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Digital Accounting History—Adoption of a Digitalized Historical Research Methodology

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ABSTRACT: This paper presents details and examples of use of a digitalized research methodology adopted to investigate a mid-15th century Venetian double entry ledger. A digitized journal of the ledger was created, populated using the data entered in the ledger, particularly the contra account references recorded in each entry. This enabled missing entries to be generated and accounts only partially surviving, even missing entirely, to be recreated. The digitization process was facilitated by proprietary software developed by the authors, enabling a comprehensive analysis of the merchant's accounting system. Examples are provided of these activities focusing on the account for profits and losses because the final pages on which it was recorded have not survived, but any account could have been selected. Overall, adoption of a digital methodology greatly increased research productivity, improved clarity and understanding of the double entry accounting system, the business, and its successes and failures.

JEL Classifications: M41; N83.

Keywords: digitizing history; digitalization; medieval; bookkeeping; double entry; profit and loss; Jachomo Badoer.

I. INTRODUCTION

Digitization is the process of converting information from a physical format into a digital format. For many years, researchers and archivists have been engaged in the process of digitizing the account books and other records of various entities ensuring their future accessibility and longevity. The establishment of digital archives facilitates research by making it less necessary to visit an archive in order to physically examine the records it keeps. However, the vast majority of surviving records—account books and related documents—of medieval and early modern (i.e. pre-1800) double entry accounting continue to be available only in their original handwritten form. Beyond digitization of the physical source in order to preserve it, another digital opportunity is presented by the existence of technology capable of being used to develop a digitized version of the source itself. Capturing the original data digitally enables analyses on a scale beyond what is possible using traditional research methods.

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This article has been prepared in response to a call for papers for a special section of the *Accounting Historians Journal* dedicated to contemporary methods and sources in historical accounting research (Keyser, Flesher, and Black 2024). It seeks to present examples of ways in which a digitalized research methodology may be used, not just to preserve surviving records, but to interrogate them and, most importantly, restore them digitally by recovering data lost over the passage of time. And, it demonstrates how modern digital tools enable not only the automation of processing large volumes of data from archival sources, they also offer new research opportunities for the analysis, verification, and visualization of historical data. The archival source digitized using the process described in this paper is the double entry ledger of Jachomo Badoer, a Venetian merchant working in Constantinople—present day Istanbul—in the mid-15th century.

The digitization process adopted in this investigation has undergone augmentation and refinement over several years by this research team. It involves the adoption of a digitalized research methodology whereby technology is embedded in the investigative process, replacing traditional manual research methods and supporting those that are retained (Quinn and Murphy 2025, 3). The first time we adopted the digitalized research methodology described in this paper, it was applied to the double entry account books of the Venetian merchant Andrea Barbarigo between 1430 and 1434 (Kuter, Sangster, Gurskaya, Lugovsky, and Evtykh 2025b). In doing so, a specially created software program was developed to examine the bookkeeping method and design of the accounting system of this Venetian merchant's double entry journal and ledger. This led to several unexpected discoveries, including a cash account that consistently maintained a credit balance for almost a year, as well as the cessation of use of the journal for two months during a period when the business appeared to be switching from a combination of high value wholesale trade and low value local retail, to retail only. This was then reversed when the journal was reintroduced. That paper demonstrated benefits of this digitalized research methodology in both the enhanced accuracy of the data used, and in the power of the analysis undertaken. Benefits such as these that typify the possibilities for research and discovery of a digitalized research methodology which are greatly increased compared to traditional approaches and methods.

During that study, our digitalized research methodology was refined and the technology we developed to assist our activities was improved. It was then reconfigured to match the design of whichever other accounting records we examined. This involved a redesign of the technology to match the accounting system under examination. In the present case, this was the ledger of another Venetian merchant, Jachomo Badoer, who was resident in Constantinople during 1436–1439.

Badoer's double entry ledger is preserved in the Venetian State Archive. It was selected because it was contemporary with Barbarigo's. Although double entry in various forms was also used in other regions of medieval Northern Italy, Luca (Pacioli's 1494) treatise claimed that the Venetian double entry method was the best one to use, and Pacioli gave detailed instruction of how a Venetian double entry accounting system was organized (Pacioli 1494). In doing so, he provided a normative model against which any 15th-century Venetian merchant's double entry accounting system could be assessed and interpreted. And it was the Venetian *libro doppio* method he described, embracing a double entry journal with its ledger, that spread throughout Europe and is the basis for the one used today in most countries of the world.

The double entry accounting system of earlier Venetian merchants, such as the Soranzo brothers of the early 15th century (Ryabova 2018), included use of a *memoriale* (an account book used to record initial records of transactions), a journal (a register of consecutive chronological entries primarily drawn from the *memoriale*), and a ledger (primarily containing double entries posted into accounts from the journal), sometimes in combination with other notebooks as sources for entries. In contrast, our previous study of Andrea Barbarigo found that he used a paired journal and ledger in the *libro doppio* style described by Pacioli with no indication that he used a *memoriale*. Badoer's ledger includes occasional mention of notebooks being the original source record for entries but, in keeping with Pacioli's description and Barbarigo's bookkeeping practice, the ledger account entries give no indication of whether a journal was used from which all entries for transactions recorded in the ledger were posted and no journal has survived which could have confirmed one was being used. However, the manner in which the ledger was maintained is entirely consistent with Pacioli's description of how to maintain a *libro doppio* ledger, as was Barbarigo's. Both merchants used the same form of *libro doppio* ledger.

The digitalized research methodology we developed and used in the investigation reported here assisted us in identifying how all the accounts in Badoer's ledger were linked together in the accounting system. It then enabled us to use that knowledge to recover data lost from the ledger. Doing so was our initial goal. It was motivated by several pages of the ledger having been damaged, making parts of them illegible, and the last fifteen sheets, on which the final accounts prepared when the ledger was closed, have been lost, along with a few others. The loss of those final ledger sheets makes any assessment of the merchant's success or failure during the period covered by the ledger limited, if not impossible using traditional research methods. Our use of digital technology made it possible. Among the data we recovered were the missing records of the account for profits and losses (*Utel e dano*). This was made possible by our embracing the principles of the double entry method into the design of the program we developed, which was used to extract data

from the ledger and, from it, generate a digital version of the journal. This, in turn, allowed us to generate ledger accounts that had been lost, along with missing entries in incomplete ledger accounts that had suffered damage or partial destruction.

We believe that the manner in which the double entry accounting system is organized to meet the management needs of the entity deserves recognition as a separate research area of accounting history. Approaching an investigation from that perspective enables scholars to determine what the double entry accounting system was being used to do, which in medieval Venice was not to determine the overall financial result. An account for profits and losses was simply that: As described by Luca Pacioli in 1494, it served as a depository of nominal account balances when they were closed and when the ledger was closed.

It is important in any historical study to be aware of context, otherwise interpretation and explanation of what is seen is unlikely to be little more than speculation, or even guesswork. For example, regional differences in how double entry accounting was done in Italy in medieval times are well known (Pilla 1974; Antinori 2004), but differences in accounting system design between individual entities from the same region are seldom investigated. Anyone who does so will realize that differences in design of medieval double entry accounting systems depended on, not only the region where the bookkeeping was done, but also the form of entity and, most importantly, the type of activity. Special attention must be paid to what was being recorded—the nature of the transactions being recorded—not just to the recording process, the bookkeeping method, but also to how the accounting system is organized. That is what is necessary for anyone to conduct meaningful in-depth investigations of double entry records (Kuter, Baker, and Gurskaya 2022; Kuter, Baker, Gurskaya, and Sagitova 2024; Kuter, Gurskaya, and Gurskii 2025a). In addition, our experience has taught us that it is vital that as much as possible is discovered about the entity and the merchant whose account books are being studied, of the surrounding context or environment in which the transactions recorded occurred, and of how the information recorded in the accounting system was used. That knowledge enables explanations to be identified for the design of the double entry accounting system and the use made of the double entry method.

A detailed study of the features of a double entry accounting system of medieval business allows us to identify not only the specifics of this activity, methods, and tools of accounting. Beyond the single entity, it also reveals the peculiarities of medieval business activity in general—trade routes, prices for goods and services, names of counterparties, profitability of certain operations, information on exchange rates, interest rates, and much more. In this case, we discovered information from the entries recorded about the nature and form of the trading activity of Venetian merchants in Constantinople and in the Mediterranean, some of which had not previously been identified in the accounting history literature.

This paper expands our knowledge of the peculiarities of business organization and the support obtained from the double entry accounting systems used by medieval Venetian merchants. In doing so, it contributes to the historical accounting literature. But, the most important contribution is the exposition in this paper of use digital technologies, namely the program we have developed, without which it would be impossible to carry out such research on this scale. It describes how we did so and demonstrates, not just how important it is to use modern technologies in historical research but also how, through careful design of the manner in which the technology is used, many more discoveries can be made than is feasible or even possible using a traditional manual approach. It is our hope that those who read this paper will be encouraged to adopt a digital research methodology to address the issues they encounter in their own research of any historical period.

