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NORTHERN IS BETTER? A QUANTITATIVE TRANSACTION COSTS ANALYSIS OF THE NORTHERN INVASION PHENOMENON, GENOA 1590-1616

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ABSTRACT

This paper quantitatively analyses the role of transaction costs in Northern vessels' operating expenses versus their Mediterranean competitors between 1590 and 1616. It is based on an understudied risk-sharing institution, General Average (GA), and on data extrapolated from the *AveTransRisk* database and unpublished archival sources. We apply a Structural Vector Autoregression Model (SVAR) analysis by considering the Northern Invasion phenomenon as a series of structural shocks on Mediterranean seaborne trade. The SVAR model will test how the greater reliability of Northern vessels, constantly highlighted by the literature on the Northern Invasion, impacted on the repartition of damages following a GA, considered as a proxy of transaction costs. Results support the interpretation according to whom the transaction costs played a relevant role in the persistency of the Northern Invasion in the Mediterranean Sea.

Keywords: Northern Invasion, Transaction Costs, General Average, Shipping, SVAR.
JEL Codes: N44, N73, N23.

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Introduction

This paper follows Stefano Fenoaltea's methodology by applying cliometrics to quantitatively analyse the role of transaction costs in early modern European maritime trade.[1] In particular, we investigate the impact of transaction costs during the 'Northern Invasion' phenomenon. Our research has been possible thanks to the General Average (GA) data preserved in the State Archives of Genoa, one of the major European maritime international hubs already since the Medieval period.[2]

The Northern Invasion argument asserts that the Dutch, English and French ships swarmed into the Mediterranean between the 16th and 17th centuries and rapidly seized control of the sea's commercial, financial and maritime life thanks to their superior sailing ships.[3] It was a long-run phenomenon (Grendi 1971: 31). Braudel used a striking metaphor to describe it: "The Dutch swarmed into the Mediterranean like so many heavy insects crashing against the window panes – for their entry was neither gentle nor discreet" (Braudel 1972: 634). No one argues anymore that the Northerners' arrival led inevitably and relatively quickly to their pre-eminence in Mediterranean maritime trade, and it is true that Northerners had little impact on the structures of cabotage shipping, but this process had important repercussions, particularly on the long-distance maritime trade, which they quickly came to dominate (Fusaro 2010: 1-23; Greene 2002: 42-71). Following Colin Heywood (2014: 193-209) indications, we want to revisit Braudel's construction of the Northern Invasion to refine its evidential bases.[4]

The port of Genoa, the capital of a small oligarchic republic, is a suitable observation point for this phenomenon. Here, northern vessels' presence consolidated between 1590 and 1620. In particular, their arrivals show specific peaks in 1591-1594, 1602, 1607-1609, and 1620. Our sources allow for quantitative analysis from 1590 to 1616, thus excluding the 1620 peak. By then, Northern vessels and merchants' presence were quite common. Already in 1616, for example, the Dutch merchant Nicola Van Rhyn, living in Genoa, was appointed as the first consul of his 'nation' (Grendi 1971: 45).

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[1] Fenoaltea, for example, investigated the importance of risk management strategies and transaction costs on Medieval agriculture (1976: 129-151; 1988: 171-240).

[2] GA is a key institution in today's global trade as well. For a critical analysis see Kruit (2017).

[3] This definition of the Northern Invasion, and a critical approach to it, is in Greene (2002: 42).

[4] See a critique of the Braudelian approach and the bibliography cited in Harsgor (1986: 135-157).

When dealing with the concept of Northern Invasion, scholars usually refer to the relevant role played by transaction costs on its emergence and persistency. In this analysis, GA expenses are treated as a proxy of transaction costs. GA is a specific institution related to maritime trade and risk management strategies. Its funding principle relates to the common proportional liability of all participants in the sea venture to contribute to the loss of one or a few of them, incurred to save the vessel otherwise in distress, such as throwing cargo overboard to keep a vessel afloat until rescued. It is a spreading risk technique that redistributes unforeseen expenses that can occur to ship or cargo from the loading to the unloading amongst all stakeholders. For this reason, we could refer to it as a form of mutual protection. Despite local specificities, GA was a well-known institution widely employed all over coastal European states. GA procedures impacted both on Mediterranean and Northern vessels' transaction costs, since they all suffered damages deriving from GA events. Giuseppe Felloni (1999 [1978]: 843-860) was the first scholar to highlight the potential of such sources for researches on maritime trade, transport costs, etc. However, his hypothesis and methodology were not followed by more quantitative studies on European GA procedures until the recent ERC coordinated by Maria Fusaro (University of Exeter), *Average-Transaction Costs and Risk Management during the First Globalization (Sixteenth-Eighteenth Centuries)*.[5] Northern vessels' superiority could be explained through their competitive advantage when facing unexpected transaction costs, such as GA damages, with respect to Mediterranean ships.

Since we assumed that the sudden arrivals of Northern ships in Genoa acted as structural shocks on seaborne trade, we decided to employ a Structural Vector Autoregression Model (SVAR) to describe and interpret them. This approach introduces the possibility of making a more precise characterisation of the responses of the variables when all of them are intrinsically endogenous, as is the case with transaction costs and northern ships design. Specifically, we estimate the relationships between two time series elaborated exploiting GA data and the literature on Northern Invasion.

We will first deal with the use of GA as a proxy of transaction costs, relying partly on the existing literature and partly on the recent studies on this institution. The historical contextualisation of this research will then

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[5] Felloni employed GA sources to investigate other factors related to early modern vessels' operating expenses, while the *AveTransRisk* ERC project (Grant agreement No. 724544) studies GA sources *per se*. For more information on this project, please visit https://humanities.exeter.ac.uk/history/research/centres/maritime/research/avetransrisk/ (accessed: May 31, 2022).

follow, in which the main elements related to the Northern Invasion and Genoese policies will be addressed. Finally, the last part of this paper is a quantitative analysis realised through a SVAR model.

