during the reign of Timur (1370–1405). However, during the reign of Timur's son and heir, Shah Rukh (1405–1447), this very term was used for large stone-shooting cannon made of metal.[14] Similarly, in our fifteenth-century Ottoman sources the Turkish word "top" was used for both the shots of cannon and the cannon itself, and it is not always obvious which of these meanings we should apply. Furthermore, the mere lack of the word "cannon" or "gun" in the sources does not necessarily indicate that the weapon itself did not exist. (While the word "saltpeter," for example, first appears in English sources as late as the sixteenth century, saltpeter had been known and used 200 years earlier.) Lastly, we should not overvalue the importance of these "first references" to gunpowder weaponry. It took decades after the first appearance of firearms for soldiers to employ them regularly and in large enough quantities to be tactically significant. Likewise, it was not until the sixteenth century that these weapons proved to be central to military strategies.

We should bear this in mind since Turkish historians tend to ascribe too much importance to the first, though dubious, references to firearms cited in the earliest Ottoman chronicles. According to the historical chronology of the

Ottoman Empire, the Ottomans cast cannon as early as 1364 and used them, together with hand firearms, against the Karamanids in 1386.[15] Although these dates have found their way into Western scholarly literature through Carlo Cipolla's influential work on European artillery,[16] we should not forget that these dates derived from the sixteenth-century chronicle written by Şikari, who died in 1584—that is, 200 years after the events in question. When referring to the famous fifteenth-century Ottoman chronicler Neşri (deceased before 1520), other Turkish historians claim that the Ottomans used cannon at the battle of Kosovo in 1389.[17] A recent study argues that they used cannon as early as 1354 during the siege of Gallipoli. Yet again, this was based on a much later source, the early sixteenth-century chronicle of Kemal Paşazade (deceased 1534).[18] While we know that Kemal Paşazade used earlier sources and relied on an oral tradition based on eyewitnesses of the original events, the problem persists: he might have projected the terminology of his own time.

In view of these obstacles, it is hardly surprising that some European Ottomanists—trained originally in either classical philology or medieval and early modern European history, and thus well aware of the methods of source criticism—expressed their concerns about the first references to firearms in Ottoman chronicles. When Paul Wittek re-examined the earliest references to the Ottomans' use of firearms he expressed his doubts about the validity of the sources in question, and was "inclined to think that before 1400 the Ottomans had no knowledge of firearms."[19] Wittek mentioned that the first trustworthy references appearing in separate sources refer to the siege of Constantinople in 1422 and that of Adalia (Antalya) in southern Asia Minor in 1424.[20] His conclusions were later modified by Halil İnalcık, who referred to an Ottoman tax register from 1431. This alluded to a certain Ali, the son of a cannonier. İnalcık therefore claimed that the Ottomans might have used guns during the reign of Mehmed I (who ruled 1413–1421) "*and perhaps even earlier.*"[21] This chronology, established by Wittek and modified by İnalcık, was also accepted by Vernon J. Parry when writing his *Encyclopedia of Islam* article on 'Bārūd'.[22]

We can minimize these ambiguities by taking a closer look at the early history of gunpowder weaponry in the Balkans, Byzantium, and the Islamdom, possible regions through which firearms might have reached the Ottomans. Sources indicate that bombards were employed in the siege of Zara in 1346. In 1351, the Ragusan senate ordered a certain Nicola Teutonicus to make a *spingarda*. Although Nikola never completed his work, from 1362 to 1363 a local smith in Ragusa manufactured several *spingarda*s.[23] By 1378, firearms had become regular weapons in the defense of the city. In August of the same year, the defenders of Kotor employed bombards against Venetian warships, and, by 1380, firearms were fairly commonly used in Bosnia. The Serbians imported

bombards from Venice in the 1380s before manufacturing their own weapons in the 1390s.[24] Thus, during their raids, sieges, and battles on the peninsula, the Ottomans had the opportunity to capture some of these new weapons along with their manufacturers and gunners. In view of the small size of these early cannon, smuggling or transporting them should not have been a problem (the smallest bombards manufactured in Ragusa were sixteen to forty centimeters in length, and the smallest *spingarda*s weighed only 14 kilograms).[25] Djurdjica Petrović, who examined archival sources from Venice and Ragusa (Dubrovnik) as well as near-contemporary narratives from Serbia, Bulgaria, and Western Europe, also drew attention to the fact that some of his Western and Slavic sources, unexplored before him, mention firearms during the first battle of Kosovo (1389) and the siege of Constantinople (1394–1402). These near-contemporary sources substantiate Petrović's conclusion that the Ottomans had used firearms before the close of the fourteenth century.[26]

Gunpowder weapons might also have reached the Ottomans through either Byzantium or Islamic states. Firearms had been used in Byzantium in 1390, and from 1396 to 1397. It seems, however, that most of these weapons were of Genoese origin.[27] The first references for Muslim use of firearms (1204, 1248, 1258–1260, and 1303) go back as far as the thirteenth century, though they must be taken with caution since the terminology used for gunpowder and firearms in contemporary Arabic sources is very confused. As with references to early Ottoman firearms, most of these testimonies were provided by later chroniclers of the fifteenth and sixteenth centuries. It is without doubt, however, that the Mamluks used artillery from 1366 to 1368.[28] These references also corroborate the assumption that the Ottomans might have been familiar with gunpowder weapons before the end of the fourteenth century.

Ottoman and European narrative sources alike affirm that firearms in the Ottoman Empire gained tactical significance only in the latter part of the fifteenth century. As Vernon Parry and Colin Heywood have suggested, the Hungarian-Ottoman wars in the Balkans of 1443–44 proved to be crucial for the evolution of Ottoman military technology and warfare, because the Ottomans were forced to match their opponents' weaponry and tactics. As for siege artillery, the Ottomans successfully used their cannon during the siege of Thessalonoiki in 1430, and in demolishing the eight-kilometer defensives of the Isthmus of Corinth in 1446. By 1444 they possessed cannon at Silistre and in the fortress of Nicopolis. At this time, their cannon "gave a hard time" to the Burgundian ships at the Dardanelles, indicating that Ottoman gunners deployed their weapons not only against city walls but also against highly maneuverable galleys. In these instances, the artillery was cast in situ from material the Ottoman forces had transported.[29] Yet we should not overvalue the

role of cannon. Just as in contemporary Europe, they were not the only means of siege warfare. Even after the successful conquest of Constantinople, where artillery proved to be crucial, other types of siege weaponry continued to be employed. Furthermore, long-lasting blockades remained a regular practice that complemented or assisted siege artillery. The change in military technique was slow to take root, and new weapons competed with old ones for decades everywhere in Europe.

Channels of Military Acculturation: The Human Factor

Fifteenth- and sixteenth-century Western historical accounts and travel books have revealed that large numbers of European renegades, cannon founders, and artillerists worked for the Ottomans. European historians have relied on this evidence to demonstrate the Ottomans' dependence on Western military technology. They have paid special attention to such European renegades as Master Orban, most probably a Hungarian or German from Transylvania, or Jörg of Nürnberg.[30] Though European cannon founders and artillerymen might have played some role in the early history of the Ottoman artillery, their contribution should not be exaggerated. Our sources make as many references to Turkish as to European artillerists. During the siege of Constantinople in 1453, Mehmed II is known to have had Turkish cannon founders and technicians working independently of Master Orban. One of them, a Turkish founder named Saruca, also cast a large cannon.[31] Nicolo Barbaro reported that in 1453 the Ottomans used at least twelve cannon from four positions to besiege the walls of the Byzantine capital. Other sources claim that Mehmed II brought sixty-two cannon against Constantinople. Yet only one cannon had been made by Master Orban.[32] In 1456, during the siege of Belgrade, Mehmed II used at least twenty-seven large bombards, seven mortars, and more than 100 smaller artillery pieces. Giovanni da Capistrano, who was among the defenders of Belgrade, allegedly counted 300 guns after the siege. Even if we trust contemporary sources claiming that most of these cannon were operated by Germans, Italians, Hungarians, and other Europeans, there should have been dozens, if not hundreds, of Turkish gunners present.[33]

The employment of foreign military technicians and artisans does not necessarily indicate that the Ottomans were technologically inferior, since this was a well-established practice all over Europe. Most of the gunners serving in medieval Hungary or in Ragusa were of German and Italian origin. In the sixteenth century, Spanish monarchs repeatedly employed Italian, German, and Flemish cannon founders. At that time, the lack of skilled workers was a significant problem for the Portuguese war industry as well, and even England

lacked sufficient native gun founders. Both countries therefore recruited foreigners.[34] In short, the casting of ordnance was an international business: technicians who worked for a certain ruler in one year could serve his enemy in another.