II. DIGITAL RESEARCH IN ACCOUNTING HISTORY

The use of digital technologies in historical research is still in its early stages of development. According to Professor Georg Vogeler, a renowned German medieval historian and digital humanities[1] specialist, accounting documents are particularly well suited for digital reproduction. These documents contain a substantial amount of highly structured information that should have been calculated in their original context (Vogeler 2014). This suggests that creation of a digital data base to facilitate statistical and numerical analysis of accounting records should to be a promising approach for their analysis. It is reasonable to assume that such an approach will become the prevailing standard and may, as previously suggested, evolve into a distinct domain of accounting history. In a similar fashion to the present categorization of historical accounting research as either Traditional or New Accounting History, a future categorization of Digital Accounting History may emerge. Thus, through adoption of innovative forms of studying the past

[1] Digital humanities can be defined as new ways of doing scholarship that involve collaborative, transdisciplinary, and computationally engaged research, teaching, and publishing. It brings digital tools and methods to the study of the humanities with the recognition that the printed word is no longer the main medium for knowledge production and distribution (https://en.wikipedia.org/wiki/Digital_humanities).

such as this, accounting history researchers can contribute to a better understanding of the modern world, its governance, and accounting (Cordery, Gomes, Leoni, McBride, and Napier 2023). Ongoing research can shed light on the significance of accounting in bygone eras and its potential transformation in the present.

In 2017, José Manuel de Matos Carvalho presented a tool for the digitalization of accounting documents: an original digital solution using an Excel spreadsheet. The primary resources he used for data base generation were the double entry journal and ledger of a silk factory company (1745–1747). He emphasized the importance of accounting history research shifting to a digital paradigm, and anticipated that a digital history research methodology (digitization of documents, automated reading, text coding, data bases, and other subsequent digital outputs) would soon become the most popular research method (Carvalho 2017). In 2019, at The XVII International Congress of Accounting and Auditing, Accounting in the Digital Age: Opportunities and Challenges, a paper coauthored by him with Pedro Carvalho was presented on an early attempt to digitize the entire accounting system in spreadsheet data bases across nine existing ledgers (J. Carvalho and P. Carvalho 2019).

In 2022, the journal *Accounting History* announced the formation of a special issue of the journal on accounting history research in the age of digitalization. This sparked the interest of researchers in this topic. That special issue brought together articles on accounting history in the digital world, and has attracted studies that explore the impact of digitalization on accounting history and its use in research. The call for papers clearly aimed to popularize the adoption of digitalization in accounting history research, highlighting a myriad of opportunities including, using more sources, obtaining stronger evidence from different sources, exploring new topics and under-researched historical periods, and cross-country comparisons of data relating to past accounting practices (Leoni and Sangster 2022).

One of the papers published in that special issue by Quinn and Murphy (2025) presents empirical data from two research subjects—the religious organization Magdalene Laundry and the Guinness Brewery—to show what digitalization means in terms of "doing" accounting history research. The paper offers reflections on what the digital methods and tools employed may mean for the development and future of accounting history research.

Special issue co-guest editor Alan Sangster presented the case for accounting historians to "go digital." The paper described his own journey in applying digital technologies to accounting history research, presenting motivations, strengths, weaknesses, opportunities, threats, and outcomes (Sangster 2025). But he primarily focused on the benefits that can be gained by utilizing modern digital technologies now and in the future.

Whereas in the field of accounting history we are just beginning to talk about the use of digitalization, economic historians are paying more attention to this area. More widely, there is a growing trend toward digital history, such as the digital humanities. Digital history can be understood broadly as an approach to studying and representing the past that embraces use of new communication technologies of the computer, internet networks, and software systems (Seefeldt and Thomas 2009).

There can be little doubt that Digital Accounting History will soon become widespread among accounting historians, and that technology and digitalized research methodologies will be recognized as a functional approach for improving the quality and productivity of research in the field of accounting history.

Furthermore, our specialist journals, while supporting and encouraging research on the history of the accounting profession, encourage us to seek enlightenment on where accounting principles and concepts originated, the changes and compromises along the way, the conceptual arguments and counterarguments, and the broad historical forces that have shaped the modern profession (Black 2019). There can be no more appropriate place to begin than at the beginning of modern double entry accounting when the double entry method first developed and served diverse needs in medieval Italy. Doing so will test the capability of modern technologies against the most difficult sources to examine, and the least complete archival accounting sources, which is what anyone faces when examining accounting artifacts from that period. This is why in this paper we focus on the sometimes illegible ledger of the 15th-century Venetian merchant, Jachomo Badoer.

III. JACHOMO BADOER'S LEDGER IN THE LITERATURE

The double entry ledger of Jachomo Badoer is of particular interest for the study of the historical beginnings of Venetian use of the double entry method Badoer (1436–1439). As previously mentioned, unlike Andrea Barbarigo's ledger of the same decade, no journal is available to assist in identifying the entries that have been lost due to missing sheets, entries lost due to water damage, eaten by rodents and insects, or faded text.

Traditional historical research methodologies have been applied to this ledger several times. Among accounting historians, Fabio Besta, whose work has made a significant contribution to the understanding of the economic history of the Venetian Republic and business practices in the 15th century, was one of the first to examine the ledger, in 1880 (Besta 1880). He then analyzed and described it in greater detail in the course of lectures on accounting that he gave at the Royal Higher Commercial School in Venice in 1891 (Besta 1891). In his later work, particularly his three-volume

La Ragioneria, Besta continued to refer to the materials of Badoer's ledger, seeing them as important historical sources for the study of accounting and economic practices (Besta 1909). In 1891, Valery Alfieri published a detailed description of the ledger, including a transcript of several of the early pages (Alfieri 1891). Others to examine the ledger include Florence Edler de Roover (De Roover 1945), Frederic C. Lane (Lane 1944, 1945, 1977), Federico Melis (Melis 1950), Tommaso Zerbi (Zerbi 1952), Raymond de Roover (de Roover 1956), Alvaro Martinelli (Martinelli 1974), Turgot Var (Var 1976), Edward Peragallo (Peragallo 1977, 1980, 1981, 1983), and Carlo Antinori (Antinori 2004). However, few who have focused on the accounting have explored the missing data or identified the data on missing pages.

Economic and business historians have also used Badoer's ledger as a valuable source of information about the conduct of business and everyday commercial practices of the time. These include Dimitrios Gofas (Gofas 1996), Takashi Iida (Iida 1998), Cécile Morrisson (Morrisson 2001), Thierry Ganchou (Ganchou 2003), Jean-Claude Hocquet (Hocquet 2010), Rafael Fernández (Fernández 2010), and Stefania Montemezzo (Montemezzo 2012, 2019, 2024). However, as with those who have looked at the accounting, few have investigated the missing data or identified the data on the missing pages, which is what we sought to do using our digitalized research method.

IV. JACHOMO BADOER, HIS BUSINESS, AND HIS LEDGER

Jachomo Badoer was a prominent figure in Venice in the mid-fifteenth century. He belonged to one of the city's prominent patrician families and was active in Venetian maritime trade. His importance lies not only in his family background but also, for accounting historians, in the fact that he kept extensive records. His detailed ledger provides valuable insights into the economic activities and daily life of merchants in Venice and Constantinople at the time, providing historians with a unique insight into the complexities of trade, finance and daily transactions in these busy commercial centers (Astuti 1968). Although Badoer was not among the wealthiest or most influential merchants of his era, his meticulous documentation has become one of the most important sources for understanding the economic history of the late medieval and early Renaissance periods.

There is limited information about Badoer's life before his journey to Constantinople. What is known is that he was engaged in trade in conjunction with his brother Geronimo. Their joint business was successful and they invested heavily in trading operations. Badoer's journey to Constantinople began on July 24, 1436 and ended when he arrived there six weeks later, on September 2. This was an important step for him to take as it allowed him to expand his business ties and strengthen his position in international trade. His activities in Constantinople could also be linked to the development of trade relations between Venice and the Byzantine Empire, which at that time was under considerable pressure from the Ottoman Empire (Peragallo 1977, 882).

He spent almost three years and six months in Constantinople, until February 26, 1439 (1440 according to the modern calendar—at that time, the year end was at the end of February). During this period he was actively engaged in trade, establishing business ties both in Constantinople and with other Mediterranean cities. He often received goods from his brother in Venice, as well as from other merchants, but he was not in partnership with his brother, or anyone else—that is, in Constantinople he was a sole trader and commission agent (Morrisson 2001, 220). His business covered a wide range of goods, from luxury goods to everyday necessities. Among those he traded were: spices, including pepper, cinnamon, ginger, cloves, and others that were highly valued in Europe; expensive clothing, which included fine fabrics and accessories; raw silk to be processed into textiles; and inexpensive items such as leather goods, provisions, and necessities. The variety and range of goods he dealt in were in demand among various segments of the population. He also traded in gems, and in slaves, who were counted, as was the norm at that time, head-by-head, like cattle. His activity in slaves was so prosperous that it accounted for one third of his turnover (Stevelinck 1994, 6).

As a commission agent, Badoer made purchases and sales on behalf of other Venetian merchants using their funds, acting as an intermediary, representing them and ensuring that the various tasks involved in buying, selling, and transporting merchandise were completed (Peragallo 1977, 891). In return, he took a commission for these services. Such arrangements were crucial to maintaining the flow of trade over long distances and were commonplace among Venetian merchants, each of whom acted at times as either principal or agent or both with each other.