1. GA procedures in Genoa as a proxy of transaction costs

The 'transaction costs' approach is the cornerstone of the Institutional Economics stream. It was first formalised by Coase (1937: 386-405), theorised and tested by Williamson (1981: 584-577). Among others, North (1984: 7-17; 1981) and, more recently, Acemoglu and Robinson (2012) further re-elaborated it.[6] In recent years, transaction costs have also been used by early modern historians when referring to maritime risk management tools and international trade.[7]

Following North's thought, institutions are defined as "the rules of the game" of a society. Consequently, their ability to reduce transaction costs shapes incentives that allow economic, political and social exchanges. Evolution of institutions in couple with technological progress is the driver that allowed to overcome the Malthusian stagnation and to start a sustained economic growth. According to North's definition (1984: 7), transaction costs are the costs of specifying and enforcing the contracts that underlie exchanges and therefore comprise all costs of political and economic organization. They are generally divided into three categories that affect, at various degrees, economic activities: information costs (i.e. surveying the market), bargaining costs (i.e. drawing contracts) and enforcement costs (i.e. the costs of enforcing contracts). Long-distance trade expansion in early modern Europe involved specific transaction costs, which led to the development of innovative institutions. These innovations aimed to reduce costs concerning increase in capital mobility, information costs and risk sharing costs. North mainly highlighted the role of premium insurance as a driver of pre-industrial maritime trade, while we focus on another (older) institution, which is the GA. Both institutions aimed at reducing transaction costs by sharing or transferring risks against unpredictable maritime events.

GA sets out an extracontractual norm on which the involved parties agreed on *a priori*. This institution was widely used by merchants and shipowners (Dreijer 2020: 31-54).[8] It offered them *ex post* risk management and

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[6] On the historical evolution of this concept, see Habimana (2015: 36-42).

[7] On recent works on transaction costs theories applied to Economic History researches, especially when dealing with insurance, see Leonard (2015); Casado Alonso (2015: 1253-1270); Tortella Casares (2014); Go (2009); RHM9 (2008); Addobbati (2007).

[8] See also Dreijer (2021).

covered a wide variety of maritime risks by sharing damages (i.e. the compensation) in an equitable way. GA procedures did not require an upfront payment; this made them useful for parties who had no upfront capital to spare (e.g. the shipowner). They provided the certainty of a closed interest community, influencing the distribution of risk and minimising enforcement costs as damages were shared by a small group of people who had often signed a freight contract. GA was a discrete type of agreement governed by rules, which were generally acknowledged and accepted across Europe.[9] As such, values in GA calculation should reflect ships and cargoes' effective values better than market tools like premium insurance, one of the most frequently cited source in the literature on transaction costs. Some goods, moreover, simply could not be insured or the insurance costs could be too high. Insurance was based on the forecasting of maritime risk, and it was influenced by several factors (ship's quality, personal trust, information flow, etc.). GA institution was based on the sharing or maritime risk after that it really happened. That is why GA procedures' data are used as a proxy.

Genoese lawmakers ruling on GA adopted a combination of Roman law, their customary laws and the *Consolat de Mar* written in Barcelona in the 15th century. The 1589 Civil Statutes contain two chapters specifically on GA administration: one on the jettison procedure (vol. IV, chap. XVI, *De jactu, et forma in eo tenenda*), and one on the institution of a new magistracy to deal exclusively with GA calculation, the *calcolatori* (vol. I, chap. XI, *De calculatoribus et eorum officio*).[10] These Statutes were applied without significant changes at least until the first half of the 17th century, although they were still published and formally enacted until the 18th century.[11] Therefore, GA rules did not change in the analysed period, 1590-1616.

A standard Average procedure consisted of a 'narrative' and social component, the report, and, eventually, of an 'accounting' and economic component, the damage apportionment calculation. The report was a transcription of the events that occurred during navigation leading to the Average act. The shipmaster narrated his voyage before the authorities in the first port in which he stopped after the accident. The most common GA

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[9] States had their own set of rules that could slightly differ from each other. However, local rules were uniformly applied on all vessels entering a specific port. See Fusaro, Addobbati and Piccinno (forthcoming).

[10] The long preparatory phase of the Genoese Civil Statutes began in 1551 and ended in December 1588. They were formally approved and published in June 1589. Biblioteca Universitaria Genova, ms. C. III. 13, *Statutorum civilium Reipublicae Genuensis*, 1589.

[11] On the development of GA procedures in Genoa over the 7th century, see Iodice (forthcoming).

accidents were: jettison (throwing of goods overboard), cutting of the mast or the shallop's abandonment. Shipmasters and officers voluntarily choose to suffer such accidents in order to increase the ship's manoeuvrability and avoid a greater danger, i.e. a shipwreck.[12] Once in Genoa, they carried their sealed Average report to the deputed magistrate.[13] Genoese policymakers aimed at inviting merchants and vessels to trade and guaranteeing them speedy procedures, also by allowing shipmasters declaring a GA event to have the right of way on other vessels already in port. If certain conditions were met, the report was approved and the *calcolatori* magistracy drafted a GA calculation. As such, not all GA reports ended up in a calculation. A calculation was an estimate of the value of the vessel, the cargo and, depending if the GA event happened in the first or second half of the voyage, the freights. The sum of each calculation's values was called the *risico*, the risk, meaning all that was "at risk" during the perilous event. Freights, therefore, are often endogenously included in GA calculations. The *risico* was complemented by the calculation of damages to the vessel and/or to the cargo, and that of all administrative and unforeseen expenses. This procedure was, and still is, quite complicated and required a certain amount of bureaucratic effort. According to Felloni (1999 [1978]: 850-851), around 60% of large vessels (with a tonnage over 1,500 *cantari*, roughly 71.40 tons) arriving in Genoa between 1599 and 1601 started a GA procedure, even if not all reports resulted in a GA calculation.[14] Depending on the year, from 18% to 30% of the reports resulted in a GA calculation. The simple fact that in Genoa a specific magistrate was appointed for GA calculations is evidence of the importance of this institution in supporting maritime trade, which was a key element in Genoese politics. For these reasons, our time series, based on aggregation of GA calculations, should represent around 11-21% of the total number of large vessels arriving in Genoa.[15]

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[12] On the difficulty of assessing the free willingness behind a GA act see Addobbati (forthcoming).

[13] According to the 1590 Genoese Civil Statutes the *calcolatori*, a semi-indipendent magistracy in charge of GA calculations, received shipmasters that wanted to declare a GA report. However, especially starting from 1602, this task was contended and definitely acquired by the superior magistracy of the *Conservatori del Mare*.

[14] Felloni grounds this statement on the number of vessels above 1,500 *cantari* annually entering the port of Genoa and paying the anchorage tax, studied also by Grendi.

[15] We checked this data on 1599, 1600 and 1601, the same period considered by Felloni, by comparing the available GA calculations with the total number of vessels arriving in port. Some small vessels are also included in our sample. It is impossible to estimate how many small vessels arrived in Genoa in our period of analysis but given that only few of them suffered GA events, this does not affect the reliability of the sample.