Both contemporary European sources and later historical works overemphasize the role of Marranos and Jews in the transmission of Western military technology to the "infidel enemy" of Christendom. Although the Marranos and Jews played some role in the transfer of European military know-how and weaponry to the Ottomans, the exaggeration of this role might have fueled the already hostile attitudes towards them in many parts of Europe, and might have helped to justify their expulsion.[35] We should note that besides the Marranos and Jews, there were numerous French, Venetian, Genoese, Spanish, Sicilian, English, German, Hungarian, and Slavic experts working at the Ottoman cannon foundries. Professional miners from Novo Brdo in Serbia were used by Mehmed II in 1453 to dig mines under the walls of Constantinople. Ottoman pay registers also show that until the middle of the sixteenth century a considerable number of Christian smiths, stone carvers, masons, caulkers, and shipbuilders served in Ottoman Balkan fortresses. We should not forget, however, that the situation was similar on the other side of the borders. Slavic and Gypsy artisans and technicians from the peninsula who escaped from the Ottoman rule served the Hungarian kings and such towns of his realm as Buda, Pécs, Brassó, and Szeben. They built ships and made swords, guns, projectiles, and gunpowder, thereby fostering military acculturation and homogenized weaponry.[36]

Historical sources on the Barbary corsairs also suggest that renegades and adventurers played an important role in the transmission of European maritime and gunpowder technology to the Ottomans. In his famous work on the history of Algiers, Diego de Hadeo, a Spanish Benedictine and a captive in Algiers from 1579 to 1582, listed 35 corsairs who owned galliots in Algiers in 1581. Of the 35 shipowners, 22 were renegades and three were sons of renegades. The renegades comprised six Genoese, three Greeks, two Spaniards, two Venetians, two Albanians, one Hungarian, one French, one *judeo de naçion*, one Corsican, one Calabrian, one Sicilian, and one Neapolitan. Only ten of them were Turks.[37] Given such a cultural variety among the Barbary ship owners, it is hardly surprising that the corsairs provided the Ottomans with an invaluable reservoir from which the Sultan's naval empire drew its best human capital. The employment of hundreds of these renegades in the Mediterranean facilitated military acculturation and resulted in a common military and nautical knowledge of the region. The Turkish naval vocabulary of Italian and Greek origin mirrors this "cultural unity" of the Mediterranean.[38]

On land, the Ottomans found unexpected opportunities for recruiting highly skilled European military technicians at the end of the sixteenth century. During the Long Habsburg-Ottoman War fought in Hungary between 1593 and 1606, mutinies of European mercenaries provided a pool of European musketeers skilled in the use of up-to-date weaponry and tactics. In 1596, during the siege of Eger, some 250 Christian soldiers defected from the garrison and "fled to the sultan's camp and became Turk."[39] In the summer of 1600, at a critical juncture of the war, the unpaid French and Walloon mercenaries of the garrison of Pápa seized the garrison and, after careful negotiations with the Ottomans, offered their services to the Sultan. To stop this betrayal, imperial forces besieged Pápa and killed several mutineers. Nevertheless, some 400 to 500 mercenaries escaped to the Ottoman garrison of İstolni Belgrad (Székesfehérvár).[40] In 1601, during the siege of the Ottoman fortress of Kanije (Kanizsa), which had been captured by the Sultan's forces just a year before, several Italians deserted the camp and fled to the Ottomans. Italian mercenaries also served in the Ottoman army during the siege of Székesfehérvár in 1602 and the siege of Buda by the imperial forces in 1603.[41]

The Ottomans clearly valued the skills of the Pápa mutineers. They offered them generous terms and increased their pay by four times what they had received at the service of the Emperor.[42] This is hardly surprising, since by this time both sides had realized the firepower and tactical superiority of the imperial forces. As early as 1577, at a military conference held in Vienna, Habsburg military counselors were of the opinion that "for the time being, hand firearms are the main advantage of Your Majesty's military over this enemy [i.e., the Ottomans]."[43] An Ottoman observer from Bosnia, who participated in the major battle of the Long War at Mezőkeresztes in 1596, complained that the imperial forces had gained an edge over the soldiers of Islam "in their use of certain newly invented weapons. They invented hand guns and cannon, that is to say several types of hand guns and cannon, and they used them excessively."[44] Later, in May 1603, Yemişçi Hasan Pasha, Grand Vezier and commander-in-chief on the Hungarian front, reported to the Sultan that "in the field or during a siege we are in a distressed position, because the greater part of enemy forces are infantry armed with muskets, while the majority of our forces are horsemen and we have very few specialists skilled in the musket."[45] A recent study based on recruitment contracts has convincingly demonstrated that the Habsburg legions employed in Hungary during the Long War were dominated by infantry soldiers carrying hand firearms, and that the tactics of these troops were based on firepower.[46]

The prevalence of firearms in infantry tactics explains why the Ottomans welcomed the French and other European musketeers; however,

given the contradictory nature of our sources, it is difficult to determine the effects of their employment during the latter part of the war. Some 400 French and Walloon mercenaries from the Pápa garrison received their first assignment right after they defected in 1600. At the siege of Kanizsa, the most important Hungarian fortress in Trans-Danubia, they were appointed to oversee the Ottoman siege cannon. After the successful siege, they were rewarded for their useful service. The Pápa renegades fought with the Ottomans during the remaining years of the war: in 1601, they were employed at the defense of İstolni Belgrad; and in 1602, they helped to retake the very same garrison. When the war ended on the Hungarian frontier in 1606, they were assigned to other campaigns. In 1607, they were sent against the Cossacks at the mouth of the Danube; in 1610, those who were still alive fought against the Safavids in the East. The Sultan himself, who saw the renegades first when they entered Istanbul after the Hungarian war, was impressed by their muskets and arquebuses. He was especially amused when they fired a salute in an unfamiliar manner.[47]

During the seventeenth century, along the Mediterranean and the Danubian frontiers, the Ottoman military mastery was supposedly in decay. Yet the Ottomans continued to rely on military technicians similar to their Venetian or Habsburg adversaries; consequently, they shared technology. The Ottoman admiral in 1645—Yusuf Pasha, alias Yosef Masković—was a renegade from the Veneto-Ottoman frontier of Dalmatia. He successfully commanded the Sultan's fleet during the first landing in Crete in the summer of 1645, which ended with the surrender of Canea (Hanya).[48] When in 1669 an English ship captured a small vessel from Algiers, off the southern Mediterranean coast of Spain, the English found that her captain was a certain Lübeck renegade called Ali Reis. Ottoman chronicles and personal accounts also mention some celebrated defectors and Christian renegades in the service of the sultans.[49] In addition, the Ottomans seized Christian captives during major battles at sea, as well as during raids against Spanish and Venetian coastal cities and Spanish presidios in North Africa. These provided the Ottoman navy with thousands of European oarsmen if not experts. After the Venetian victory at the battle of the Dardanelles in 1656, the galley slaves on board the eleven captured Ottoman vessels comprised 194 Poles, 60 Germans, 51 Spaniards, 92 French, 182 Italians, 43 Sicilians, 26 Neapolitans, 106 Greeks, 143 Hungarians, 119 Muscovites, and 1,087 Ukrainians.[50] Records on 9,500 Spanish war prisoners freed by the Spanish redemptionist orders reveal that, although the North African subjects of the Sultan did not encourage conversion, they did welcome captives who possessed special technical skills. Furthermore, when North African Muslim rulers needed soldiers with adequate military skills, they offered deals to their

Christian captives; records suggest that in certain cases large numbers of Spaniards accepted conversion and service.[51]

No revolutionary innovations occurred in European firearms technology "between the middle decades of the sixteenth century and the widespread use of the bayonet late in the seventeenth." After the introduction of "controlled-grain corning" and the wheel-lock pistol, further innovations in the production of powder and weapons had no "important ballistic effects."[52] Along with the Ottomans' indigenous inventiveness, the small number of European renegades were thus able to keep pace with the Christian forces. Furthermore, Ottoman siege technique matched that of the Hungarians and Habsburgs at least until the second half of the seventeenth century. While at the end of the seventeenth century the Ottomans lacked experienced artillerists, the Sultan's sappers are reported to have done a better job than their colleagues in the imperial army. Marsigli praised the Sultan's Armenian sappers and miners who were from Istanbul and who were "especially skilled in wooden-works and in laying mines." They were not only more experienced and diligent than the Christians but more effective too. Unlike the sappers in the Habsburg army, these Ottoman-Armenian miners and sappers "were working in a sitting position," and "consequently they carried out the same work in just half of the time and with half of the effort" of their Christian counterparts.[53]

Although Marsigli is viewed as one of the foremost experts on the late seventeenth-century Ottoman army, his observations need to be cross-referenced with other accounts of Ottoman sieges.[54] His comments on Ottoman mastery of siegecraft are supported by numerous examples taken from the Hungarian and Cretan wars—that is, from the two major fronts where the Ottomans encountered more or less up-to-date fortifications and defense tactics. The medieval fortifications of the Hungarian Kingdom could not resist Ottoman artillery. A statistical analysis of the Ottoman sieges in Hungary during the reign of Süleyman the Magnificent, who ruled from 1520 to 1566, shows that between 1521 and 1566 only thirteen Hungarian castles were able to resist Ottoman sieges for more than ten days, and only nine for more than twenty days. In this period, only four fortresses were able to withstand Ottoman assaults: Kőszeg/Güns in 1532, Temesvár/Timişoara in 1551, Eger in 1552, and Szigetvár in 1556. However, only Kőszeg was besieged by the Sultan's army. Temesvár and Eger were attacked by the troops of the Grand Vizier, and Szigetvár by the governor-general of Buda. Three of these fortresses were nonetheless captured some years later: Temesvár in 1552, Szigetvár in 1566, and Eger in 1596.