Illustrating how extensive and complex the network of trade routes was in that period, Badoer's ledger reveals that his commercial ties extended far beyond Constantinople and Venice to many different regions, including cities on the Black Sea and Aegean coasts, Southern Italy, and Anatolia (Iida 1998, 45–47). Badoer's ledger is also an important source of information about the daily life and habits of the people of the time, providing deep insights into the social aspects of the lives of medieval Venetian merchants. These include the items that were considered necessary for traveling, how resources were allocated, and how the day-to-day affairs of a trading enterprise were carried out.

The idea of conducting a full-scale study of the ledger of Badoer's ledger emerged in 2016, when two members of our research team spent one day creating digitized images of the ledger in the State Archive. Initially, it was intended

only to use the digital images to chart the double entry accounting system applying the method of logical-analytical modeling we had developed in previous studies of medieval ledgers from archives in Florence, Genoa and Prato (Gurskaya, Kuter, and Bagdasaryan 2019; Kuter, Gurskaya, Andreenkova, and Bagdasaryan 2017, 2018; Kuter, Bagdasaryan, and Gurskaya 2019; Kuter, Sangster, and Gurskaya 2020).[2] However, the significant information losses in Badoer's ledger, especially the absence of the last 15 pages, required the development of a new, more advanced use of technology than we had used previously. This involved developing customized technology to reconstruct the missing data, a necessary step before we could finalize our preparation of our models of the accounting system.[3]

As a first step, we created an information base for the study in the form of a digitized journal, which simulates what Badoer's journal would have contained had he maintained one. This was the technology that generated the missing entries. We had previously used a similar approach to generate ledger accounts of Andrea Barbarigo (Kuter et al. 2025b) but, in that case we used the handwritten journal as our source. In the case of Badoer, the absence of a journal meant that the ledger became the primary source for our digital journal.

V. FORMATION OF A DIGITAL INFORMATION BASE FOR THE STUDY

In addition to having to use a different source for our digital journal, we also had to address the change in currency and money of account from Venetian ducats and lire to the *perperi* and *carati* of Constantinople, and their subdivisions into quarters and halves (Morrisson 2001). This was a significant change, requiring a different structure with less monetary denominations, less monetary columns, and different exchange rates. The data base we created had to be redesigned to address these differences. To generate the digital journal, we had to enter data from a total of 1,418 accounts in the ledger, including missing accounts restored during the process.

Creation of the digitized journal represented a pivotal phase of the research. Its creation made it possible to recover missing account data and generate any ledger account involved in any transaction recorded in our digitized journal. This enabled us to use it to generate a digital version of the ledger accounts we wished to examine. In turn, this allowed us to conduct a full analysis of the ledger accounts at a far more complete level than previous researchers had found possible. The key to making this possible was the duality of the double entry method, whereby each entry recorded told us into which account its contra entry was made.

The development of the digital data base and its population with data took two members of the research team approximately 6 weeks. It began in late 2023, and involved the utilization of a software product that integrates the programming languages Visual Basic for Application (VBA) and M in the .NET environment (NET Framework). The program that was developed incorporates a verification process during initial processing which employs a cross-reference check to ensure the presence of a contra entry in the data base for each entry. In the event of its absence (missing data), the absent entry is automatically generated. The data entry screen from which data transfers to our data base (Base) and the digitized journal, and the three screens used for data manipulation and analysis are shown in Figure 1.

VI. BADOER'S DOUBLE ENTRY ACCOUNTING SYSTEM

There was no concept of periodicity in medieval Venetian double entry accounting systems. Ledgers reveal the profits and losses on various individual activities, with no attempt made to attribute profits and losses to specific periods of time (Lane 1977, 189). Rather than income-focused double entry accounting with accounts for sales and purchases, as are used today, medieval Venetian merchants used the double entry method for Venture Accounting, whereby the focus was on the assets of the business, with each good, consignment, voyage, or investment recorded separately in its own account (Lane 1945). Consequently, there was no place in the accounting system for sales or purchases accounts.

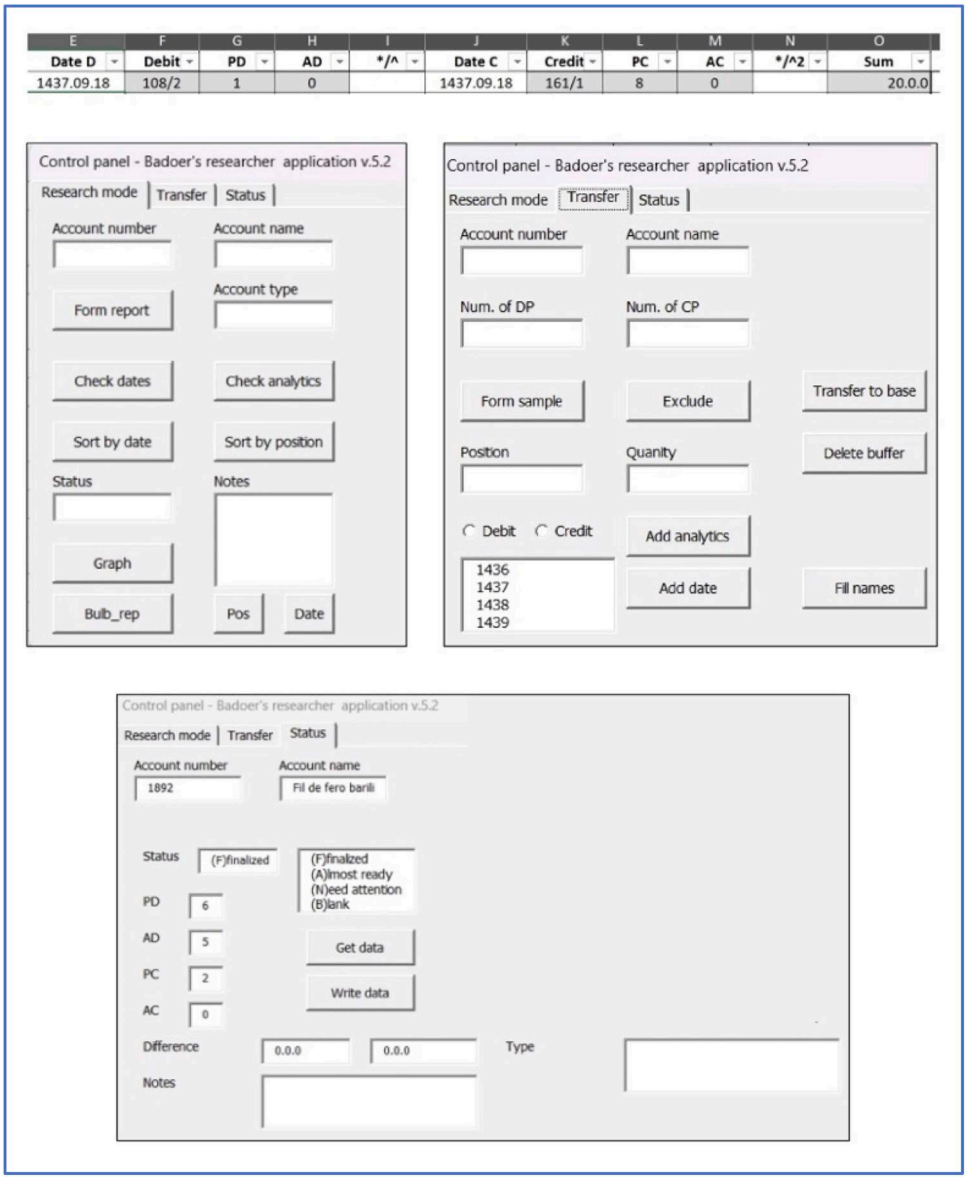
There is no doubt that the main tool for management decisions at that time was the double entry venture accounting, and that double entry accounting systems were employed for the purpose of stewardship of the assets and liabilities and of those who managed them. Thus, the objective of their double entry accounting systems was to manage each

[2] One of the 30 logical-analytical models we prepared is presented in Appendix B. Each model took two to three days to complete. We have been using models of this type for over a decade and have found them very useful in providing an overview of a section of the accounting system we are examining. They help us to check the digitized accounts generated by our program. Also, in more complex accounting systems involving many account books, models of this type are particularly helpful in highlighting the source of entries. In medieval Tuscany, for example, a contra entry to an entry in the ledger may be in the ledger, in a cash book, a merchandize book, and even a daybook. A logical-analytical model makes such things very visible.

[3] A transcript of Badoer's ledger was published by Dorini and Bertele (1956), but we were unaware of it until after we had completed our initial work. When we consulted it, we discovered little that we had not already found. However, had we had access to it from the start, it would have sped-up our progress, but it would not have solved the problem of missing data.

FIGURE 1

Images of the Data Entry and Data Manipulation and Analysis Screens



(The full-color version is available online.)

venture and manage those who managed each venture. All direct costs and income were entered into the account of the venture to which they related. Upon completion of a venture, the profit or loss on that venture could be readily found from its account. The entries in an account could be checked against other information obtained, such as letters from correspondents, widely circulating merchant manuals, knowledge of official charges and taxes, and information from other merchants (Lane 1977).

This was particularly relevant to merchants who engaged commission agents to carry out their activities and, at the same time, the agents. The merchants oversaw the quality and reliability of their agents by assessing their activities and the quality of their performance using the agent's double entry accounting records, which they were sent by their agents, and then compared against data available from other sources (Lane 1945, 170; Lane 1977). Consequently, when Badoer recorded entries in his ledger, in his role of commission agent he was motivated to meticulously attribute costs

and income to the relevant venture account. Doing so helped him to maintain the trust of the merchants whom he was representing, which helped him secure further appointments in future.