2. The Northern Invasion and the republic's policies

Until the medieval period, ships of different nationalities sailed between Mediterranean and Northern Europe (Orlandi 2019: 49-70). Starting from the end of the 16th century, Northern vessels increased their presence in Mediterranean waters and almost excluded from their native regions the presence of Southern vessels (Greene 2002: 47). Northern merchants followed (Fusaro 2015b: 21-42; Ressel 2015: 141-157). According to Richard Rapp (1975: 501), it was the "Mediterranean invasion", not the exploitation of the Atlantic that produced the Golden Ages of Dutch and English states.[16] Scholars explained this phenomenon by referring to the well-known structural factors related to hull design such as the greater tonnage or the low freight rates and heavier weaponry of northern vessels. Let us recall, for example, the structural factors that allowed a strategic vantage to Dutch vessels. Dutch shipbuilders apported several productivity-boosting innovations in ship manufacture and also sold their ship to other Northern countries, like England (Rapp 1975: 522), as well as to Mediterranean countries, like Genoa and Venice (Gatti 1973: 174-179; Lane 1933: 219-239). They specialised in cheap construction and efficient design. For example, they used fir instead of the more expansive oak wood, they employed labour-saving devices in shipyards and bought raw materials on large scale, thus allowing lower transport costs. The construction cost of ships in Dutch shipyards was commonly reckoned to be 40% to 50% lower than in English in the middle of the 17th century (Parry 1967: 211). By 1670 the volume of Dutch-owned shipping exceeded that of Spanish, Portuguese, French, English, Scottish and German combined (*ibid.*: 210). However, no revolution occurred in ships' technology: it was a period of steady development rather that of revolutionary innovations (*ibid.*: 213; Unger 2011). The most striking innovations were in hull design, something that allowed to increase the ship's capacity and reduce her operation costs in relation to her dimension. The Dutch were also specialised in unarmed, light and capacious merchant vessels.[17]

All these elements allowed them to ask for low freight charges. According to the research of Rigamonti (2016: 146), for example, the freight for a bale of cloth from Genoa to Palermo in 1619 on a large Dutch vessel was less than half that the one paid to a Mediterranean *fregata* or *felucca*.[18]

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16 See also Puttevils (2020); Fusaro (2015c); van Gelder (2009); van Tielhof (2002).

17 On the strategies they followed when involved in Mediterranean trade, where they often operated with armed vessels, see Antunes, Münch Miranda and Salvado (2018: 501-521); van Gelder (2013: 141-166).

18 On Dutch maritime trade in these years see also de Vries and van der Woude (1997).

At the same time, their freight rates were 30% to 50% lower than their English competitors, which used armed merchantmen. Ragusan ships constitute a significant example: they were among the main carriers for cereals across the Mediterranean but, by 1620, they had almost disappeared, largely replaced by English vessels, which asked for lower freights (Moroni 2011: 221-223). However, information on freights is scarcely reported in the sources, making it hard to pin it down.[19] Quantitative data from GA sources should, on the other hand, be a reliable proxy of transaction costs and an alternative to freights, since they are directly accounted for roughly 50% of GA calculations.[20]

One of the ports most affected by Northern vessels' competition was Genoa, due to its "non protectionist" policies.[21] Small states usually did not have the political and military power to control maritime routes. That is why Genoa, although the Republic was formally an ally of the Spanish Empire, adopted neutrality policies that allowed the development of an international hub already from the beginning of 16th century.[22] Here, vessels of different nationalities could operate as in a "competitive market" (Kirk 2005; Bitossi 1990). A vessels' flag did not influence the taxes it had to pay when arriving in Genoa. A further step in this sense was the creation of the free port (*portofranco*) in 1590.[23] This measure aimed at attracting vessels

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Still, at the same time, we must keep in mind that Mediterranean port retained their often very efficient local ship's types, like the *tartana*. The latter was one of the most used vessel on Mediterranean sea routes between 17th and 18th century.

19 The few authors of time series based on freight sources have highlighted the difficulty in finding such data. Osvaldo Baffico (1979: 123-146), for example, built a time series of the freight rates paid by Genoese merchants for the transport of silk from Southern Italy to Genoa in the 16th century. However, his data are mainly based on freights paid to the republic's galleys and the author pointed out that the sources were few and available only for a limited years. Further limited data on freight rates charged on Genoese galleys in the 16th century can be found in Borghesi (1973: 187-223).

20 Freights contributed and were recorded in GA calculations if the accident occurred in the second half of the voyage, as only in this case they were considered "earned". In case of an accident, there was roughly 50% chances that it happened in the second part of the voyage. A check on sample confirmed this rough estimate.

21 Genoese merchant marine declined in particular between 1606 and 1610. It was only from 1611 that it recovered, following an "invasion" of smaller vessels from all coastal centres (Grendi 1971: 36).

22 Zanini (2020).

23 The free port's principle is based on the assumption that lowering or cancelling custom duties and granting a safe-conduct to foreign merchants and shipmasters stimulated trade. It was not aimed at merchants or shipmasters of a given nationality. Therefore, it could be said that the free port's institution in Genoa favoured shipping competition. In such competition, Northern vessels proved to be more reliable than their Mediterranean counterparts to the point that, albeit gradually, the former replaced the latter even on numerous Mediterranean "traditional" routes.

loaded with cereals from all over Europe.[24] Moreover, in 1609 the Senate ordered the creation of a general free port, which gradually evolved into a long-term state economic policy.[25] Therefore, although the Republic's role might appear as secondary compared to the main European nation-states, we must keep in mind the importance of the traffic calling at the port of Genoa and the adoption of neutrality policies. Some historians refer to the years between the 16th and the 17th century as the "Age of the Genoese" (Braudel 1984[1979]: 157). Such factors allowed this small Republic, traditionally perceived as a "weak" state, to survive and maintain its independence in the political and military struggles that ravaged across Europe in the early modern period (Fusaro 2015c: 92).

3. Empirical analysis

Data

As also suggested by the literature, we assume that the transaction costs played a key role in the Northern Invasion between the 1590s and the 1600s, which affected the entire Mediterranean area regardless of local states' policies. This is the reason why we elaborated two time series to estimate, through a SVAR model, the relationship between transaction costs and the Northern Invasion phenomenon.

Our first time series (AGAR) is based on the exploitation of the archival sources from the *AveTransRisk* online database.[26] From these sources, we extracted information on 289 voyages with GA calculations drafted in the selected time period, 1590-1616, which are representative of the number of vessels calling at the port of Genoa. GA calculations reported the value of the ship, the contributing rate paid by each involved party and the shipmaster's nationality. Their information does not uniformly cover all the period

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[24] Vessel loaded for at least two thirds of cereals would have benefited from a general safe-conduct of the duration of one year, while ships with unsold cereals could leave without paying fees. Archivio Storico del Comune di Genova, *Magistrato dell'Abbondanza*, Actorum 723, 11/08/1590. The spreading of the news about the free port's decree probably allowed the arrival of ships from Danzig and Lübeck loaded with cereals (Andersen and Pourchasse 2011: 21-44).