During the latter part of the sixteenth century, the Habsburgs initiated a large-scale modernization project in Hungary. The key fortresses were redesigned in the *trace italienne* style, according to the plans of such Italian military

engineers as Pietro Ferabosco and Carlo Theti. In the case of Győr (Raab), Komárom (Komron/Komárno), Érsekújvár (Neuhäusel/Nové Zámky), Kassa (Kaschau/Košice), Várad (Oradea), and Szatmár (Satu Mare), not only the fortress but also the entire town was fortified. Thus, the process gave way to the development of the fortified town, the *Festungstadt*. However, during the Long War at the end of the sixteenth century, the Ottomans captured most of these fortresses: Győr, in 1594, Eger in 1596, and Kanizsa in 1600. Other *trace italienne* fortresses were taken by the Köprülü Grand Veziers in 1660 and 1663.[55]

Nonetheless, by the end of the seventeenth century Ottoman cannoniers could not match the knowledge of their European counterparts. Paul Rycaut observed that few of the *topçu*s (cannoniers) "are expert in their art, and are ill practised in the Proportions and Mathematical part of the Gunners Mystery. . . . And herefore knowing their own imperfections in this exercise, when Christian Gunners are taken in the War, they entertain them with better usage than other Captives, quartering them in the Chambers appropriate to that Profession, alloting them with others a pay from 8 to 12 Aspers a day; but because this is too considerable a maintenance to allure men who are otherwise principled, most of them as occasion offers, desert the service of the Turk, and fly to their own Country."[56]

The Ottomans were also hit hard when their competent gunners who had gained experience in Candia were dead by the end of the seventeenth century. The head of the gunners, the *topçubaşı*, repeatedly complained to Marsigli about the lack of experienced cannoniers; therefore, he decided to fetch Christian experts to inform him of the latest achievements of European military engineering.[57] European observers also noted that Ottoman gunners were careless and often overloaded their cannon, firing a variety of cannon balls from the same piece. The retention of the elevating wedge also militated against accuracy.[58]

"The Great Equalizer of Civilizations": War as a Means of Military Acculturation

It is well established that constant wars, "the great equalizer of civilizations,"[59] played an important role in the transmission of Western military technology from Europe to the Ottomans.[60] We have already mentioned that Ottoman raids and campaigns were responsible for the transmission of firearms from the West to the Ottomans as early as the waning years of the fourteenth century. Somewhat later, in the 1440s, the Hungarian-Ottoman wars of János Hunyadi were of crucial importance in diffusing European military technology and know-how to the Ottomans. It was during these wars that the Ottomans

became acquainted with the *Wagenburg* (wagon fortress) system, a defensive arrangement of "war wagons" chained together, wheel to wheel, and protected by heavy wooden shielding. Manned with crossbowmen and handgunners, it protected against cavalry assault. Hunyadi learned the use of war wagons during his wars against the Hussites in Bohemia, when he served as a commander for Sigismund of Luxemburg, King of Hungary (1387–1437) and Bohemia (1419–1437) and Holy Roman Emperor (1411–1439). When Hunyadi was preparing against the Ottomans in March 1443, he relied on the well-developed industry of the Saxon cities of Transylvania and ordered the artisans of Brassó to send "war wagons furnished with guns, arquebuses and other war-machines, made according to the instructions of a certain Bohemian artisan."

Brassó was not the only city whose artisans furnished Hunyadi's army with war wagons made according to the "Bohemian manner" (*currus Bohemico more instructos*). Hunyadi spent a great amount of money on the construction of war wagons, and his Czech mercenaries also brought several war wagons to his camp. In all, 600 wagons, operated almost entirely by Czech mercenaries, were reported to have been employed in his "winter campaign" of 1443–44. It was probably the first opportunity for the Ottomans to see the war wagons in operation. In November 1444, in the Battle of Varna, war wagons again played an important role. Learning of the arrival of the Ottoman forces led by the Sultan himself, Cardinal Giuliano Casarini, the papal legate and the guiding spirit of the anti-Ottoman crusade, suggested in a war council that the army take up a position behind the "wagon camp."[61] This strategy is confirmed by the well-informed anonymous author of the contemporary Ottoman chronicle, the Gazavatname. The same source indicates that by then the Ottomans knew how to besiege the *tabur,* or the Christian wagon camp named so in Ottoman sources after the Hungarian szekér (wagon) tábor (camp).[62] In this battle, the Ottomans defeated the Crusaders' army and captured the Christian war wagons and weapons. During these crusading wars, the Ottomans acquired a solid knowledge of the *tabur* system and the *tabur cengi* (the camp battle), the new technique which relied on war wagons armed with firearms. Later, Ottoman experts introduced the *tabur cengi* to the Safavids and Mughals, who called it *destur-i Rumi*, the Ottoman order of battle.[63] In the latter part of the sixteenth century, Lazarus von Schwendi, the commander of the imperial forces in Hungary from 1564 to 1568, observed that the Ottomans could use the *Wagenburg* system very successfully against the imperial forces and that they owed their military success to the *tabur*. Consequently, he urged the Emperor's troops to use war wagons armed with double arquebuses and light cannon.[64]

Hungary was the major theatre of land warfare between the Ottomans and their Christian adversaries during the sixteenth and seventeenth centuries.

There, wars offered a continuous opportunity for both sides to learn about the latest developments of the enemy's military techniques and skills. During the siege of Székesfehérvár of 1543, Ottoman soldiers confiscated several wheel-lock pistols from German horsemen. Introduced first in Italy about 1520, the wheel-lock was unfamiliar to the Ottomans serving in Hungary until this siege.[65] A report dated 1594, however, states that the Turkish soldiers had not yet adopted the pistol.[66] Other Western weapons had better luck with the Ottomans. After the Ottoman conquest of the Hungarian fortresses in the middle of the sixteenth century, most of the artillery pieces cast in Europe and employed in these strongholds by the Hungarians fell into Ottoman hands; they remained in use until the end of Ottoman rule. According to one member of the Habsburg embassy to the Porte in 1572, the majority of the cannon in the Ottoman garrison of Varadin (Pétervárad), near Belgrade on the Danube, were of European origin. He counted some thirty pieces, of which only one was a Turkish falcon, a gun somewhat longer than the others. There were pieces originally made in 1496 for Wladislaus II, King of Hungary (1490–1516), and in 1511 for Johannes Ország de Guthi, Bishop of Sirem.[67] After the reconquest of major Ottoman fortresses in Hungary at the end of the seventeenth century, imperial forces compiled inventories that also listed several European cannon in the possession of the Ottomans. Guns found at the fortress of Gyula in 1695 had been cast in 1547, 1548, and 1559 for Ferdinand I of Habsburg, King of Hungary (1525–1564) and Holy Roman Emperor (1556–1564). Some estimate that 80–90 percent of the cannon found in certain reconquered Ottoman fortresses in Hungary in the 1680s were of Western origin.[68] Official Ottoman registers, nevertheless, indicate a more significant presence of their cannon cast either in the Imperial Cannon Foundry in Istanbul or in the Balkans.

Merces Prohibitae: Trade in Weaponry and the Dependence Theory[69]

Trade also played an important role in the diffusion of military technology. Although both European rulers and Ottoman sultans forbade the export of arms and war materials and declared them prohibited goods (*merces prohibitae* and *memnu eşya*, respectively), they never stopped this lucrative trade. It seems that the illicit exchange of war material was part of the everyday pattern on the frontiers, and it constituted a significant component of East-West trade. While it is obvious from the sources at our disposal that this diffusion was never one-sided and involved Western exports as well as imports of strategic material, Western historiography has nonetheless focused on Western exports to the Ottoman realm and has advanced the dependency theory.

Quick to acquire Western military technology in the fifteenth and early sixteenth centuries, the Ottomans proved to be "expert imitators, but poor innovators," according to Geoffrey Parker. Relative to their Christian counterparts, the Ottomans were not only inferior designers of gunpowder technology but they also "experienced difficulty in mass-producing" it.[70] Consequently, both Ottomanists and European historians claim that the Ottomans became dependent on imported weaponry and war materials.[71] From the 1580s, other historians suggest, the English became the main supplier of the Ottomans, who, after their naval defeat at Lepanto (1571), were eager to replace their losses through imports from the West.[72] The two main commodities were tin, "without which they [i.e. the Ottomans] cannot cast their cannon,"[73] and gunpowder. According to an English captive in Istanbul from 1603 to 1606, the janissaries had "not one corne of good powder but whyche they get from overthrone Christians, or else is broughte them out of England."[74] However, by the end of the seventeenth century, claims Rhoads Murphey, the channels of this trade had clogged up. The decline of Western ammunition imports "correspond rather closely with the beginning of decline in Ottoman naval fortunes after 1669 and of military fortunes after 1683." Murphey argues that "it was neither inferior technology nor inferior tactics which brought about the lessening in the Ottomans' ability to wage war, but their supply situation."[75]

The main problem with the above arguments is that they are based on random evidence, often atypical narrative data. Ottoman archival evidence unearthed so far concerning domestic production of Ottoman weaponry and ammunition disproves the dependency theory and supports the Ottomans' military self-sufficiency as first suggested by Vernon Parry. To help resolve this question we must estimate at least the ratio of imports to domestic production on the one hand, and the ratio of imports to domestic consumption on the other. Yet, given the nature of the contraband trade, the exact volume of imports will remain unknown. Nevertheless, this essay will provide estimates on Ottoman gunpowder imports and domestic production based on published ambassadorial reports and official production data, respectively.

Venetian ambassadors report that between 1579 and 1610, a period of constant warfare, only eleven English ships reached the Ottoman capital. It was only in 1605 that an English ship actually carried gunpowder, of which 700 barrels were confiscated. If we add to this a similar quantity of Dutch powder and count the whole as an annual import, we still only get a modest quantity of imported powder relative to that of domestic sources.

In the sixteenth century, important gunpowder works operated in Istanbul, Cairo, Baghdad, Aleppo, Yemen, Buda, Belgrade, and Temeşvar. Secondary production centers were located in Estergon, Erzurum, Diyarbekir, Oltu,

and Van. In the seventeenth century, the Ottomans established major gunpowder works in Bor (in the province of Karaman), Selanik (Thessalonica), Gelibolu (Gallipoli), and Izmir. In addition to these gunpowder works, smaller mills driven by either animals or manpower operated in several fortresses of the empire. Tables 4.1 and 4.2 show the actual and estimated production data of some of the major Ottoman gunpowder works and the stock of powder. Based on the data summarized in table 4.1, I estimate the quantity of gunpowder produced annually in the major gunpowder works of Egypt, Baghdad,

Table 4.1
Gunpowder production in the Ottoman Empire in the second half of the sixteenth century.