The accounting system used by Badoer consisted of sequential accounts formed on *kartas*—facing pages with both sides identically numbered. The accounts kept included many for merchandise for sale, both his own and belonging to others; a merchandise expenses account from which amounts were transferred to individual merchandise accounts; a commission account; accounts for voyages; an account for cash; and an account for profits and losses into which the final profit or loss on each venture was entered. An account was also kept in which he recorded all expenses that were unrelated to the management of his business, such as those incurred on food, lodging, transportation, and other daily needs (Zerbi 1952, 401). He charged commission on all the merchandise he handled, including his own. In doing so, he separated that activity from his activities as a merchant. It was viewed as a separate business, a separate venture within his double entry accounting system. It not only included commission on sales and purchases, on exchanges, and on commissions on amounts collected on behalf of third parties (Zerbi 1952, 407), it also included commission charged for finding buyers. His account for losses and profits served the role of a clearing account, one that eliminated accounts from the ledger in the manner described by Luca Pacioli (Pacioli 1494).

Overall, his double entry accounting system informed him of the cost of his goods when he was agreeing a sale, provided the detail required of him by those for whom he acted as an agent, enabled him to accurately calculate the profit or loss on each venture in which he engaged, and helped him to efficiently manage the resources for which he was responsible, both his own and those he managed for others.

As mentioned previously, whereas many of the accounts have survived undamaged in the ledger, several have not. Consequently, gaining an overview of the business as a whole from it is not possible using traditional research methods, though some, such as Edward Peragallo (Peragallo 1981) have tried. The next section illustrates how we used our digitalized research methodology to reconstruct missing data.

VII. RECONSTRUCTING MISSING ENTRIES

For this illustration, we focus on the account for Profits and Losses (*Utel e dano*). It was initially recorded on three separate *kartas* (65, 306, and 367) that have survived.[4] *Karta* 65 is well-preserved, but the other two *kartas* are damaged. Using our customized program, we were able to fully reproduce the information presented on all three *kartas*. We began by using our digitized journal to generate a digital version of the account on *karta* 65. It was then checked against the analog (handwritten) account in the ledger. The original account and our digitally generated version are shown in Figure 2. The circles around the amounts overlaid on the images identify how we confirmed the overall accuracy of both versions of the account.

From Figure 2, it can be seen that profit and loss accumulated for the period June 13, 1437, to December 15, 1438, included 14 losses amounting to *perperi 321 carati 4* on the debit of the account and 24 profits amounting to *perperi 2,448 carati 16* on the credit. The balance carried forward to the continuation of the account on *karta* 306 is shown in the final debit entry: *perperi 2,127 carati 12.*

Illustrating the operating of the double entry method, the original wording in the ledger of the first debit entry on *karta* 65 indicates that the contra entry was to *karta* 7 relating to a loss on a voyage which had been in the hands of an agent, Jachomo di Stefano:

> *Utel e dano diè dare a di 13 zugno per il viaggio di Trabexonda del 1436 rechomandado a Jachomo di Stefano, per dano seguido de quello,* ***karta*** *7, perperi 4 carati 8.*

Digitally generated *karta* 65 in Figure 2 indicates that this was the second account on *karta* 7, presented as "007/2" in the column headed "Corr. C."

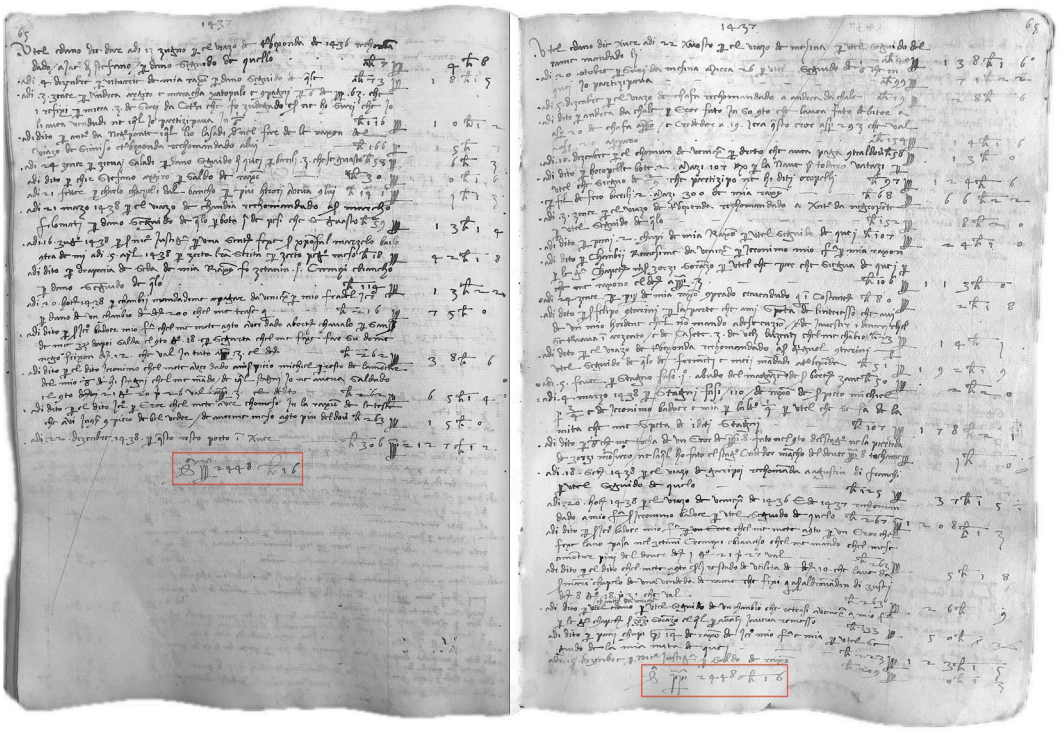
A digital image of the second account of *karta* 7 and its digitally generated version are shown in Figure 3. The contra entry to *karta* 65 is highlighted on the row above the column totals.

As identified in Figures 2 and 4, on each side of the accounts (debit and credit) the total of the entries was entered. By doing so, Badoer confirmed adherence to the immutable rule of Venetian double entry: When an account is closed, the sum of the entries on the debit side must equal the sum of the entries on the credit side. However, as is shown on the debit side in Figure 3, Badoer did not enter a total on a side of the account when there was only one entry on that side. The slanting lines visible in that figure, written across the two sides of the account, indicate the account was closed. This removed any necessity to otherwise indicate that there were no further entries on either side.

[4] The logical-analytical model we prepared to represent the structure of the double entry accounting system as it applied to *kartas* 65, 361, and 367 is presented in Appendix B.