[25] Archivio di Stato di Genova, *Archivio Segreto*, 1030, Propositionum, 12/02/1613.

[26] The State Archives of Genoa preserves the oldest and one of the largest notarial collections in the world. Author A uploaded all the following unpublished archival sources into this database: ASG, Notai Giudiziari (NG), 629 (1590-1593), 630 (1592), 634 (1598), 635 (1599), 636 (1600), 637 (1601). In addition, we consulted the following archival series: ASG, NG, 631 (1593-1599), 632 (1595-1596), 633 (1597), 638 (1603-1604), 639 (1605), 640 (1607-1608), 1643 (1606-1615), 1644 (1611), 1645 (1612-1613), 1646 (1614-1616).

considered, as is usually the case with time series from pre-industrial sources; specifically, they are abundant from 1596 to 1602, while they are limited for period 1603-1605. Despite these irregularities, we aggregated the data using several central tendency indexes to build a complete time series with yearly frequency of the average GA contributing rate. It will be used as a proxy for transaction costs related to maritime trade.

The second time series (NSR) is based on data on Northern ships arrivals in Genoa built and published by Edoardo Grendi (1971: 23-71). Grendi based his time series on the data extracted from mooring taxes and sanitary registers in Genoa between 1590 and 1666, and he repeatedly pointed to the need for specific researches on Genoese maritime trade by crossing his data through in-depth studies of archival sources and individual sea voyages. We used Grendi's time series to calculate the percentage of Northern ships over the total arriving in Genoa between 1590 and 1616. We interpolated three missing years (1590, 1595, 1598) according to the information we have from the literature on this topic. It will be used as a proxy of the Northern Invasion phenomenon. Data used to build both time series are available in Table A1 in the Appendix.

The SVAR will analyse relationships between these two time series. In particular, we hypothesized that a shock in arrivals of Northern ships could affect the average GA contributing rate and vice versa. We assumed that shocks and responses of these endogenous variables explain the relationship between transaction costs and the Northern Invasion. Table 1 describes the endogenous variables contained in the SVAR. Figure 1 shows NSR trend, while Figure 2 shows AGAR trend for the whole period of analysis, 1590-1616.

Tab. 1. *Description of the variables included in the SVAR model*

Variables	*Description*	*Unit of measure*	*Period of observation*	*Frequency*	*Sources*
Average GA rate (AGAR)	Average percentage of total damages on total risk	Percentage (%)	1590-1616	Annual	*AveTransRisk*/ Archival sources
Northern Ships Ratio (NSR)	Percentage of Northern ships on total of ships arriving in Genoa	Percentage (%)	1590-1616	Annual	Grendi, 1971

Fig. 1. *Average yearly Northern Ships Ratio (%) trend for the period 1590-1616. The black line represents the average Northern Ships Ratio across time.*

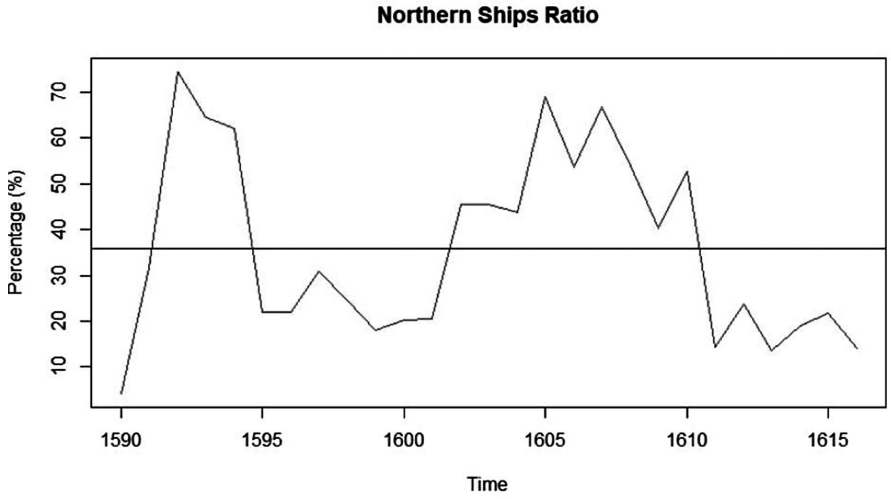
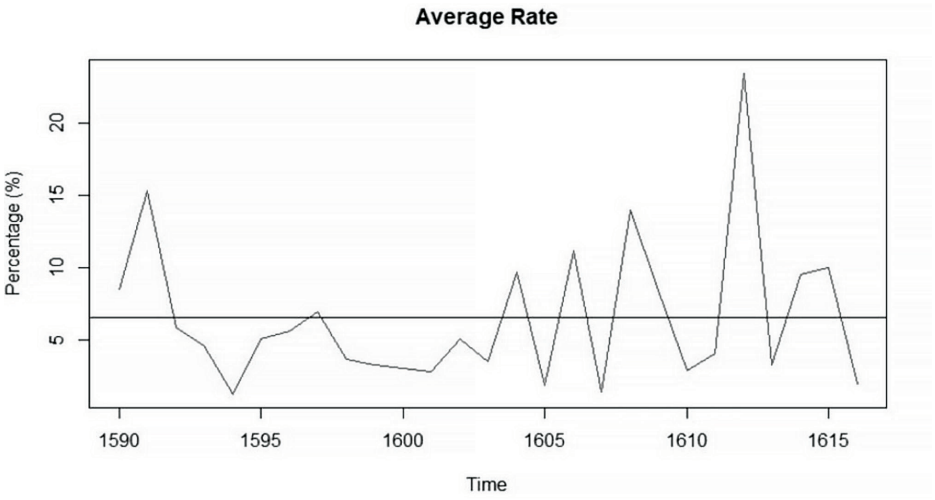


Fig. 2. *Average yearly GA rate (%) trend for the period 1590-1616. The black line represents average value across time.*



Structural Vector Autoregression model (SVAR)

We adopted a SVAR model to test the supposed relationship between AGAR and NSR time series. SVARs are the most popular macro econometrics tool to study the dynamic effects of economic shocks (Sims 1980: 1-48). When adopting SVARs, it is assumed that the studied economy is driven by exogenous orthogonal structural shocks (Slutsky 1937[1927]: 105-146; Frisch 1933: 171-205). These shocks are dynamically propagated through the Impulse Response Functions (IRFs), the outcome of agents' decisions. Thus, the economy's structure is influenced by the result of these exogenous shocks plus the response of economic agents. In economics literature, such models are particularly useful to detect the effects of monetary policy shocks, fiscal policy shocks or demographic shocks.[27]

Northern Invasions phenomenon shows several features that make it appropriate to SVAR modelling. They represent exogenous orthogonal structural shocks on Mediterranean maritime trade between late 16th and early 17th centuries. In addition, the application of a SVAR approach is particularly suitable given the endogenous nature of the variables involved in our analysis: the transaction costs are influenced by the ship's hull, and, in turn, the ship's hull depend on ships' nationality, as stated in much of the literature on Northern Invasion.