Gunpowder works	Date of production and/or inventory of stocks	Production (kantars/year)	Stock (kantars)
Istanbul/Kağıthane	1571	1,800–3,600*	1,600
Istanbul/Şehremini	1571	900–1,800*	
Istanbul	1594–95		4,460
Buda		1,000–2,000*	3,000–4,000
Temeşvár		800–1,200*	1,500–2,000
Baghdad	1570		3,000–4,000
Baghdad	1574–75	2,500	
Baghdad	1575–76	5,000	
Egypt	1574	4,000	
Egypt	1593		7,000
Egypt	1595		7,000
Egypt	1599		4,000
Aleppo	1570	1,000	1,000
Erzurum	1579		2,000
Total		11,100–18,101.2	16,100–24,460

Sources: Istanbul 1571: Başbakanlık Osmanlı Arşivi, Istanbul (Ottoman Archives of the Prime Ministry, henceforth BOA), Mühimme Defterleri (MD) 16, p. 375, no. 656; Istanbul 1594–95: ibid., Maliyeden Müdevver Defterleri (MAD) 383; Buda and Temeşvar: Gábor Ágoston, "Ottoman Gunpowder Production in Hungary in the Sixteenth Century: the *Baruthane* of Buda," in G. Dávid and P. Fodor, eds., *Hungarian–Ottoman Military and Diplomatic Relations in the Age of Süleyman the Magnificent* (Budapest, 1994), 149–59; Egypt 1593 and 1599: Topçular Katibi Abdülkadir Efendi, *Tarih–i Al–i Osman*. Vienna, Nationalbibliothek Handschriftensammlung, Codex Vindobonensis Palatinus Mxt. 130, ff. 7/a and 113/b, 1595: MD 73 p, 221. no. 518. and p. 353, no. 775; Baghdad: Turgut Işıksal, "Gunpowder in Ottoman Documents of the Last Half of the 16th Century," *International Journal of Turkish Studies* 2. 2. (1981–82), p. 85; Aleppo: MD 9, p. 46; Erzurum: MD 32, no. 579. *: estimates, based on figures of stocks or of imperial orders. Lower figures for Istanbul (1571) take into consideration the fact that the powder works operated only for 6 months a year.

Table 4.2
Gunpowder production and gunpowder stocks in Ottoman Empire, 1663–1800.

Gunpowder works	Dates of production	Actual or estimated production (kantars)	Stock (kantars)	Source
Istanbul	III.25.1663–VI.1664		11,211	MAD 3279[a]
Istanbul	III.30.1683–VI.10.1686	6,275		DBŞM 449
Istanbul	XI.07.1687–XI.23.1688		7,183	MAD 15758[b]
Istanbul	VI.05.1689–XII.02.1690	1,750		DBŞM 598
Istanbul	XII.03.1690–VI.15.1692	1,989		DBŞM 642
Istanbul	I.08.1693–I.07.1694	2,004		MAD 3620, pp. 80–81
Istanbul	XI.26.1696–III.23.1697	571		DBŞM 844
Istanbul	III.11.1697–X.24.1699	4,581		DBŞM 19085
Istanbul	XI.03–1701–X.12.1703	2,430		MAD 7488, pp. 2–13
Istanbul	IV.15.1706–IV.03.1707	2,500		MAD 2652
Istanbul	1793–94	1,500		DBŞM BR < 18319
Istanbul	1794–95	1,500		DBŞM BR < 18321
Istanbul	1799–1800	10,000		Cevdet Askeriye 9756
Gelibolu	VII.31.1696–VII.19.1697	1,000		MAD 3127, p. 45
Gelibolu	VII.20.1697–VII.09.1698	1,000		MAD 3127, p. 45
Gelibolu	VII.10.1698–VI.28.1699	1,000		MAD 3127, p. 54
Gelibolu	1747–54	1,000/year		KK 6691
Gelibolu	1782	2,000/year		Cevdet Askeriye 9594
Izmir	1685–87	3,144		MAD 885.10–14
Izmir	I.17.1694–II.19.1695[c]	2,248.5		MAD 3620, p. 70.
Izmir	VII.31.1696–VII.9.1698	3,534.4		MAD 6880, p. 26–27
Izmir	VII.10.1698–VI.28.1699	2,081		MAD 6880, p. 17
Selanik	XI.17.1686–X.25.1688	4,970		DMKF 27627/189–A
Selanik	1695–96	2,520	3,081	MAD 3620, p. 27
Selanik	1696–97	2,035.5	3,231	MAD 3620, p. 87
Selanik	1697–98	3,078.5	3,306	MAD 3620, p. 37
Selanik	1716–17	3,000		MAD 10312
Selanik	1717–18	3,000		MAD 10312
Selanik	1718–19	1,500		MAD 10312
Selanik	1719–20	2,000		MAD 10312
Selanik	1720–21	1,500		MAD 10312
Selanik	1741–42	1,200		KK 6691

Table 4.2
(continued)

Gunpowder works	Dates of production	Actual or estimated production (kantars)	Stock (kantars)	Source
Selanik	1742–51	1,800/year		KK 6691
Selanik	1751–62[d]	1,500/year		KK 6691
Selanik	1765–66	1,500		Cevdet Askeriye 9814
Selanik	1777	2,000/year		Cevdet Askeriye 9595
Karaman	1637–38	3,300		MAD 5472
Karaman	Second half of 17th century	1,800–2,000/year[e]		MAD 3279, 5685
Karaman	1644–45	7,392.8		MAD 7512
Temeşvar	1672	1,000[f]		MAD 1497
Temeşvar	1679–80	1,380		KK 2682
Egypt	1663–64	2,000		MAD 3279[g]
Buda	1684		10,000	MAD 177

a. Total gunpowder income of imperial ammunition stores.
b. Total amount of gunpowder to be found in the imperial armory in this period.
c. According to BOA, MAD 6880, p. 26, the production in H 1106 (VIII.22.1694-VIII.11.1695) was 1,887.6 kantars.
d. In H.1168 (X.18.1754-X.06.1755) only 750 kantars.
e. MAD 5685 and MAD 3279. The annual obligation of Karaman in this period was 80,000 okka (1,818 kantars). However, during campaigns such as the 1663–64 Hungarian campaign, the officials in Karaman had to send more gunpowder than their annual obligation.
f. In July 1672, 800 kantars of gunpowder were delivered to Varad (MAD 1497, p. 9).
g. On May 6, 1663, 818 kantars. On June 25 a further shipment of 613 kantars arrived from Egypt for the 1663–64 Hungarian campaign. On October 15, again 613. On April 17, another shipment of 818 kantars arrived from Egypt for the 1664 campaign.

Istanbul, Buda, and Temeşvar at the end of the sixteenth century to be 11,000–18,000 kantars (594–972 metric tons). Needless to say, this estimate does not include the production output of such gunpowder works as Belgrade, Yemen, or Aleppo, which would considerably increase the figure for domestic production.

It is not until the end of the seventeenth century that official Ottoman registers document gunpowder purchases from European merchants. In 1688 the Imperial Armory purchased 295 kantars of gunpowder from a European

merchant and a Christian subject of the Sultan. However, this amount was less than 5 percent of the Armory's total income of gunpowder (6,003 kantars) in that year.[76] Exhausted from the long-lasting wars fought against the Holy League since 1683, the Porte purchased 818 kantars of powder from an English merchant for its navy between 1697 and 1698. This amount was again less than 10 percent of the 8,550 kantars of gunpowder that the admiral of the fleet received from various sources.[77] It was only in January 1700, after the peace treaty of Karlóca (Karlowitz), that the registers cite a considerable amount of imported gunpowder. At this time, the allotment of the Imperial Armory was for 2,108 kantars of gunpowder, of which 1,208 kantars (57 percent) were bought from an Englishman.[78] Data presented in table 4.2, nonetheless, suggest that domestic gunpowder production was still significant in the late seventeenth century. We may estimate total annual gunpowder production in the 1680s in the *baruthane*s of Istanbul, Buda, Temesvar, Selanik, Gelibolu, Izmir, Bor, and Cairo at 14,000–19,000 kantars (756–1,026 metric tons). In other words, there was no decline in the output relative to the sixteenth century, and we may assume that domestic gunpowder production still met the vast majority of the Ottoman's needs—at least until the middle of the eighteenth century.

Secondary literature maintains that by the second half of the eighteenth century the Ottomans produced only about 3,000 kantars of poor-quality powder annually.[79] It is obvious from the available sources that the domestic supply did not meet the demand. In the 1770s and the 1780s, the powdermills at Selanik and Gelibolu were supposed to produce 2,000 kantars of gunpowder each; however, both mills had serious difficulties in fulfilling these expectations.[80] Consequently, the Porte had to import ever-larger quantities of gunpowder; therefore, new suppliers appeared. In 1778, with the assistance of the Swedish ambassador to Istanbul, the Ottomans bought 1,500 kantars of gunpowder from Sweden.[81] It seems that the Ottomans purchased further shipments of gunpowder from Sweden. In November 1782, the Imperial Armory received 1,693 kantars of gunpowder from this source.[82] By the end of the eighteenth century the gunpowder works at Azadlı, which had been modernized by French assistance, were able to produce sufficient quantities of gunpowder of a much better quality.[83] In 1800 the gunpowder works at Azadlı supposedly produced 10,000 kantars of high-quality gunpowder.[84] Although there were some difficulties with providing sufficient saltpeter, this amount shows that by the end of the eighteenth century the empire had again become largely self-sufficient in the production of gunpowder.