FIGURE 2

Digital Image of *Karta* 65 and Its Digitally Generated Reconstruction

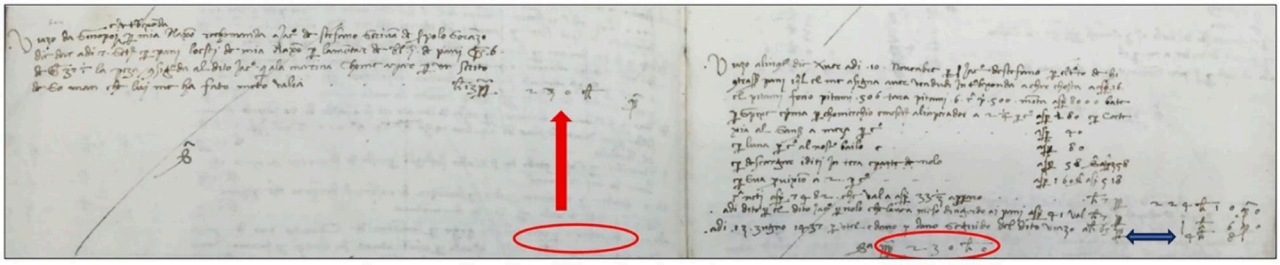


Account		065/1		Acc. name			Utel e dano 1									
№	Name	Date D	PD	Cor. Date C	Cor. C	Cor. PC	SumAD	SumD	Date C	PC	Cor. Date D	Cor. D	Cor. PD	SumAC	SumC	CURR.
178	Utel e dano 1|Viazo da Sinopoi	1437.06.13	1	1437.06.13	007/2	3		4.8.0								PCQ
95	Viazo da Mesina e Saragoxa|Utel e dano 1								1437.08.22	1	1437.08.22	040/1	2		138.16.0	PCQ
277	Zurze de Zezillia|Utel e dano 1								1437.10.20	2	1437.10.20	099/1	8		71.22.0	PCQ
183	Utel e dano 1|Vituarie	1437.12.04	2	1437.12.04	073/1	9		18.15.0								PCQ
214	Viazo de Chafa|Utel e dano 1								1437.12.05	3	1437.12.05	079/1	3		28.6.0	PCQ
336	Andrea da Chale|Utel e dano 1								1437.12.05	4	1437.12.05	154/1	2		14.16.0	PCQ
170	Chomun de Veniexia|Utel e dano 1								1437.12.10	5	1437.12.10	058/2	1		13.0.0	PCQ
272	Horipele bote|Utel e dano 1								1437.12.10	6	1437.12.10	097/1	8		124.6.0	PCQ
195	Fil de fero barili|Utel e dano 1								1437.12.10	7	1437.12.10	068/2	4		66.22.0	PCQ
185	Utel e dano 1|Andrea a l'inchontro	1437.21.03	3	1437.21.03	116/2	5		10.12.0								PCQ
187	Utel e dano 1|Antonio da Negroponte	1437.21.03	4	1437.21.03	166/1	4		15.7.0								PCQ
335	Viazo de Trabexonda|Utel e dano 1								1437.21.03	8	1437.21.03	152/2	3		8.20.0	PCQ
294	Pani|Utel e dano 1								1437.21.03	9	1437.21.03	107/1	6		24.10.0	PCQ
293	Chanbii|Utel e dano 1								1437.21.03	10	1437.21.03	106/2	4		113.0.0	PCQ
181	Utel e dano 1|Pessi saladi	1437.21.24	5	1437.21.24	058/1	3		6.3.0								PCQ
180	Utel e dano 1|Chir Stefano Argiro	1437.21.24	6	1437.21.24	030/3	4		0.16.0								PCQ
218	Piper|Utel e dano 1								1437.21.24	11	1437.21.24	080/2	2		2.18.0	PCQ
75	Debitori a l'inchontro|Utel e dano 1								1437.21.24	12	1437.21.24	023/3	3		14.1.0	PCQ
5190	Ser Felipo Chontarini fo de ser Marin|Utel e dano 1								1437.21.24	12	1437.21.14	023/3	3		14.1.1	PCQ
157	Viazo de Trabexonda|Utel e dano 1								1437.21.24	13	1437.21.24	051/2	9		192.19.0	PCQ
154	Stagno faso|Utel e dano 1								1437.22.05	14	1437.22.05	050/1	4		2.20.0	PCQ
186	Utel e dano 1|Ser Charlo Chapello	1437.22.21	7	1437.22.21	141/1	15		1.13.0								PCQ
295	Stagni fasi|Utel e dano 1								1437.23.04	15	1437.23.04	107/2	7		178.21.0	PCQ
3028	|Utel e dano 1								1438.03.04	16	1438.03.04	999/9	15		1.0.0	PCQ
182	Utel e dano 1|Viazo de Chandia	1438.03.21	8	1438.03.21	059/1	2		13.14.0								PCQ
184	Utel e dano 1|Draparia de Seda	1438.07.16	10	1438.07.16	114/2	2		13.22.0								PCQ
5329	Utel e dano 1|Ser Nicolò Giustinian	1438.08.16	9	1436.10.16	018/1	6		42.18.0								PCQ
308	Viazo da Garipoi|Utel e dano 1								1438.10.18	17	1438.10.18	125/2	7		37.15.0	PCQ
188	Utel e dano 1|Chanbii mandadime a pagar da Veniexia	1438.10.20	11	1438.10.20	216/1	2		75.0.0								PCQ
189	Utel e dano 1|Ser Jeronimo Badoer mio fradelo 2.4	1438.10.20	12	1438.10.21	262/1	2		38.6.0								PCQ
190	Utel e dano 1|Ser Jeronimo Badoer mio fradelo 2.4	1438.10.20	13	1438.10.21	262/1	4		65.14.0								PCQ
500	Viazo da Venexia de 1436 e de 1437|Utel e dano 1								1438.10.20	18	1438.10.20	267/1	2		1208.13.0	PCQ
493	Ser Jeronimo Badoer mio fradelo 2.5|Utel e dano 1								1438.10.20	19	1438.10.20	263/1	10		5.18.0	PCQ
494	Ser Jeronimo Badoer mio fradelo 2.5|Utel e dano 1								1438.10.20	20	1438.10.20	263/1	12		26.9.0	PCQ
318	Chanbii a l'inchontro|Utel e dano 1								1438.10.20	21	1438.10.20	133/2	2		50.0.0	PCQ
420	Pani chontrascriti|Utel e dano 1								1438.10.20	22	1438.10.20	223/1	5		123.15.0	PCQ
191	Utel e dano 1|Ser Jeronimo Badoer mio fradelo	1438.10.22	14	1438.10.21	263/1	4		15.0.0								PCQ
412	Ser Nicholo Justignan|Utel e dano 1								1438.12.15	23	1438.12.15	209/2	10		0.13.0	PCQ
177	Utel e dano 1|Utel e dano 2	1438.12.22	15	1438.12.22	306/1	1		2127.12.0								PCQ
193	Utel e dano 1 Historical total							2448.16.0							2448.16.0	
	Utel e dano 1 Work total							2448.16.0							2448.16.1	
	Utel e dano 1 Difference							0.0.0							0.0.1	

Source: Badoer (1436–1439). Reprinted with permission from the Ministero Della Cultura, Venice, Italy.
Due to the limitations of the date function in spreadsheets, the entries in the date column for January and February in this, and all other digitally generated accounts in this article, show the month as 21 and 22, respectively. The other months are numbered "normally" from March (3) to December (12).
(The full-color version is available online.)

FIGURE 3

Digital Image of the Second Account on *Karta* 7—*Viazo di Sinopoi et di Trabexonda* (Sinopoli and Trabizonda Voyage)—and Its Digitally Generated Version



Account		007/2		Acc. name			Viazo da Sinopoi									
№	Name	Date D	PD	Cor. Date C	Cor. C	Cor. PC	SumAD	SumD	Date C	PC	Cor. Date D	Cor. D	Cor. PD	SumAC	SumC	Curr.
15	Viazo da Sinopoi|Pani loesti bale	1436.10.07	1	1436.10.07	013/2	1		230.0.0								PCQ
5207	Not double entry|Analytics								1436.11.10	1.1				180		ASP
5208	Not double entry|Analytics								1436.11.10	1.2				40		ASP
5209	Not double entry|Analytics								1436.11.10	1.3				80		ASP
5210	Not double entry|Analytics								1436.11.10	1.4				58		ASP
5211	Not double entry|Analytics								1436.11.10	1.5				160		ASP
5212	Not double entry|**Analytics sum**								1436.11.10	1.6				518		ASP
200	Ser Davit Chontarini|Viazo da Sinopoi								1436.11.10	1	1436.11.10	007/4	1		224.10.0	PCQ
201	Ser Davit Chontarini|Viazo da Sinopoi								1436.11.10	2	1436.11.10	007/4	2		1.6.0	PCQ
178	Utel e dano 1|Viazo da Sinopoi								1437.06.13	3	1437.06.13	065/1	1		4.8.0	PCQ
16	Viazo da Sinopoi Historical total							230.0.0							230.0.0	PCQ
	Viazo da Sinopoi Work total							230.0.0							230.0.0	
	Viazo da Sinopoi Difference							0.0.0							0.0.0	

Source: Badoer (1436–1439). Reprinted with permission from the Ministero Della Cultura, Venice, Italy.
A translation of account 007/2 is shown in Appendix A. As can be seen two of the entries in the digitally generated version (1.5 and 1.6) were entered on one line in the ledger (line 5).
(The full-color version is available online.)

Missing Data

Several entries on the second *karta* of the profits and losses account, *karta* 306, were lost. Using our data base digitized journal we were able to reconstruct the full account. The handwritten *karta* and the digitally generated version are presented in Figure 4. The foot of the latter reveals that a small addition error was made on the debit side by Badoer.

On the final surviving *karta* of the account, *karta* 367, the debit side has been lost. Again, we used our data base (digitized journal) to reconstruct the missing entries. The *karta* contains entries relating to two accounts:

367/1 is the final surviving account for profits and losses (*Utel e dano*).
367/2 is the account of Ser Zuan Andrea e Jachomo da Campi (not reproduced).

Our digitization found 14 missing entries on *karta* 367. Ten were for the account for profits and losses. The digital reconstruction of the account on *karta* 367 is presented in Figure 5. We knew from our digitized journal that this account for profits and losses was also recorded on *karta* 405, which is missing. Consequently, it generated the 11th debit entry for the balance on the account, and recorded it as being carried forward to *karta* 405. Missing data is addressed in more detail in the next two subsections.