More formally, to elaborate our SVAR model we started from the following stylised representation of the economy as[28]

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \tag{1}$$

where y_t represents a $(K \times 1)$ vector of observable and stationary time series variables, the A_j $(j = 1, \cdots, p)$ is a $(K \times K)$ matrix of coefficients, and u_t is a K-dimensional white noise with $u_t \sim (0, \sum_u)$.

If y_t is stationary then it admits a Wold MA representation:[29]

$$y_t = u_t + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots, \tag{2}$$

where

$$\phi_s = \sum_{j=1}^{s} \phi_{s-j} A_j, \quad s = 1, 2, \cdots, \tag{3}$$

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[27] See, for instance, Oddo and Zanini (2022: 1-27); Arias, Caldara and Rubio-Ramírez (2019: 1-13); Nicolini (2007: 99-121); Uhlig (2005: 381-419); Christiano, Eichenbaum and Evans (1999: 65-148).

[28] Lütkepohl (2009: 357-362).

[29] Wold's theorem states that every covariance-stationary time series can be written as Vector Moving Average, i.e., the sum of two time series, one deterministic and one stochastic. The Vector Moving Average is fundamental if and only if the det $(I_k - A_1 z) \neq 0$ for all $|z| < 1$.

with $\phi_0 = I_k$

where the elements ϕ_j of the matrices are the forecast error impulse responses.

However, isolate shocks in the components of u_t may be problematic given that they could be instantaneously correlated: $\sum_u$ may not be a diagonal matrix.

We chose a common approach to overcome these problems by adopting a model with instantaneously uncorrelated residuals, modelling the instantaneous relations between the observable variables directly. We considered a structural form model:

$$A_{yt} = A^* y_{t-1} + \cdots + A_p^* y_{t-p} + \varepsilon_t \tag{4}$$

where

$$A_j^* := \mathrm{A} A_j \ (j = 1, \cdots, p) \tag{5}$$

and

$$\varepsilon_t := A u_t \sim (0, \ \textstyle\sum_\varepsilon = \mathrm{A} \sum_u \mathrm{A}'). \tag{6}$$

Therefore, to obtain a proper value for, it is necessary to adopt a diagonal covariance matrix for ε_t,

$$\textstyle\sum_\varepsilon = \mathrm{A} \sum_u \mathrm{A} \tag{7}$$

where $\sum_\varepsilon$ is a diagonal matrix.

To obtain a unique matrix of instantaneous effects we need to set up $K(K+1)/2$ additional equations as restrictions for the elements of A. To normalise matrix, we chose the diagonal elements to be unity. In addition, we need more $K(K-1)/2$ restrictions. Such restrictions derive from non-sample sources: economic theories applied to Northern Invasion phenomenon through a transaction cost approach. That is why we adopted a recursive identification strategy. The resulting impulse responses are fundamentally the same as the orthogonalized impulse responses, based on a Cholesky decomposition. This model is commonly called A-model.

SVAR estimate

If AGAR and NSR show a stationary sequence, the analysis of our bivariate SVAR modelling can be adopted. The stationarity of the data has been tested through standard unit root tests: the augmented Dickey-Fuller, and the Phillips-Perron. The results are presented in Table 2.

Tab. 2. *Phillips-Perron and ADF tests*

	Northern Ships Ratio	Average GA rate
Philipps-Perron*		
PP	–2.9198	–5.9063
Augmented Dickey Fuller**		
ADF	–1.0152	–1.8078

* Z statistics critical values:
1% level: –3.71
5% level: –2.98
10% level: –2.63

** Test critical values:
1% level: –2.62
5% level: –1.95
10% level: –1.61

Phillips-Perron test rejects the null of a unit in the two time series respectively at the 10% and 1% significance level. However, NSR does not pass Augmented Dickey Fuller test, while it rejects the null of a unit root for AGAR at the 10%. In any case, NSR passed PP test. Also, graphical analysis shows that it persistently fluctuates around the mean (Figure 1). This allows us to hypothesise that the NSR can be covariance stationary. Therefore, endogenous variables are affected by shocks with only temporary effects.

The estimation of the SVAR implies a choice about the lag length. In order to choose the optimal lag length, we adopted the data-oriented strategy. This strategy allows, through the application of several information criteria, to select the best trade-off between parsimony and realism of the model. According to AIC, Hannan-Quinn and Schwarz criterion minimization, we chose the VAR model with lag order 1.

Once the estimated Wold coefficients are available, the structural IRFs i.e., the response of economic variable to economic shocks are obtained, as explained in the previous section, as a lower-triangular matrix following Cholesky decomposition identification strategy.

The idea is to have a model with short-run restrictions to estimate those interactions (Nicolini 2007: 116). The first shock is the only shock affecting the first variable contemporaneously, the first and the second shock are the only two affecting the second variable and so on.

Having adopted a recursive identification strategy, choosing the order of the endogenous variables is extremely important. In our model, we chose to order NSR after the variable AGAR, since we think that the arrivals of Northern ships in Genoa does not immediately affect the average GA rate. This happened because, especially in a pre-industrial market characterised by structural rigidity, prices adjusted on shocks over the long-run (Sánchez and Kaps 2016; Bateman 2013). Conversely, NSR immediately responds to changes in AGAR. The intuition behind this assumption is that

average GA rate could prompt Northern shipmasters to move to the Mediterranean Sea to gain market shares. Despite the information asymmetries due to long distances between Northern and Southern Europe, we must also bear in mind the significative presence of a Genoese diaspora in the main Northern and in particular Flemish marketplaces between 16th and 17th century (Lo Basso 2015: 137-155; Dauverd 2014; Arrighi 2005; Massa 2003: 18-21; Doria 1995: 91-156).

Once the SVAR is estimated, it is necessary to conduct some tests to verify its stability. First of all, eigenvalues are lower than 1; therefore, the SVAR system is stable.

Finally, to test the validity of our SVAR A-model, we conduct other tests to verify the following:

– the absence of autocorrelation (Asymptotic Portmanteau test);
– the approximation to a normal distribution (Jarque-Bera test);
– the homoscedasticity of the model (ARCH-LM test).