The situation with firearms seems to be somewhat different, even in the seventeenth century. In November 1605, an English vessel, destined for Istanbul, was held up by the ships of the Duke of Savoy and the Knights of

Malta, who confiscated the cargo. Apart from the 700 barrels of gunpowder mentioned earlier, the cargo consisted of 1,000 arquebus barrels and 500 arquebuses for horsemen.[85] Data suggest that "this ugly business"—as Ottaviano Bon, Venetian ambassador to Istanbul called it[86]—continued. It is quite possible that other cargoes reached the Ottomans. From the point of view of technology diffusion, these imported weapons had some significance, although we need more research to understand fully their importance.

We should not overvalue the significance of such trade. We have to remember that the import of weaponry and ammunition was a widespread practice in Europe during the period under discussion. Studies concerning contemporary European arms industry and ammunition supply suggest that countries that supposedly were "second-tier producers," according to Krause's model, were more dependent on imported weaponry and ammunition than were the Ottomans. In 1570, Castile imported 6,000 arquebuses from the Netherlands and 20,000 arquebuses from Italy, and from the 1580s onward large quantities of gunpowder had to be obtained regularly from outside sources (including Naples, Flanders, Germany, and Liege) because Spanish domestic production failed to meet requirements.[87] On the other hand, in the sixteenth and seventeenth centuries the Ottoman Empire, a supposedly "third-tier producer," according to Krause, remained largely self-sufficient in the production of cannon, firearms, and gunpowder, with the proportion of imported weapons and ammunition never reaching a significant percentage of domestic production.[88] Unfortunately, available evidence unearthed so far does not offer similar estimates for pistols and flintlock mechanisms. Sporadic sources, however, indicate that they might have had a different story.

Similarities in Military Hardware and the Question of the Ottomans' Technological Inferiority

As we have seen, the employment of foreign experts ensured that new technology and know-how was disseminated relatively quickly within and outside Europe. As a consequence, it became virtually impossible to gain any significant technological superiority in the long run. However, echoing Carlo Cipolla's notion, recent Western historiography claims that the Ottoman artillery hardware missed out on developments in European artillery from the middle of the fifteenth century onwards. Whereas European ordnance increasingly emphasized the design of artillery for both sieges and battles, the Ottoman ordnance remained infatuated with giant cannon.[89]

As this essay has demonstrated, there was an intensive military acculturation through the common pool of military experts, direct military conflicts,

and the prohibited trade in weaponry and ammunition during the sixteenth and seventeenth centuries. This not only questions the Ottomans' supposed technological inferiority but also suggests close similarities in military hardware. It has already been noted that such similarities are reflected in military terminology: names of the common Ottoman cannon, such as *balyemez, bacaluşka, darbzen, kolunburna,* and *prangi*, are distorted versions of Italian, Spanish, Catalan, and Portuguese designations of well-known European firearms. These mirror the common material culture of the Mediterranean.[90] Other weapons, such as the small *şakaloz* (which acquired its name from a Hungarian hand cannon, the *szakállas puska*), reflect the Central European component of Ottoman weaponry.[91] The *szakállas* (puska) is the Hungarian equivalent of the Latin (*pixis*) *barbata*, or "hook gun," referring to a large-caliber hand firearm with a hook. The hook served to fix the weapon firmly to the rampart in order to absorb the firearm's heavy recoil. A considerable part of the artillery in both Hungarian and Ottoman fortresses consisted of Hungarian *szakállas*es and Ottoman *şakaloz*es. Unlike the Hungarian weapons, the latter seem to have been set on stock (*kundak*) and transported by gun carriages.

Accounts of production output of the Istanbul State Cannon Foundry, as well as inventories of such strategically important Ottoman fortresses as Baghdad, Belgrade, and Buda, convincingly demonstrate that an overwhelming majority of Ottoman cannon included light and medium-weight guns, and that the Ottomans had a long tradition of deploying smaller artillery pieces. For example, 97 percent of the 1,027 guns cast at the Imperial State Cannon Foundry in Istanbul in the four years before the battle of Mohács (1526) consisted of light and medium-weight cannon. Seventy-two percent of the 300 cannon cast at the foundry in 1685 and 1686 fired cannon balls of 1.28, 0.64, and 0.32 kilograms. Contemporary narrative descriptions of the Ottoman weaponry in operation reveal that the use of small-caliber cannon on battlefields was a common practice in the Ottoman army.[92] The available evidence shows that, even though Ottoman artillery pieces were heavier than some of the European ones of the same caliber, this seldom constituted serious logistic difficulties for the Ottomans—except in the Siege of Vienna in 1683, for example.

We must also handle with caution the bewildering confusion of Ottoman artillery and the lack of standardization—observed by such contemporaneous Europeans as Luiggi Ferdinando Marsigli and presented in the secondary literature—as further proof of the Ottomans' technological inferiority. Contemporary descriptions and weaponry inventories of Spanish, Austrian, and French artillery reveal similar variety and confusion.[93] Research concerning European artillery has demonstrated that attempts to standardize weaponry

in the sixteenth and seventeenth centuries largely failed, for these were no more than attempts.[94] The Spanish Army of Flanders and the Dutch forces under Maurice of Nassau were the notable exceptions.

The supposed "metallurgical inferiority" of the Ottoman artillery[95] is based on a superficial assessment of insufficient and random evidence. Chemical analysis has shown an Ottoman gun barrel cast in 1464 for Mehmed II to be composed of excellent bronze containing 10.15 percent of tin and 89.58 percent of copper.[96] The bronze of almost the same composition was recommended by Vanoccio Biringuccio (1480–1539), the famous Italian expert of the sixteenth century, and was used in contemporary Europe.[97] A study of the technology of cannon-casting, used by Mehmed II's technicians at the time of the Siege of Constantinople in 1453 and described in detail by Kritoboulus, has revealed that the Ottoman technology of gun-casting was the same as the one applied in contemporary Europe.[98] Given this fact, it is hardly surprising that the Spanish artillerist Collado, the author of one of the most popular treatises on gunnery in the sixteenth and seventeenth centuries,[99] described Ottoman cannon to be of good metal, though ill-proportioned.[100] Ottoman production data at our disposal suggest that, at least until the end of the seventeenth century, their cannon founders used the typical tin bronze, which contained 8.6–11.3 percent tin and 89.5–91.4 percent copper. (See table 4.3.)

Table 4.3
Compositions of Ottoman bronze cannon.

	Copper	Tin
1464	89.58%	10.15%
1517–1523	91%	9%
1522–1526	90.5%	9.5%
1604	90.8%	9.2%
1685–86	91.4%	8.6%
1693–94	89.5%	10.5%
1704–1706	89.6%	10.4%
1704–1706	89.5%	10.5%
1704–1706	88.7%	11.3%
1706–07	89.5%	10.5%

Sources: Piaskowski, "The Technology of Gun Casting," 168 (for 1464); Istanbul, BOA, MAD 7668 and Heywood, "The Activities of the State Cannon-Foundry," and İdris Bostan, "XVI Yüzyıl Başlarında Tophane-i Amirede Top Döküm Faaliyetleri" manuscript to be published in the İnalcık Festschrift (for 1517–1523 and 1522–1526); MAD 2515 (for 1604); MAD 4028 and DBSM TPH 18597, 18598 (for 1685–86); MAD 5432 (for 1693–94); MAD 2652 (for 1704–1706) and MAD 2679 (for 1706–07).

The above data ought to be handled cautiously. In spite of similar composition, sloppy foundry techniques or impurities in the metal all might have caused significant porosity. It is obvious that, apart from further archival research, we need more metallurgical examinations of extant artillery pieces. However, the results of these examinations should not be taken at face value. Such results always reflect the composition or purity of the metal of the individual cannon examined, and can hardly be applied to other pieces cast elsewhere from different raw material and by another cannon founder. More importantly, slight technological inferiority alone did not matter in the sixteenth and seventeenth centuries, especially when the Ottomans could easily compensate for it with their enormous resources.

Apart from the technology of gun-casting, Ottoman gunpowder production also shows close similarities to that of the Europeans. In Turkish archival documents from the end of the seventeenth century, we frequently come across a certain type of gunpowder called "English powder" *(İngiliz perdahti)*. This was not an imported powder from England, but a specially refined gunpowder produced locally in Ottoman powder-works according to the new mixture (*be ayar-i cedid*) or the so-called English proportion (*be ayar-i perdaht-i İngiliz*). The powder contained 75 percent of saltpeter and 12.5 percent of charcoal and sulphur, which was the most usual proportion in England and in most of the European countries, even in the first half of the eighteenth century.[101] During the second half of the eighteenth century, Ottoman gunpowder was still manufactured according to this formula; however, by the end of the eighteenth century (1794–1795), the Ottomans produced a better quality of gunpowder mixed in the proportions of 76-14-10, which closely followed the standard European proportions of 75-15-10.[102] It is important to bear in mind that there was no standardized mixture of gunpowder in Europe. In the middle of the sixteenth century, for example, more than 20 different types of powder were produced in Europe, the saltpeter content of which fluctuated between 50 and 85 percent. Besides showing the lack of any standardization, data presented in table 4.4 reveal that the proportions of Ottoman gunpowder closely resembled those of the European mixture.