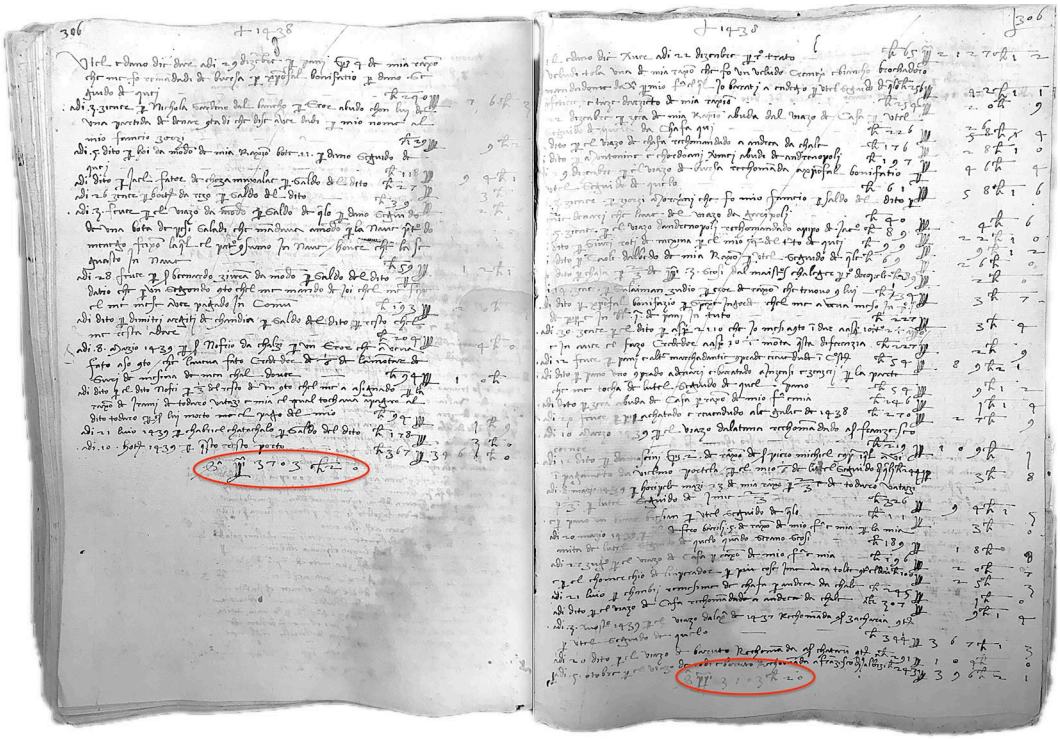
Illustrating the superiority of a digitalized methodology, Dorini and Bertele (1956, 736), who transcribed the ledger and used the contra entries to add some of the missing entries, did not find the final debit entry of *carati* 9 on *karta* 367. And, perhaps because they were historians of coinage not accounting historians, they did not record the balance they had found on the account. That impacted what they were then able to do on the remaining *karta* of the account, which they populated with several missing contra entries from elsewhere in the ledger, but not with their balance from *karta* 367.

Missing Account

The next step was to digitally generate the missing account for profits and losses on *karta* 405. All account balances representing profit or loss not entered in one of the previous three *kartas* of the account were entered, including the

FIGURE 4

Digital Image of *Karta* 306 and Its Digitally Generated Reconstruction



Account	306/1	Acc. name		Utel e dano 2										
№	Name	Date D	PD	Cor. Date C	Cor. C	Cor. PC	SumAD	SumD	Date C	PC	Cor. Date D	Cor. D	Cor. PD	SumAC	SumC	CURR.
177	Utel e dano 1|Utel e dano 2								1438.12.22	1	1438.12.22	065/1	15		2127.12.0	PCQ
463	Veludi tola|Utel e dano 2								1438.12.22	2	1438.12.22	256/1	5		42.11.0	PCQ
460	Chonfetieri|Utel e dano 2								1438.12.22	3	1438.12.22	254/2	4		20.9.0	PCQ
423	Zera in scudele|Utel e dano 2								1438.12.22	4	1438.12.22	226/1	9		26.4.0	PCQ
365	Viazo da Chafa|Utel e dano 2								1438.12.22	5	1438.12.22	176/3	5		28.10.0	PCQ
1969	Montonine|Utel e dano 2								1438.12.22	6	1438.12.22	197/3	5		46.4.0	PCQ
645	Utel e dano 2|x	1438.12.29	1	1438.12.29	240/3	3		76.3.0								PCQ
171	Viazo de Bursa|Utel e dano 2								1438.12.29	7	1438.12.29	061/1	4		58.16.0	PCQ
100	Zorzi Morexini|Utel e dano 2								1438.21.03	8	1438.21.03	040/3	5		4.6.0	PCQ
642	Utel e dano 2|Oi da Choron	1438.21.05	3	1438.21.05	188/1	5		94.13.2								PCQ
635	Utel e dano 2|Jael fator de Choza Muxalach	1438.21.05	4	1437.21.05	027/1	4		3.2.0								PCQ
265	Viazo d'Andreanopoi|Utel e dano 2								1438.21.05	9	1438.21.05	089/3	4		22.10.0	PCQ
279	Suri roti da Mesina|Utel e dano 2								1438.21.05	10	1438.21.05	099/4	4		9.12.0	PCQ
196	Taole d'albedo|Utel e dano 2								1438.21.05	11	1438.21.05	069/2	4		26.0.0	PCQ
567	Cassa 9|Utel e dano 2								1438.21.05	12	1438.21.03	289/1	12		2.0.0	PCQ
320	Salaiman zudio|Utel e dano 2								1438.21.14	13	1438.21.14	134/2	8		3.7.0	PCQ
637	Utel e dano 2|Bortolamio da Rezo	1438.21.26	5	1438.21.26	039/1	4		2.0.0								PCQ
425	Cristofal Bonifatio|Utel e dano 2								1438.21.28	14	1438.21.28	227/2	3		3.4.0	PCQ
426	Cristofal Bonifatio|Utel e dano 2								1438.21.30	15	1438.21.30	227/2	6		2.9.0	PCQ
638	Utel e dano 2|Viazo da Modon	1438.22.03	6	1438.22.03	059/2	2		12.15.0								PCQ
162	Pani e altre|Utel e dano 2								1438.22.12	16	1438.22.12	054/2	5		89.21.0	PCQ
163	Pano un bastardo scarlatin|Utel e dano 2								1438.22.12	17	1438.22.12	054/3	6		9.12.0	PCQ
446	Zera|Utel e dano 2								1438.22.18	18	1438.11.16	246/1	5		1.14.0	PCQ
511	Piper achatado|Utel e dano 2								1438.22.20	19	1438.22.20	270/2	2		27.9.0	PCQ
643	Utel e dano 2|Ser Bernando Civran	1438.22.28	7	1438.22.28	193/1	2		20.3.0								PCQ
644	Utel e dano 2|Dimitri Argiti	1438.22.28	8	1438.22.28	204/2	3		4.0.0								PCQ
639	Utel e dano 2|Nofrio da Chalzi	1439.03.08	9	1439.03.08	094/3	4		10.0.0								PCQ
640	Utel e dano 2|Nofrio da Chalzi	1439.03.08	10	1439.03.08	094/3	5		1.9.0								PCQ
416	Viazo da la Tana|Utel e dano 2								1439.03.10	20	1439.03.10	219/3	4		109.1.0	PCQ
445	Pipo de Jachomo|Utel e dano 2								1439.03.12	21	1439.03.12	244/3	5		3.8.0	PCQ
2040	Oripele a l'inchontro|Utel e dano 2								1439.05.08	22	1439.05.08	326/3	3		94.15.0	PCQ
18	Pano|Utel e dano 2								1439.05.08	23	1439.05.08	011/3	3		3.0.0	PCQ
384	Fil de fero barili|Utel e dano 2								1439.05.20	24	1439.05.20	189/2	6		18.8.0	PCQ
388	Viazo de Chafa|Utel e dano 2								1439.05.27	25	1439.05.27	196/2	5		20.7.0	PCQ
281	Comerchio |Utel e dano 2								1439.05.30	26	1439.05.30	100/2	1		25.3.0	PCQ
447	Chanbii remesime|Utel e dano 2								1439.06.21	27	1439.06.21	246/2	5		1.0.0	PCQ
648	Viazo de Chafa|Utel e dano 2								1439.07.20	28	1439.07.20	307/1	2		9.14.0	PCQ
641	Utel e dano 2|Ser Chabriel Chatachalo	1439.07.21	11	1439.07.21	178/4	2		3.0.0								PCQ
735	Viazo d' Alexandria|Utel e dano 2								1439.08.03	29	1439.08.03	344/1	2		367.13.0	PCQ
583	Viazo da Baruto|Utel e dano 2								1439.08.20	30	1439.08.20	291/1	2		104.0.0	PCQ
441	Viazo de Rodi e de Baruto |Utel e dano 2								1439.10.05	31	1439.10.05	243/1	6		396.21.0	PCQ
646	Utel e dano 2|Utel e dano 3	1439.10.10	12	1439.10.10	367/1	1		3467.0.0								PCQ
5252	Utel e dano 2|Caloianni Sarandino banchier	1439.21.03	2	1439.21.03	029/3	23		9.22.0								PCQ
647	Utel e dano 2 Historical total							3703.20.0							3703.20.0	
	Utel e dano 2 Work total							3703.19.2							3703.20.0	
	Utel e dano 2 Difference							0.0.-2							0.0.0	

Source: Archivo di Stato di Venezia (top graphic). Reprinted with permission from the Ministero Della Cultura, Venice, Italy. (The full-color version is available online.)