Table 3 illustrates the main results of these tests.

Tab. 3. *Asymptotic Portmanteau test, Jarque-Bera test and ARCH-LM test*

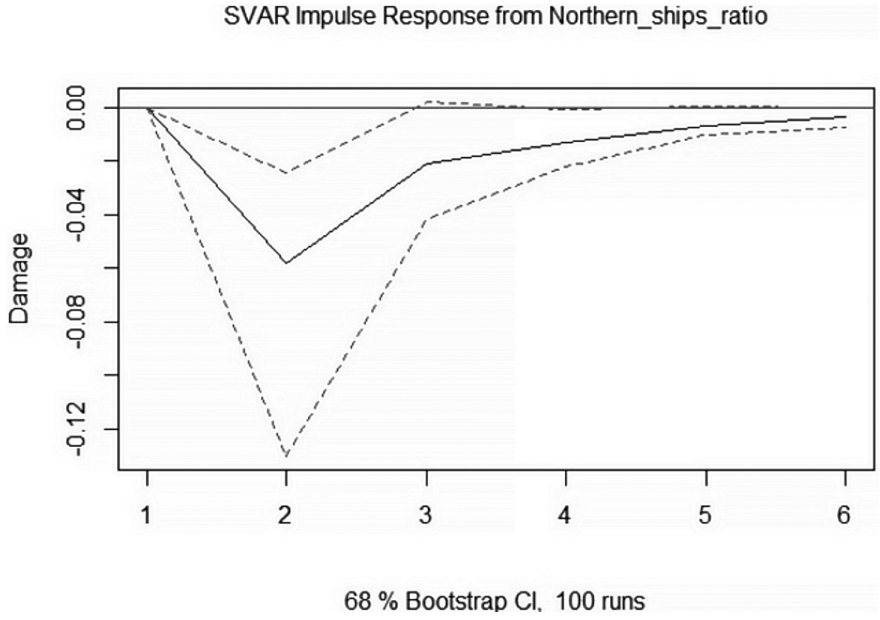
Test	*Null-hypothesis*	p-*value*
Asymptotic Portmanteau test	H0: no-autocorrelation	0.931
Jarque-Bera test	H0: normal distribution	0.3069
ARCH-LM test	H0: no-heteroskedasticity	0.4385

All tests do not reject the null hypothesis; therefore, we can state that there is no evidence to reject the hypothesis that our SVAR model is not autocorrelated, that it is not normally distributed and that it is not heteroskedastic.

Finally, IRFs are estimated and plotted. Figure 3 shows as a positive standard error shock in NSR leads to strong decrease in AGAR. This dynamic suggests that a sudden and consistent rise in northern ships' arrival in Genoa pushed AGAR down. Thus, it seems to confirm our thesis: Northern Invasion affected transaction costs by compressing them.

Figure 4 highlights as a positive standard error shock in AGAR trigger an increase of Northern ships. This suggests that changes in average GA rate affected Northern shipmasters' behaviour. The rise in transaction costs attracted them to the Mediterranean Sea to gain market shares. Both IRFs show low statistical significance at 90%; this is probable due to the small size of our sample. Therefore, results should be taken with caution.

Fig. 3. *Response of the average GA rate to standard error shock of the Northern Ships Ratio (68% and 90% CI).*



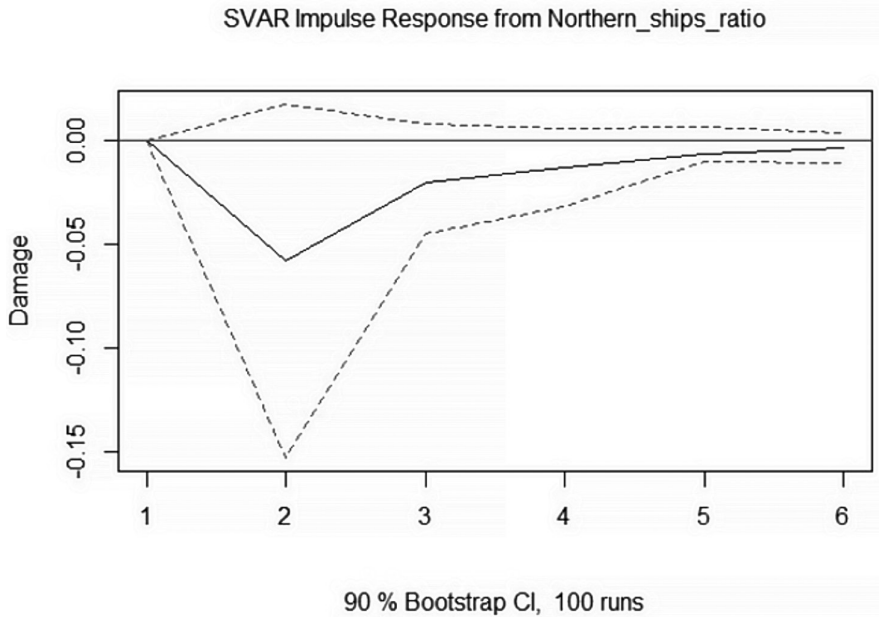
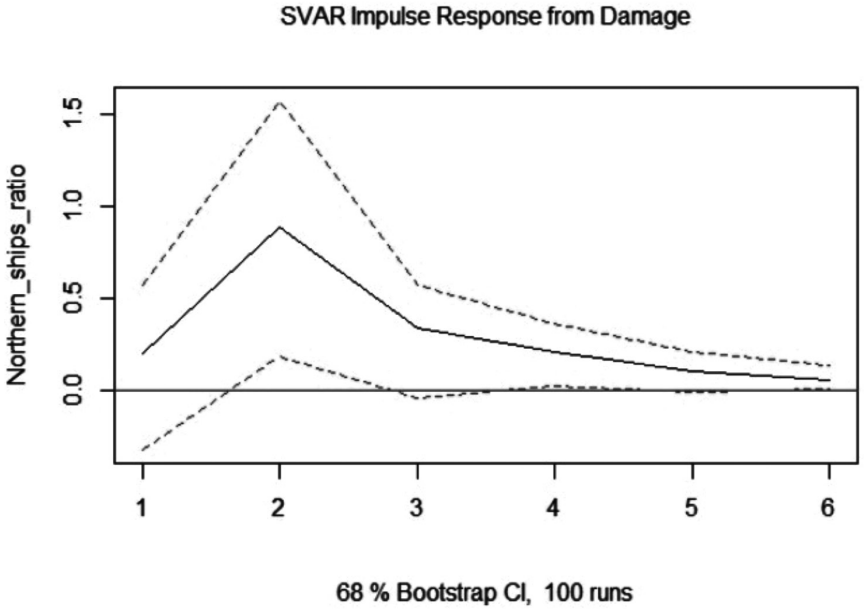
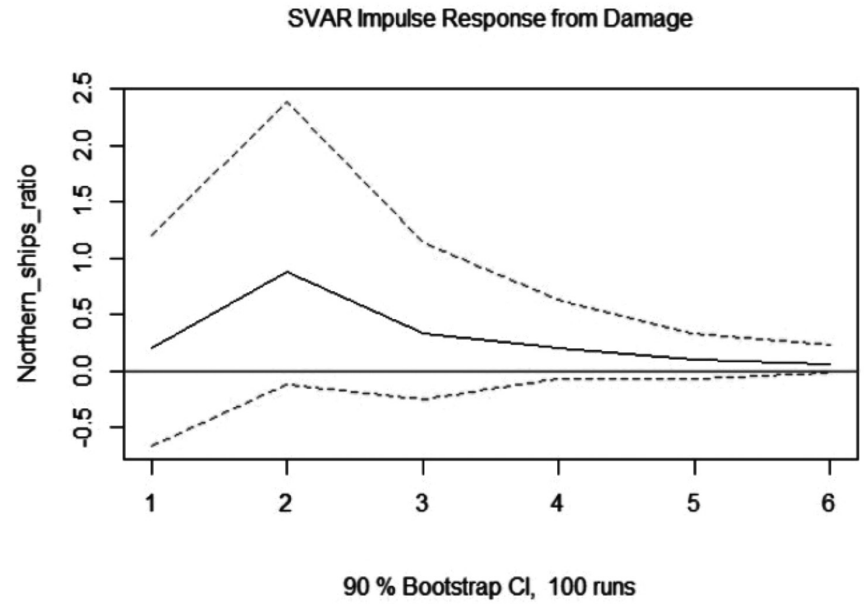