Again, we need to handle the above data carefully. Maintaining consistent standards was impossible in an empire where gunpowder production was scattered among so many powdermills throughout the empire from Buda to Baghdad. During its "shelf life" and transportation, the powder could have acquired further "post-manufacture defects."[103] This is why contemporary narrative sources present such a contradictory picture of the gunpowder produced in the Ottoman Empire. While some Ottoman chroniclers and Marsigli complained about the quality of Ottoman powder,[104] Raimondo Montecuccoli

Table 4.4
Mixture of gunpowder in selected European countries and in the Ottoman Empire, 1560–1795.

		Saltpeter	Charcoal	Sulfur
1560	Sweden	66.6%	16.6%	16.6%
1595	Germany	52.2%	26.1%	21.7%
1598	France	75.0%	12.5%	12.5%
1608	Denmark	68.3%	23.2%	8.5%
1649	Germany	69.0%	16.5%	14.6%
1650	France	75.6%	10.8%	13.6%
1673	Ottoman Empire	69.0%	15.5%	15.5%
1686	France	76.0%	12.0%	12.0%
1696	France	75.0%	12.5%	12.5%
1696–97	Ottoman Empire	75.0%	12.5%	12.5%
1697	Sweden	73.0%	17.0%	10.0%
1699–1700	Ottoman Empire	75.0%	12.5%	12.5%
1700	Sweden	75.0%	9.0%	16.0%
1742	England and Europe	75.0%	12.5%	12.5%
1793–94	Ottoman Empire	77.1%	12.5%	10.4%
1794–95	Ottoman Empire	75.8%	13.7%	10.5%

For European data, see Arthur Marshall, *Explosives I. History and Manufacture* (London, 1917), p. 27; West, *Gunpowder,* 170; O. F. G. Hogg, *Artillery: Its Origin, Heyday and Decline* (London, 1970).

stated that the Ottomans used "excellent" powder, "as is evident from the noise of discharge, and the velocity and range of the shot."[105] To be sure, this was not only the Ottomans' problem: all those European empires and states that acquired their powder from similarly varying supply sources faced the same difficulties.

Conclusion

We may conclude that the various channels of military acculturation, examined briefly in this essay, helped the Ottomans keep pace with the developments of European military technology. These channels created similarities in artillery hardware and military technology on both sides of the European-Ottoman military frontier. During the seventeenth century and well into the first half of the eighteenth century, when the Ottomans were supposedly inferior to their European rivals, there were hardly any radical differences as far as European and Ottoman gunpowder hardware was concerned. The applicability of this technology and the deployability of weaponry require further analysis, however.[106]

The Ottomans not only hindered the victory of European hegemony but dominated their European adversaries until the late sixteenth century. Montecuccoli, after all, was the first early modern Christian to defeat the Ottomans in a large field engagement at Szentgotthárd in 1664. Unlike many of their rivals, such as the Spanish and Austrian Habsburgs, the Ottomans were capable of manufacturing their weaponry and ammunition within the borders of the empire. Contrary to the received wisdom, they did not depend on foreign sources of supply. In the long run, however, military self-sufficiency is not necessarily an advantage. It can hinder the adoption of new technologies and know-how and can easily promote complacency.[107] The Ottomans might have held on to their traditional military practices until the eighteenth century because their ongoing logistical strengths could compensate for the growing tactical superiority of their Christian adversaries.

Perhaps it was neither the Ottomans' "inferiority" with military technology, as suggested by traditional Eurocentric historiography, nor their supposed shortcomings with ordnance production that brought on their military failures at the end of the seventeenth century. Such factors as two-front engagements and overstrained communications were obviously of greater significance in an empire where weaponry and ammunition manufacturing plants were scattered from Cairo to Buda, often thousands of miles from the theaters of war. It became increasingly difficult to maintain a thriving manufacturing sector in an empire where the economy as a whole experienced the contractions plaguing the entire Mediterranean region. They consequently started to lag behind the Western European economy in fields such as production capacity and productivity. In comparison with the European logistical systems, the Ottoman system proved to be more effective until the introduction of wide-ranging economic and administrative reforms in Europe. After these crucial administrative-bureaucratic reforms had taken place by the late seventeenth century, however, the European adversaries of the Porte were able to supply their ever-growing armies with the necessary weaponry and munitions. Furthermore, such hardware, including the flintlock musket, was of higher quality than that of the Ottomans. The Sultan's adversaries had by then outstripped their mighty rival not only in the field of war industry and military know-how but also in such fields as production capacity, finance, bureaucracy, scientific engineering, and state patronage, to name a few. These factors had been of considerable importance for strengthening the European military machine since the Italian Renaissance. Yet, because of the sudden change in the nature of the Ottoman-European confrontation on land, all these improvements proved to be decisive at the end of the seventeenth century.

Between 1526 and 1683 there were only two major field battles (that of Mezőkeresztes in 1596 and Szentgotthárd in 1664) fought in Hungary, the

main theater of the Ottoman-European continental confrontation. Besides minor skirmishes of frontier forces, the Sultan's army and major provincial forces were engaged almost exclusively in siege operations. Consequently, they had to adapt the composition of their artillery and the training of their gunners. At the same time, the Thirty Years' War proved to be a fruitful "laboratory" for Christian armies in major field battles, as Gustavus Adolphus demonstrated. With the exception of the 1663 and 1664 wars of Köprülüzade Fazil Ahmed Pasha, the Ottomans had been given little opportunity to acquaint themselves with the intense firepower, disciplined tactics, and continuous drilling of the reformed European forces. Familiarity with European battle tactics nevertheless became essential, given the changes after the Siege of Vienna in 1683. Siege warfare progressively gave way to field battles: at the Danubian frontier, fifteen major field battles took place between 1683 and 1697. The Ottomans won just two of these battles; one battle ended in stalemate, and all others were won by the allies. By 1699, the Ottomans had lost Hungary, together with Transylvania to the Habsburgs, the Morea to Venice, and Azov to Russia.

One should avoid the temptation to overemphasize the importance of these European victories. Technological developments, such as the adoption of the socket bayonet and flintlock musket, played only a limited role in these victories.[108] It was not better guns that gave the advantage to the Europeans, but better drill, command and control, and bureaucratic administration. Additionally, the Habsburgs were able to defeat their archenemy to the East only in coalition with the other forces of the Holy League, which comprised the German Princes of the Holy Roman Empire, Venice, Poland-Lithuania, and Russia, who in effect represented all the Christian neighbors of the Sultan. The Habsburgs also had to mobilize the economic and human resources of half the continent. As a consequence of this Christian coalition, the Ottomans were forced to fight at four different theaters of war: in Hungary against the imperial forces; in Dalmatia, the Morea, and the Mediterranean against the Venetians; and in Moldavia against the Poles. The Russians, who joined the Liga Sacra in 1686, tied up the Tatars in the Eastern European "steppe frontier."[109] None of the major states in seventeenth-century Europe were capable of waging wars simultaneously at four different frontiers, and the Ottomans were no exception. Neither were the Habsburgs. After the Habsburgs were forced to withdraw their best forces from Hungary to the Rhine frontier to fight the French in the War of the League of Ausburg (1688–1697), the Ottomans quickly recaptured Belgrade in 1690. Like the Ottoman Empire, the Christian archenemy of the Sultan was still too weak to engage successfully in alternative commitments. Because of the Treaty of Karlóca (Karlowitz) in 1699, the expansion of the Ottoman Empire was finally

reversed. Yet the Habsburgs subsequently failed to push further south until the late nineteenth century, and plans to "liberate the Balkans" and conquer Istanbul remained a dream.

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Notes

1. Kenneth Meyer Setton, *Venice, Austria, and the Turks in the Seventeenth Century* (American Historical Society, 1991), pp. 6, 100, 450. Setton places too much emphasis on religion. He argues that "the Spanish were caught in an era of religious bigotry, the Turks in a renewal of Islamic fanaticism, and neither people could keep abreast of the technological innovations which had been altering European society from at least the mid-sixteenth century" (p. 6). See also Rhoads Murphey's review in *Archivum Ottomanicum* XIII (1993–94): 371–383.

2. E. L. Jones, *The European Miracle: Environments, Economies, and Geopolitics in the History of Europe and Asia* (Cambridge University Press, 1987), p. 181.

3. Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000* (Vintage Books, 1989), p. 12.

4. Jeremy Black, *War and the World: Military Power and the Fate of Continents, 1450–2000* (Yale University Press, 1998).

5. Geoffrey Parker, *The Military Revolution: Military Innovation and the Rise of the West, 1500–1800* (Cambridge University Press, 1988), p. 126. This section is missing from the second edition (1996).

6. Keith Krause, *Arms and the State: Patterns of Military Production and Trade* (Cambridge University Press, 1992), pp. 48–52. Quotation from p. 49.

7. Jonathan Grant, "Rethinking the Ottoman 'Decline': Military Technology Diffusion in the Ottoman Empire, Fifteenth to Eighteenth Centuries," *Journal of World History* 10, no. 1 (1999): 179–201.

8. Jeremy Black, *War and the World*. See also his *Why Wars Happen* (Reaktion Books, 1998).

9. Marshall G. S. Hodgson, *The Venture of Islam: Conscience and History in a World Civilization, volume III, The Gunpowder Empires and Modern Times* (University of Chicago Press, 1974); William H. McNeill, *Pursuit of Power: Technology, Armed Force, and Society Since A.D. 1000* (University of Chicago Press, 1982); McNeill, *The Age of Gunpowder Empires, 1450–1800* (American Historical Association, 1989).

10. See, e.g., Arthur Goldschmidt, *A Concise History of the Middle East* (Westview, 1999), pp. 107–132. Goldschmidt also accepts the Ottomans' technological decline and claims that "by

the end of the sixteenth century, the Ottomans lagged behind the West in weaponry and fighting techniques" (p. 127).