FIGURE 5

Digitally Generated Reconstruction of the Account for Profits and Losses on *Karta* 367

Account		367/1		Acc. name			Utel e dano 3									
№	Name	Date D	PD	Cor. Date C	Cor. C	Cor. PC	SumAD	SumD	Date C	PC	Cor. Date D	Cor. D	Cor. PD	SumAC	SumC	CURR.
646	Utel e dano 2|Utel e dano 3								1439.10.10	1	1439.10.10	306/1	12		3467.0.0	PCQ
683	Nicholo Pixano|Utel e dano 3								1439.10.15	2	1439.10.15	319/2	1		4.0.0	PCQ
2111	|Utel e dano 3								1439.10.15	3	1439.10.15	329/1	3		4.18.0	PCQ
807	Utel e dano 3 |Ser Zorzi Chunba e Dimitri so fuol	1439.10.16	1	1439.10.16	127/2	12		0.19.0								PCQ
811	Utel e dano 3 |Ser Andrea da Challe	1439.10.28	2	1439.10.28	350/3	3		14.12.0								PCQ
808	Utel e dano 3 |Ser Troio Contarini	1439.12.08	3	1439.12.08	178/2	1		2.2.0								PCQ
809	Utel e dano 3 |Costo de denari che toio in	1439.12.08	4	1439.12.08	179/4	3		28.15.0								PCQ
431	Pipo de Jachomo|Utel e dano 3								1439.12.08	4	1439.12.08	230/2	4		3.12.0	PCQ
702	Viazo de Saragoxa|Utel e dano 3								1439.21.04	5	1439.12.08	334/2	1		34.18.0	PCQ
810	Utel e dano 3 |Miser Toma Spinola	1439.21.15	5	1439.21.15	310/2	5		24.0.0								PCQ
813	Utel e dano 3 |Ser Jeronimo Badoer mio fradelo	1439.22.03	6	1439.22.03	381/1	2		316.21.0								PCQ
814	Utel e dano 3 |Ser Jeronimo Badoer mio fradelo	1439.22.03	7	1439.22.03	381/1	7		4.22.0								PCQ
2494	Utel e dano 3 |Ser Jeronimo Badoer mio fradelo	1439.22.03	8	1439.22.03	382/1	6		9.14.0								PCQ
331	Veli collo|Utel e dano 3								1439.22.03	6	1439.22.03	142/1	6		71.23.0	PCQ
400	Ser Andrea Zorzi fo de ser Almoro|Utel e dano 3								1439.22.03	7	1439.22.03	202/2	2		0.16.0	PCQ
812	Utel e dano 3 |Ser Aldrovandin di Zusti	1439.22.11	9	1439.22.11	373/1	10		3.3.0								PCQ
2112	Fil de fero|Utel e dano 3								1439.22.15	8	1439.22.15	325/1	5		23.0.0	PCQ
815	Utel e dano 3 |Ser Charlo Chapelo	1439.22.22	10	1439.22.22	398/2	9		0.9.0								PCQ
816	Utel e dano 3 |Utel e Dano-4	1439.22.22	11	1439.22.22	405/1	5		3208.22.0								PCQ
1084	Ser Toma Spinola|Utel e dano 3								1439.22.22	9	1439.22.22	395/2	8		4.4.0	PCQ
817	Utel e dano 3 Historical total							3613.19.0							3613.19.0	
	Utel e dano 3 Work total							3613.19.0							3613.19.0	
	Utel e dano 3 Difference							0.0.0							0.0.0	

balance we had found on *karta* 367. When this was attempted manually by Dorini and Bertele (1956, 813), the first credit entry they recorded was for the balance carried forward from *karta* 367, but the entry had no date and, instead of an amount, ellipses were entered in the monetary columns. This valueless entry was followed by the balances they had found, which they entered in the (date) order they were recorded in the respective contra accounts. Apart from the amount of the balance carried forward from *karta* 367, our digitized journal found one entry which they had not identified, a credit of *carati* 2 carried forward from *karta* 284 on October 15, 1439. The final balance in the account was also generated. It is the eighth debit entry in Figure 6.

From the dates in Figures 5 and 6, it can be seen that Badoer was using both *karta* 367 and *karta* 405 at the same time. The first two numbered debit entries and the first four numbered credit entries on *karta* 405 were dated earlier than the fifth credit entry, the one for the balance brought forward from *karta* 367. During that period of over three months when both *kartas* were being used, which ended on February 22, 1439 (i.e., 1440 in a modern calendar), Badoer began to balance the unclosed accounts from the beginning of the ledger, transferring the identified profits and losses to *karta* 405.

On February 26, he closed all the remaining open accounts. As seen in Figure 6, in doing so several more balances were posted to *karta* 405.[5] These included the credit balance from *karta* 409, the final *karta* of the account for the merchandise expenses. These were indirect expenses not charged directly to individual ventures, as well as various amounts of miscellaneous income, which explains why the account had a credit balance. Before February 26, that account was being maintained on *karta 372*. It was closed on that date and the balance was transferred to *karta* 409. Other merchandise expenses not previously entered into the account were also recorded. Following Venetian double entry accounting practice, the remaining balance of *perperi* 1,036 *carati* 22 was transferred as the seventh credit entry to the account for profits and losses on *karta* 405. Previous scholars had overlooked the final balance on the merchandise account. For example, working from the transcript of Dorini and Bertele (1956), Edward Peragallo identified a profit of *perperi* 3,352 (Peragallo 1981, 593) compared to our *perperi* 4,389 *carati* 14. The difference between his total and ours was the balance of the merchandise expense account on *karta* 409. Our program prevented his mistake being repeated.

The final balance of *perperi* 4,389 *carati* 14 on the account for profits and losses on *karta* 405 was then posted to the balance account (*Saldo de questo libro*), which was on missing *karta* 416, along with all the other balances on asset and liability accounts. That account listed all Badoer's assets and liabilities when the ledger was closed. As with *kartas* 405 and 409, we were alerted to its existence by the contra entries in other ledger accounts.

[5] The dates of these entries is shown in Figure 6 as 1439.22.26—"22" represents February.

FIGURE 6

Digitally Reconstructed Final *Karta* of the Account for Profits and Losses

Account		405/1		Acc. name				Utel e Dano-4									
№	Name	Date D	PD	Cor. Date C	Cor. C	Cor. PC	SumAD	SumD	Date C	PC	Cor. Date D	Cor. D	Cor. PD	SumAC	SumC	CURR.	Notes
1517	Andrea Ligiro botegier|Utel e Dano-4								1439.10.15	1	1439.10.15	284/1	3		0.2.0	PCQ	284/1-3 No page
503	Viazo da Venexia de 1436 e de 1437|Utel e Dano-4								1439.10.20	2	1439.10.20	267/2	3		24.0.0	PCQ	
1213	Utel e Dano-4|Maistro Zorzi zimador	1439.21.31	1	1439.21.31	207/2	2		8.8.0								PCQ	
825	Biache barili rezevude|Utel e Dano-4								1439.22.03	3	1439.22.03	368/2	6		19.8.0	PCQ	
1218	Utel e Dano-4|Ser Jeronimo Badoer mio fradelo 2.9	1439.22.04	2	1439.22.04	389/1	3		37.12.0								PCQ	
698	Ser Marcho Filomati|Utel e Dano-4								1439.22.18	4	1439.22.18	321/3	3		0.12.0	PCQ	
816	Utel e dano 3 |Utel e Dano-4								1439.22.22	5	1439.22.22	367/1	11		3208.22.0	PCQ	Saldo
1212	Utel e Dano-4|Oro filado	1439.22.25	3	1439.22.25	113/2	6		10.12.0								PCQ	
282	Comerchio |Utel e Dano-4								1439.22.25	6	1439.22.25	100/2	3		39.13.0	PCQ	
361	Teste|Utel e Dano-4								1439.22.25	7	1439.22.25	172/2	11		287.18.0	PCQ	
1798	Utel e Dano-4|Viazo de Maioricha	1439.22.26	4	1439.22.26	260/3	6		119.22.0								PCQ	
1216	Utel e Dano-4|Chir Chostantin Critopulo	1439.22.26	5	1439.22.26	291/3	3		183.7.0								PCQ	
1214	Utel e Dano-4|Ser Aldrovandin di Zusti	1439.22.26	6	1439.22.26	258/2	10		18.10.0								PCQ	
2708	Utel e Dano-4|Joxep Salia zudio	1439.22.26	7	1439.22.26	265/2	2		0.12.0								PCQ	
4141	Utel e Dano-4|Saldo de questo libro	1439.22.26	8	1439.22.26	416/1	8		4389.14.0								PCQ	
4422	Spexe de marchadantia 10|Utel e Dano-4								1439.22.26	7	1439.22.26	409/1	14		1036.22.0	PCQ	Saldo close
504	Viazo da Venexia de 1436 e de 1437|Utel e Dano-4								1439.22.26	8	1439.22.26	267/2	4		21.9.0	PCQ	
516	Miser Lunardo Spinola|Utel e Dano-4								1439.22.26	9	1439.22.26	271/1	5		1.14.0	PCQ	
592	Chanbii mandadi a pagar a Veniexia|Utel e Dano-4								1439.22.26	10	1439.22.26	292/3	5		7.0.0	PCQ	
910	Doble|Utel e Dano-4								1439.22.26	11	1439.22.26	375/4	2		5.20.0	PCQ	
1037	Pani largi da Londra bala|Utel e Dano-4								1439.22.26	12	1439.22.26	390/2	4		41.16.0	PCQ	
2393	Pano de seda|Utel e Dano-4								1439.22.26	13	1439.22.26	361/2	5		67.6.0	PCQ	
1200	Manuil Mancropulo|Utel e Dano-4								1439.22.26	14	1439.22.26	401/3	4		6.7.0	PCQ	
1219	Utel e Dano-4 Historical total							4768.1.0							4768.1.0		
	Utel e Dano-4 Work total							4768.1.0							4768.1.0		
	Utel e Dano-4 Difference							0.0.0							0.0.0		

VIII. CONCLUDING DISCUSSION

This paper presented a digitalized research methodology adopted for the reconstruction of the mid-15th-century Venetian double entry ledger of Jachomo Badoer. Through its adoption, we improved knowledge and understanding of the distinctive features of a medieval Venetian business organization and its implementation of double entry accounting in the management of the entity, and of those involved in its management. It is a more complete, and certainly more accurate depiction of Badoer's ledger, and its contents, than has been achieved using traditional research methodologies. As such it makes a significant contribution to the historical accounting literature. The digitized journal we created enabled us to reconstruct all the accounts mentioned in the entries. This was supplemented by the logical-analytical models we prepared showing the links between accounts on multiple *kartas* which provided us with a detailed pictorial view of specific parts of the double entry accounting system. Although not essential when using a program of this type, we felt the c. 75 days spent developing the models time well spent, not least because doing so gave those involved a deep understanding of the double entry accounting system.