Fig. 4. *Response of the Northern Ships Ratio to standard error shock of the average GA rate (68% and 90% CI).*





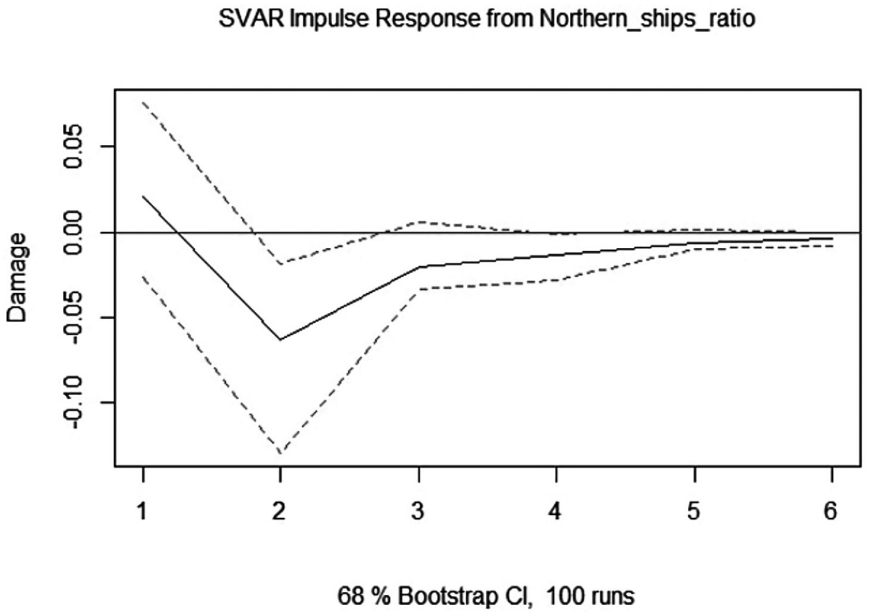
It is also possible to study the variance of the series explained by the shock at different horizons, i.e., short vs. long run, considering the forecast error in terms of structural shocks. Table 4 shows that the percentage of NSR variance explained by AGAR is quite large in the first five years after the shock, while the percentage of AGAR variance explained by NSR is very modest. These results suggests that Northern Invasions were strongly incentivised by transaction costs.

Tab. 4. *Variance decomposition from 1 to 5 years after the standard error shock*

Percentage of variance of Northern Ships Ratio due to:	*Northern Ships Ratio*	*Average GA rate*
after 1 year	96	4
after 2 years	62	38
after 3 years	61	39
after 4 years	60	40
after 5 years	60	40
Percentage of variance of average GA rate due to:	Northern Ships Ratio	Average GA rate
after 1 year	1	99
after 2 years	1	99
after 3 years	1	99
after 4 years	1	99
after 5 years	1	99

We conducted a robustness check with an alternative identification strategy. The simulation results reported in Figures 5 and 6 are quite robust when the order of AGAR and NSR are inverted. These new impulse responses are qualitatively similar to those detected in the original model. Thus, the robustness check confirms that the economic mechanisms at work are unaffected by the ordering of the variables, corroborating our hypothesis.

Fig. 5. *Response of the average GA rate to standard error shock of the Northern Ships Ratio (68% and 90% CI).*