11. See J. Black, *War and the World*; Kelly deVries, "Catapults Are Not Atomic Bombs: Towards a Redefinition of 'Effectiveness' in Premodern Military Technology," *War in History* 4 (1997): 4, 454–470; Bert S. Hall, *Weapons and Warfare in Renaissance Europe: Gunpowder, Technology, and Tactics* (Johns Hopkins University Press, 1997), pp. 212–216; Rhoads Murphey, "The Ottoman Attitude towards the Adoption of Western Technology: The Role of the Efrencî Technicians in Civil and Military Applications," in J.-L. Bacqué-Grammont and P. Dumont, eds., *Contributions à l'histoire économique et sociale de l'Empire ottoman* (Peeters, 1983), pp. 289–298; Murphey, *Ottoman Warfare, 1500–1700* (Rutgers University Press, 1999), pp. 13–15.

12. Murphey, *Ottoman Warfare*, p. 14.

13. The Spanish word *espingarda* originally was used to designate a type of crossbow that came to mean a type of hand cannon (Hall, *Weapons and Warfare*, p. 129). For the etymology of the English word "gun," see Hall, p. 44. For similar problems with regard to terminology in Byzantium, see Mark C. Bartusis, *The Late Byzantine Army: Arms and Society, 1204–1453* (University of Pennsylvania Press, 1992), p. 336.

14. A. M. Belinickii, "O poiavlenii i rasprostraneii ognestrel'nogo oruzhia v srednei Azii i Irane v XIV–XVI. vekah," *Izvestiia Tadzhiskogo Filiala Akademii Nauk SSSR* 15 (1949): 24.

15. İsmail Hami Danişmend, *İzahlı Osmanlı Tarihi Kronolojisi*, volume 1 (Istanbul, n.d.), p. 73.

16. Carlo M. Cipolla, *Gun, Sails and Empires. Technological Innovation and the Early Phase of European Expansion, 1400–1700* (Pantheon, 1965; Barnes and Noble, 1996), p. 90.

17. See İsmail Hakkı Uzunçarşılı, *Osmanlı Devleti Teşkilatından Kapukulu Ocakları*, volume 2, *Cebeci, Topçu, Top Arabacıları, Humbaracı, Lağımcı Ocakları ve Kapukulu Suvarileri* (Türk Tarih Kurumu, 1984), p. 35; Halil İnalcık, "Osmanlılar'da Ateşli Silahlar," *Belleten* XXI/ 83 (1957), p. 509.

18. Mücteba İlgürel, "Osmanlı Topçulugun İlk Devri " *Hakkı Dursun Yıldız Armağanı* (Türk Tarih Kurumu, 1995), pp. 285–293.

19. See Paul Wittek, "The Earliest References to the Use of Firearms by the Ottomans," in D. Ayalon, ed., *Gunpowder and Firearms in the Mamluk Kingdom: A Challenge to a Mediaeval Society*, second edition (Frank Cass, 1978), p. 142. (Ayalon's book was first published in 1956.)

20. Ibid.

21. İnalcık, "Osmanlılar'da Ateşli Silahlar," p. 509.

22. Vernon J. Parry, "Bārūd," in *Encyclopedia of Islam*, second edition (Brill, 1960), p. 1061.

23. Gábor Ágoston, "Ottoman artillery and European military technology in the fifteenth to seventeenth centuries," *Acta Orientalia Academiae Scienciarum Hungaricae* 47 (1994): 21–22.

24. Djurdjica Petrović, "Fire-arms in the Balkans on the Eve of and After the Ottoman Conquest of the Fourteenth and Fifteenth Centuries," in V. Parry and M. Yapp, eds., *War, Technology and Society in the Middle East* (Oxford University Press, 1975), pp. 175–178.

25. Ibid., p. 173; Ágoston, "Ottoman artillery," p. 22.

26. Petrović, "Fire-arms in the Balkans," p. 175.

27. Bartusis, *The Late Byzantine Army*, pp. 335–336.

28. See Ahmad Y. al-Hassan and Donald R. Hill, *Islamic Technology: An Illustrated History* (Cambridge University Press, 1986), pp. 113–20; Ayalon, *Gunpowder and Firearms in the Mamluk Kingdom*, pp. 2–3, 21–22, 98.

29. Wittek, "Earliest References to the Use of Firearms by the Ottomans," p. 142; Colin Heywood, "Notes on the production of fifteenth-century Ottoman cannon," in *Proceedings of the International Symposium on Islam and Science, Islamabad 1–3 Muharrem, 1404 A.H.* (Government of Pakistan, Ministry of Science and Technology, 1981), pp. 59–61 (reprinted with new notes in Heywood, *Writing Ottoman History*, Ashgate, 2002). Cannon were constructed at the site in 1422 during Murad II's siege of Constantinople; see Bartusis, *The Late Byzantine Army*, p. 337.

30. Ágoston, "Ottoman artillery," pp. 27–28; A. Vasiliev, "Jörg of Nürnberg. A Writer Contemporary with the Fall of Constantinople (1453)," *Byzantion* 10 (1935): 205–209. Doukas claimed that Orban was "a Hungarian by nationality and a very competent technician" (*Decline and Fall of Byzantium to the Ottoman Turks: An Annotated Translation of "Historia Turco-Byzantina" by Harry J. Magoulias*, Wayne State University Press, 1975, p. 200). Since most of the gun founders serving the Hungarian kings were Germans, Orban could have been a German too.

31. Selâhattin Tansel, *Osmanlı Kaynaklarına Göre Fatih Sultan Mehmed'in Siyasi ve Askeri Faaliyeti* (Türk Tarih Kurumu, 1958), p. 52.

32. Nicolo Barbaro, *Diary of the Siege of Constantinople 1453* (Exposition Press, 1969), p. 30; Tansel, *Osmanlı Kaynaklarına Göre Fatih Sultan Mehmed'in Siyasi ve Askeri Faaliyeti*, p. 52; Parker, *The Military Revolution*, p. 225, note 36. On the importance of cannon during the siege, see also Kelly DeVries, "Gunpowder Weapons at the Siege of Constantinople, 1453," in *War and Society in the Eastern Mediterranean, 7th-15th centuries*, ed. Y. Lev (Brill, 1997).

33. Gábor Ágoston, "La strada che conduceva a Nándorfehérvár (Belgrade): L'Ungheria, l'espansione ottomana nei Balcani e la vittoria di Nándorfehérvár," in Z. Visy, ed., *La campana di mezzogiorno. Saggi per il Quinto Centenario della bolla papale* (Edizioni Universitarie Mundus, 2000), pp. 239–246.

34. Cipolla, *Gun, Sails and Empires*, pp. 30–36.

35. See Bernard Lewis, *The Jews of Islam* (Princeton University Press, 1984), pp. 134–135; Stephen Christensen, "European-Ottoman Military Acculturation in the Late Middle Ages," in B. McGuire, ed., *War and Peace in the Middle Ages* (C. A. Reitzels Forlag, 1987), p. 232.

36. See Gábor Ágoston, "Muslim-Christian Acculturation: Ottomans and Hungarians from the fifteenth to the seventeenth centuries," in B. Bennassar and R. Sauzet, eds., *Chrétiens et Musulmans à la Renaissance* (Honoré Champion, 1998), pp. 293–301.

37. Henry and Renée Kahane and Andreas Tietze, *The Lingua Franca in the Levant. Turkish Nautical Terms of Italian and Greek Origin* (University of Illinois Press, 1958), p. 20.

38. Ibid., passim.

39. Péter Sahin-Tóth, "À propos d'un article de C. F. Finkel: Quelques notation supplémentaires concernant les mercenaires de Pápa," *Turcica* 26 (1994): 249–260, especially p. 258.

40. Caroline Finkel, "French mercenaries in the Habsburg-Ottoman War of 1593–1606," *Bulletin of the School of Oriental and African Studies* LV. 3 (1992): 451–471.

41. Sahin-Tóth, "À propos d'un article de C. F. Finkel," p. 258.

42. Finkel, "French mercenaries," p. 465.

43. Quoted in English by Gábor Ágoston, "Habsburgs and Ottomans: Defense, military change and shifts in power," *Turkish Studies Association Bulletin* 22. 1 (1998): 136.

44. Quoted in English by V. J. Parry, "La manière de combattre," in Parry and Yapp, eds., *War, Technology and Society*, p. 228.

45. Quoted in English by Halil İnalcık, "The Socio-Political Effects of the Diffusion of Fire-arms in the Middle East," in Parry and Yapp, eds., *War, Technology and Society*, p. 199.

46. József Kelenik, "A kézi löfegyverek jelentösége a hadügyi forradalom kibontakozásában." *Hadtörténelmi Közlemények* 104. 3. (1991): 80–121.

47. Finkel, "French mercenaries," pp. 463–465.

48. Setton, *Venice, Austria, and the Turks*, 116. See also Murphey, *Archivum Ottomanicum* XIII (1993–94): 374.

49. Rhoads Murphey, "The Ottoman Resurgence in the Seventeenth-Century Mediterranean: The Gamble and Its Results," *Mediterranean Historical Review* 8 (1993): 196.

50. M. Fontenay, "Chiormes turques au XVIIe siècle," in *Le genti del Mare mediterraneo*, ed. R. Ragosta (Lucio Pironti, 1981), p. 890.

51. Ellen G. Friedman, *Spanish Captives in North Africa in the Early Modern Age* (University of Wisconsin Press, 1983), p. 89.