Our data base also gave us access to all the data in a spreadsheet which we could, for example, analyze and interrogate, plot on histograms, use to prepare pie charts and graphs, run statistical tests, perform time series analysis; and create actor-network diagrams. These are features to be explored in subsequent studies.

Some might point to the obvious limitation to our findings: If a transaction were entered into two accounts each of which was on a *karta* missing from the ledger and the balances on those accounts were transferred to the account for profits and losses on *karta* 405, we would not know that the transaction had occurred and our total profit calculation would be incorrect. This would also be the case if both the debit and credit entry for a transaction were missing from both *kartas* where they had been entered that had survived. However, that is a problem also faced by those who adopt a traditional research methodology. It should not be seen as justification for ignoring the potential of using technology in the way reported in this paper.

The most significant contribution of this paper is its illustration of the utilization of digital technologies in historical research. In particular, the potential benefits for accounting historians of developing programs that automate the contra entry method embraced by double entry. In the case of Badoer's ledger it was instrumental in facilitating the restoration of lost information. But adoption of technology of this type is not only extremely useful when faced with missing archival account data. Its use vastly enhanced our ability to discover the recording procedures; enabled us to generate all the accounts and check the entries far quicker and far more efficiently than is possible manually. And, as mentioned, it greatly enhanced our ability to analyze what we found using the digital data we generated. All these benefits highlight the potential and importance of adopting modern technologies in historical accounting research.

Doing what we did with this 416-*karta* double entry ledger has prepared the foundations for a stream of high-quality research based on that single historical artifact which could flow over several years. Anyone seeking to emulate what we have done needs experience in using spreadsheets and, perhaps, a few days to learn how to write macros to perform at least some of the time-and-effort-saving tasks our program did, albeit in a less user-friendly way. Or, perhaps a few weeks if they wish to learn how to use VBA and NET Framework as we did. An easier and cheaper solution may be Python (https://invedus.com/blog/python-vs-net-choosing-the-right-language-for-your-project/). We did not use it because we already had the technical skills and the software we used. Rather than a steep learning curve, empowering oneself to adopt a digitalized methodology of this type is more of a gentle up-slope. Once those skills are acquired, they can be applied to any account book from any period, almost certainly repaying the investment before even the first project is completed.

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APPENDIX A

Translation of the Entries in the Sinopoli and Trabizonda Voyage Account on *Karta* 7

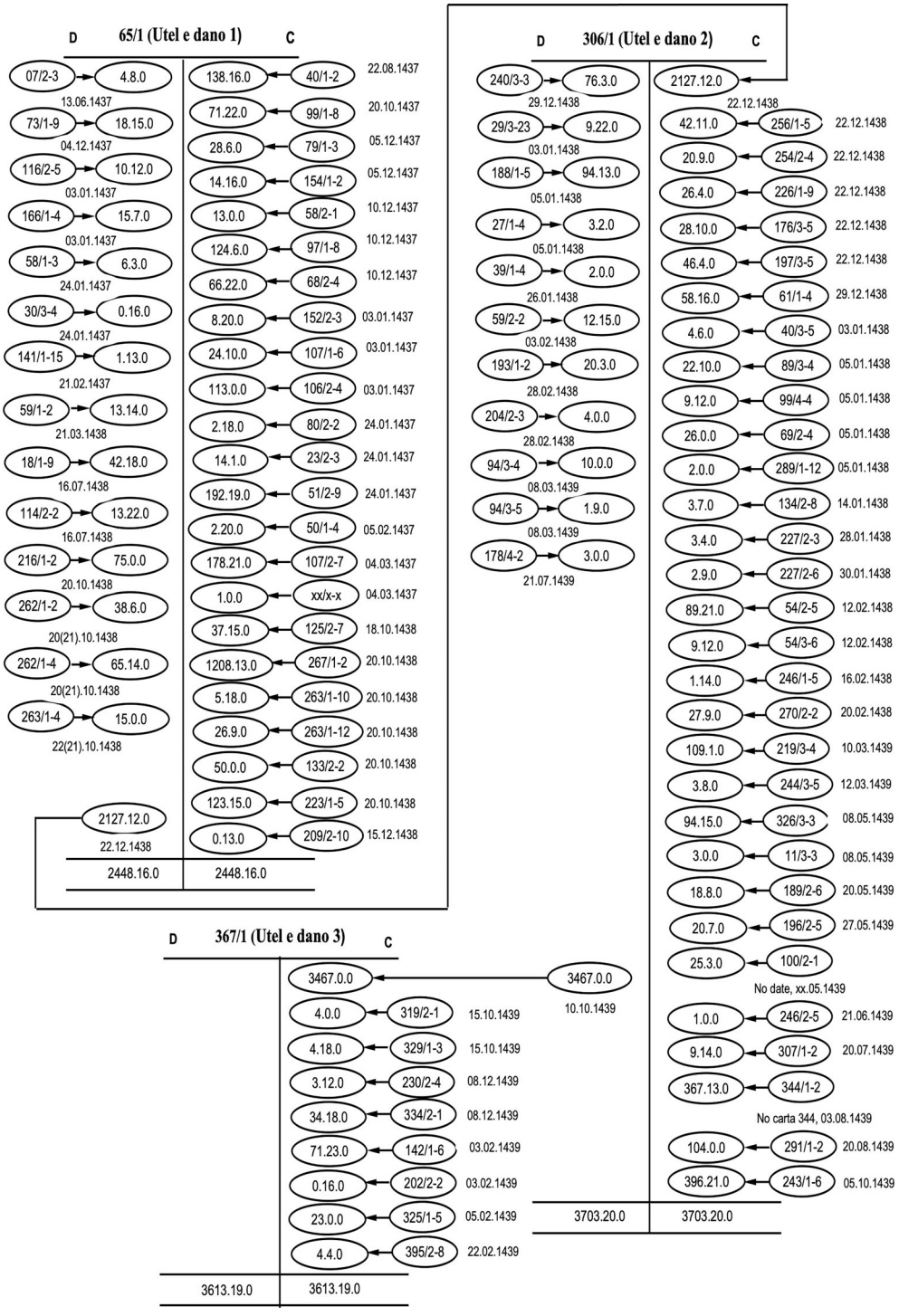
№	Description	Contra Entry	Amount
1	Voyage to Sinopoli and Trabizonda for my account, assigned to Jachomo di Stefano, scribe of Ser Polo Soranzo, debit on the 7th of September for *loesti* (Flemish) fabrics of mine, for the sum of one bale of fabrics of 6 pieces, each piece of 37 fathoms, delivered to said Jachomo here at the wharf, as shown in the handwritten note which he made for me, amount entered on . . . . . *karta* 13		*perp*. 230 *car*. 0
	Total		

№	Description	Contra Entry	Amount
1	Voyage as opposite credit on the 10th of November by Ser Jachomo di Stefano for the trade of said fabrics, which he reports to me were sold in Trabizonda to Chiru Costa at 16 *aspri* per *pitami*, that is 506 *pitami*, with a waste of 6 *pitami*, leaving 500 *pitami*, totals 8000 *aspri*, from which are deducted for expenses and for *comerchio* and *messettaria* to the emperor (local taxes) at 2¼ per cent . . . . . *aspri* 180	per cost	
2	and for the broker, at 0.5 per cent . . . *aspri* 40		
3	and for 1 per cent to our *bailo** . . *aspri* 80		
4	and for unloading the aforementioned cloths on the ground and for transport *aspri* 58		
5	and for his commission at 2 per cent . *aspri* 160	Total *aspri* 518	
6	this leaves net *aspri* 7482, which is worth at *aspri* 33⅓ per *perpero*	*karta* 07	*perp*. 224 *car*. 10
7	the same day, for the aforesaid Jachomo, for the extra weight he put on the cloth, *aspri* 41, worth .	*karta* 07	*perp*. 1 *car*. 6
8	13th June 1437, to profit and loss for losses arising from said voyage to	*karta* 65	*perp*. 4 *car*. 8
	Total *perperi* 230 *carati* 0		

* *bailo* (Latin *bajulus*, med. bailiff) - governor of the community and permanent envoy of Venice to Constantinople.

APPENDIX B

Logical-Analytical Model of the account for Profits and Losses on *Kartas* 65, 361, and 367



This model shows the sources of all the entries (i.e., the contra entry accounts) and the date of each entry. It is prepared manually when our data base is populated from the ledger. If any entries were missing, which was not the case on these three *kartas*, they were added to the model after they were generated by our program.