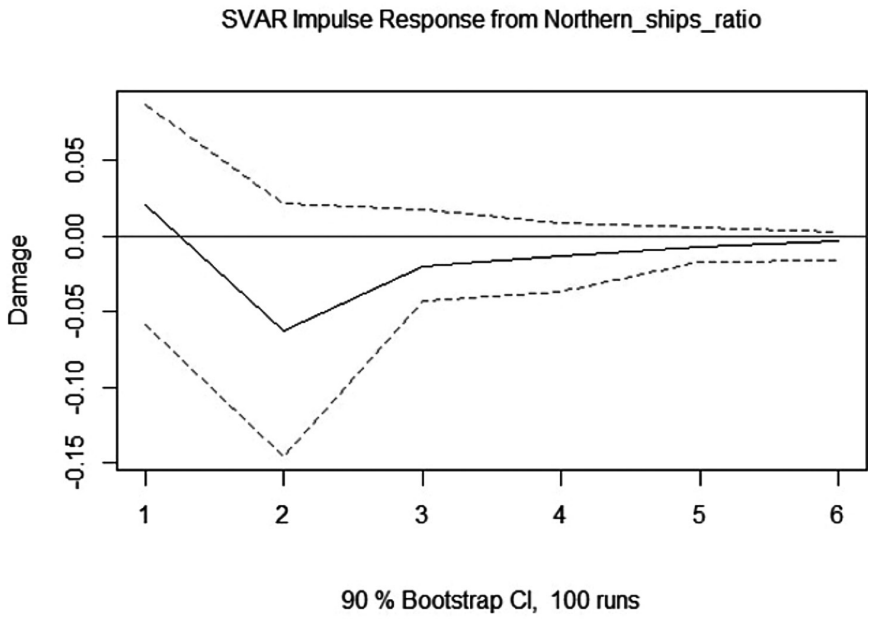
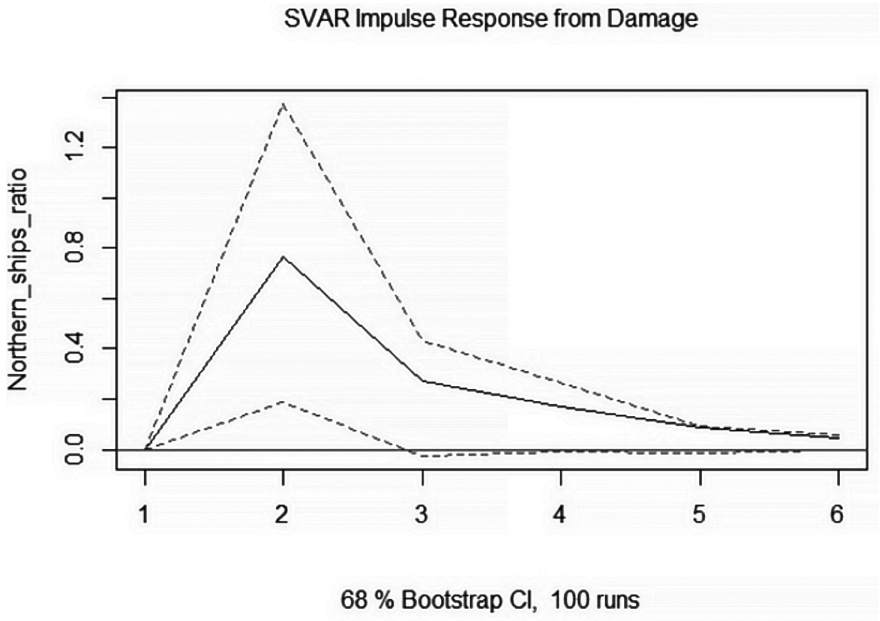
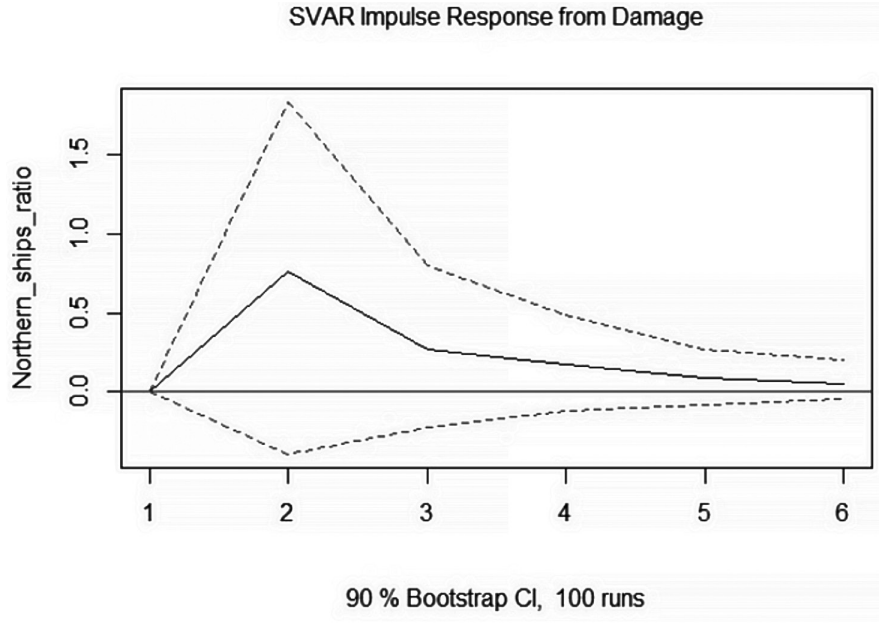


Fig. 6. *Response of the Northern Ships Ratio to standard error shock of the average GA rate (68% and 90% CI).*





Conclusion

The endogenous nature of the relevant variables usually adopted to interpret the Northern Invasion phenomenon makes the estimation of their interactions particularly difficult. That is why the adoption of SVAR methodology with short-run restrictions proved beneficial. The quantitative analysis elaborated using GA sources as a proxy of maritime shipping transaction costs complies with the existing literature on the causes of the Northern Invasion phenomenon. Fluctuations in average GA rate proved to be closely linked to the structural characteristics of maritime trade and the arrival of Northern vessels in Genoa during the examined period (1590-1616). As also underlined in the literature, Northern vessels had better vessels than their Mediterranean competitors, designed for long-distance trade. Such factors allowed them to pay lower transaction costs in case of unexpected and fortuitous events. Merchants preferred these vessels when carrying goods from Northern Europe and, during the following years, on specific Mediterranean markets as well.[30]

Our SVAR analysis suggests that Northern shipmasters arrived in the Mediterranean and exploited their comparative advantage in handling transaction costs to gain market shares. Their arrival also reduced the average GA rate paid by all vessels in Genoa during the examined period. This forced Mediterranean shipping to follow. These two dynamics, although corroborated by a small sample, strengthen the importance of transaction costs when referring to the Northern Invasion. In addition, Northern merchants and shipowners' ability to detect transaction costs' differences and fluctuations, of which GA is a proxy, shed further light on the significant level of market integration between Northern and Southern Europe in the early modern period. New researches on other factors such as freight rates, the extension of the dataset's chronological scope, or the addition of other datasets based on GA sources from different marketplaces will enrich our results.

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[30] After a crisis in the 1620s, probably due also to the Thirty Years' War that ravaged across Europe, their role kept growing in the 1630s, when Northern vessels could be found on most of Mediterranean routes (Grendi 1971: 55).

Appendix

Tab. A1. *Original data used to build the time series*

Years	*Total vessels*	*Northern vessels*	*Total GA calculations*
1590	122	?	13
1591	92	29	3
1592	263	196	20
1593	163	105	7
1594	113	70	7
1595	?	?	7
1596	64	14	16
1597	85	26	20
1598	?	?	21
1599	72	13	8
1600	94	19	21
1601	102	21	23
1602	167	76	13
1603	130	59	7
1604	105	46	2
1605	90	62	3
1606	125	67	10
1607	178	119	7
1608	237	128	10
1609	119	48	4
1610	137	72	18
1611	211	30	16
1612	322	76	7
1613	323	44	6
1614	381	72	10
1615	318	69	3
1616	249	35	7

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