52. Hall, *Weapons and Warfare*, p. 215.

53. Ágoston, "Ottoman artillery," p. 47. Marsigli's comments are based on his observations made in 1683 during his captivity when he was employed for a short time as a laborer in the Ottoman siege works. See also Christopher Duffy, *Siege Warfare: The Fortress in the Early Modern World, 1494–1660* (Routledge, 1996), p. 214. Marsigli remained very critical of the miners and sappers of the allied forces during the unsuccessful siege of Buda in 1684 when,

at an early stage of the siege, he was ordered by Lorraine to inspect their work. See John Stoye, *Marsigli's Europe, 1680–1730* (Yale University Press, 1994), p. 37.

54. He was a typical member of the late-seventeenth-century Italian intelligentsia who managed to acquire considerable knowledge in a wide-range of subjects from history to mathematics, botany or anatomy through private lessons, meetings and conversations with celebrated university teachers and scientists. In 1679–80, during his first stay in Istanbul, and then during his captivity in 1683, he had the opportunity to observe Ottoman troops, and to get first-hand information, both oral and written, concerning the organization, size, weaponry, and siege warfare of the Ottoman armed forces. It was not until the unsuccessful first siege of Buda in 1684 that he had some role in siege work, offering his advice on engineering to Lorraine and Baden. His claim before this siege, that Buda would fall as quickly as ten days, however, cast serious doubt on his "expertise" in siegecraft. In fact, Buda successfully withstood the one-and-half-month siege in 1684 and fell after a two and a half months siege in 1686. See Stoye, *Marsigli's Europe*, pp. 8–12, 36.

55. Ágoston, "Habsburgs and Ottomans," pp. 129–133. Considered "the bastion of the German empire," Győr was recaptured soon thereafter in 1598, as a consequence of a surprise attack after the besiegers had broken down the Fehérvári Gate of the fortress with a petard prepared in Vienna by the French engineer, Jerôme la Marche. Yet Eger and Kanizsa remained in Ottoman hands until the end of the seventeenth century.

56. Paul Rycaut, *The History of the Present State of the Ottoman Empire* (London, 1686), pp. 375–376.

57. Ágoston, "Ottoman artillery," p. 47.

58. Duffy, *Siege Warfare*, p. 213.

59. Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II* (Fontana, 1990).

60. See S. Christensen, "European-Ottoman Military Acculturation," pp. 227–251.

61. Gábor Ágoston, "15.Yüzyılda Batı Barut Teknolojisi ve Osmanlılar," *Toplumsal Tarih* 18 (Haziran 1995): 12–13.

62. Halil İnalcık and Mevlud Oğuz, eds., *Gazavât-i Sultân Murâd b. Mehemmed Hân İzladı ve Varna Savaşları (1443–1444) Üzerinde Anonim Gazavâtnâme* (Türk Tarih Kurumu, 1987), pp. 59–60, 68.

63. Parry, "Bārūd," p. 1062; İnalcık, "Socio-Political Effects," p. 204.

64. Parry, "La manière de combattre," p. 224.

65. Max Jähns, *Handbuch einer Geschichte des Kriegswesen von der Urzeit bis zur Renaissance II* (Leipzig, 1880), p. 1214. See also Parry, "La manière de combattre," p. 250.

66. Parry, "Bārūd," p. 1064.

67. József László Kovács, ed., *Ungnád David Konstantinápolyi utazásai* (Szépirodalmi Könyvkiadó, 1986), p. 36.

68. László Szita, *A törökök kiüzése a Körös-Maros közéröl 1686–1695* (Békés Megyei Levéltár, 1995), pp. 205–208. For two slightly different versions of the original inventory, see ibid., pp. 222–24, 242–244.

69. This section is based on Gábor Ágoston, "Merces Prohibitae: The Anglo-Ottoman Trade in War Materials and the Dependence Theory," *Oriente Moderno* XX (LXXXI), n.s. 1 (2001): 177–192.

70. Parker, *The Military Revolution*, p. 127.

71. See R. Murphey, "The Ottoman Attitude," pp. 292–293; İnalcık, "The Socio-Political Effects," pp. 215–216; Kenneth R. Andrews, *Trade, Plunder and Settlement* (Cambridge University Press, 1984), pp. 90–91.

72. S.A. Skilliter, *William Harborne and the Trade with Turkey, 1578–1582* (Oxford University Press, 1977), p. 23. See also V. J. Parry in *The New Cambridge Modern History*, volume III (Cambridge University Press, 1968), p. 368.

73. Braudel, *The Mediterranean*, p. 625.

74. Quoted by Parry in *The New Cambridge Modern History*, p. 368.

75. Murphey, "The Ottoman Attitude," p. 293.

76. Başbakanlık Osmanlı Arşivi (Ottoman Archives of the Prime Ministry, Istanbul; henceforth BOA), Kamil Kepeci Tasnifi (KK) 4738, pp. 1, 6.

77. BOA, Maliyeden Müdevver Defterleri (MAD) 8880, p. 66.

78. BOA, MAD 2730, p. 46.

79. Stanford Shaw, *Between Old and New: The Ottoman Empire under Sultan Selim III, 1789–1807* (Harvard University Press, 1971), p. 143.

80. BOA, Cevdet Askeriye 9594 and 9595.

81. BOA, MAD 10398, p. 102.

82. BOA, MAD 10405, p. 99.

83. See Shaw, *Between Old and New*, pp. 143–144.

84. BOA, Cevdet Askeriye 9756.

85. *Calendar of State Papers and Manuscripts Relating to English Affairs, Existing in the Archives and Collections of Venice, and in other Libraries of Northern Italy* X (London, 1890–1932) (henceforth CSPM, Venice): 525–6.

86. CSPM, Venice, X, p. 318.

87. I.A.A. Thompson, *War and Government in Habsburg Spain, 1560–1620* (Athlone, 1976), pp. 230–241.

88. For more details, see Ágoston, "Merces Prohibitae."

89. Cipolla, *Guns, Sails and Empires*, pp. 95–99; Grant, "Rethinking the Ottoman Decline," pp. 191–192.

90. On the various types of Ottoman cannon, see Ágoston, "Ottoman artillery," pp. 33–45.

91. This type of weapon was also known to the Rumanians and to South-Slavic people, who borrowed the name of the gun from the Hungarian and called it *sacalas* and *sakalus* respectively. See Lajos Tamás, *Etymologish-historisches Wörterbuch der Ungarischen Elemente im Rumanische* (Akadémiai Kiadó, 1966), p. 685; László Hadrovics, *Ungarische Elemente in Serbcroatischen* (Akadémiai Kiadó, 1985), p. 444; Lajos Fekete, "Az oszmán-török nyelv hódoltságkori magyar jövevényszavai," *Magyar Nyelv* XXVI (1930), p. 264.

92. Ágoston, "Ottoman artillery," pp. 43–45.

93. James D. Lavin, *A History of Spanish Firearms* (Herbert Jenkins, 1965), p. 40; Colin Martin and Geoffrey Parker, *The Spanish Armada* (Hamish Hamilton, 1988), p. 215; John A. Lynn, *Giant of the Grand Siècle: The French Army, 1610–1715* (Cambridge University Press, 1997), pp. 501–502.

94. Lynn, *Giant of the Grand Siècle*, pp. 501–502.

95. Suggested by Parker (*The Military Revolution*, p. 128).

96. F. A. Abel, "On the Chemical Composition of the Great Cannon of Muhammed II, recently presented by the Sultan Abdul Aziz Khan to the British Government," *Chemical News* 457 (4 September 1868): 111–112. See also Parry, "Bārūd," p. 1061.

97. Vanoccio Biringuccio, *The Pirotechnia* (MIT Press, 1966). See also Jerzy Piaskowski, "The Technology of Gun Casting in the Army of Muhammad II (Early 15th Century)," in *I. International Congress on the History of Turkish-Islamic Science and Technology, 14–18 September 1981. Proceedings* iii (Istanbul Teknik Üniversitesi, 1981), p. 168.

98. Piaskowski, "The Technology of Gun Casting," pp. 163–168. See also Alan Williams, "Ottoman Military Technology: The Metallurgy of Turkish Armour," in *War and Society in the Eastern Mediterranean*, ed. Y. Lev (Brill, 1997), p. 263.

99. L. Collado, *Practica Manual de Arteglieria* (Venice, 1586).

100. Cf. Parry, "Bārūd," p. 1061; Parker, *The Military Revolution*, p. 206, note 40.

101. Gábor Ágoston, "Gunpowder for the Sultan's Army: New Sources on the Supply of Gunpowder to the Ottoman Army in the Hungarian Campaigns of the Sixteenth and Seventeenth Centuries," *Turcica* XXV (1993): 87–89. In 1742 Benjamin Robins stated that the above proportion was the most usual one in Europe. Cf. Jenny West, *Gunpowder, Government and War in the Mid-Eighteenth Century* (Royal Historical Society/Boydell, 1991), p. 170. See also table 4.4 of the present essay.

102. BOA DBŞM BRİ 18321

103. Murphey, *Ottoman Warfare*, p. 14.

104. Cf. Ágoston, "Gunpowder for the Sultan's Army," p. 87.

105. Cf. Duffy, *Siege Warfare*, p. 213.

106. For such an attempt, see Murphey, *Ottoman Warfare*, pp. 115–122.

107. I owe this point to Brett Steele.

108. J. Black, *War and the World*, pp. 60–95, especially p. 90.

109. Of course, this is William McNeill's term. See his *Europe's Steppe Frontier, 1500–1800* (University of Chicago Press, 1964). One of the best surveys of the war is Ferenc Szakály, *Hungaria Eliberata* (Corvina, 1986).