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Abstract

We study the role of historic transportation in Urban Economics. We summarize attempts to measure transport speeds before the Industrial Revolution and collect corresponding transport cost parameters from the literature. We summarize results from Urban Economics and History on how historic transport costs have influenced the shape and location of cities until today. We discuss possibilities how future research might use historic transportation measures.

1 Introduction

Cities grow and shrink slowly, even in environments marked by severe shocks. Lists of the largest cities in a country or region correlate strongly over time (Polese and Denis-Jacobs 2010, Eaton and Eckstein 1997). Of the 20th largest cities in Italy all but two were already cities during the Roman Empire.¹ This persistence is sustained even in environments with severe political, technological, epidemiological and cultural shocks. Cities also often reinvent themselves (Glaeser 2005), and tasks taking place in cities change markedly over time (Michaels et al 2019). Given the slow change in the size of cities, researchers interested in the effects of various shocks on cities tend to use data that spans long periods of time.² For this reason, papers in Urban Economics often use and study datasets from history. History also provides countless examples of shocks to individual cities or urban systems that allow researchers to study urban resilience as well as adaptation mechanisms.

Given the path dependence in city formation historical transportation costs still shape the spatial equilibrium of modern economies. In this paper, we review the rich literature on the role of transport for historical city formation and structure along two dimensions. First, we focus on the role of transportation for inter-city trade and how it drives urban development. We structure this part along the different datasets and methodologies that have been used to learn about travel times or costs and thereby revisit various datasets on historic transportation and discuss how they have been used in Urban Economics. A key contribution of this paper is to contrast ways in which historic transport costs can be measured, and to collect various estimates of these costs. Second, we discuss the role of transport for the internal structure of cities across history. Given the higher data requirements and the limited changes in commuting technology prior to the railway, this part of the literature is much less developed. We then discuss open research questions in these areas, and how they may be addressed.

¹ We verified this ourselves using a list of the largest Italian cities from here:

<https://www.tuttitalia.it/citta/popolazione/>. The two exceptions are Prato and Venice.

² This relationships between Urban Economics and History was the subject of a recent special issue in RSUE, summarized by Gobillon and Heblich (2022).

Given space constraints, we only consider the relationship between urban location, urban form and transportation before the Industrial Revolution. In doing so, we only consider the quiet period before the storm. Technological changes in 19th century Britain and other parts of Europe were so dramatic that they have been called the 'transport revolution' (Bagwell 1988, Bogard 2018), a period of dramatic increases in travel speeds and decline in freight rates. Real railway freight charges per ton mile in 1870 were equal to only five percent of the freight charge for horse-drawn wagons in 1700. Journey travel times by railway were ten percent the travel time of coaches in 1700. This coincided with a first wave of globalization, and the emergence of an Atlantic economy (O'Rourke and Williamson 2001). These new transport technologies have significantly shaped the structure and size of modern metropolises (Heblich et al 2020, Pascali 2017). Transport costs continued to decline by over 90 percent over the 20th century (Glaeser and Kohlhase 2004). Yet, knowing about the dramatic changes brought about by steam engines and following developments, we focus here on the calmer period before. A period that used less powerful technology but has likely exhibited a more important relationship between trade and cities.³ Many developments in the pre-industrial era shape cities today, traces of the past are visible on the maps and in the streets of old cities around the world. Many events from ancient history can serve as instruments for variation we experience today and thus can help us understand problems of Urban Economics today.

The remainder of the paper is structured as follows. In Section 2 we first describe the role of historic transport for economic geography, highlighting different methodologies and datasets that can be used to measure transport times before the Industrial Revolution. We provide a collection of such estimates of speed for various means of transport across the pre-industrial time period. In Section 3, we then focus on the internal structure of cities and discuss how transport technology and other factors have shaped the pre-industrial city. We then discuss open questions that could prove useful for further research (Section 4) and offer a brief conclusion (Section 5).

2 Historic transport and economic geography

2.1 Measuring interurban transport and its challenges

Estimates of transport times before the Industrial Revolution can be inferred in different ways, which all are ultimately rough because of various limitations. Estimates differ widely, and there is also disagreement on whether transport became faster at all between Antiquity and modern times. Braudel (1979) quotes Paul Valery as saying, 'Napoleon moved no faster than Julius Caesar', arguing that means of transport hardly changed in the centuries before the Industrial Revolution. "In the past [...] other calculations would give the same conclusions, namely that with horses, coaches, ships and runners, it was the general rule to cover at most 100 kilometres, in 24 hours", in context probably referring to speeds between 1500 and 1750. There are, however, notable exceptions of innovation to transport technology that Braudel also notes. These include vehicles with a moveable front-axle, employed after 1470. Primitive coaches did not appear until the end of the sixteenth century. Diligences were a product of the seventeenth century. Stagecoaches for travelers only appeared in any number in the Romantic period. The first canal locks date from the fourteenth century. Lopez (1956) mentions that horseshoes, rigid horse collars and explosives to build tunnels improved land-based transportation during the Middle Ages. As these references show, whether any of these technologies, advanced transport costs significantly is a matter that can be debated.

A reason for the uncertainty is that historic transportation costs can't easily be directly measured, and have to be estimated, typically using ancient documents. In this section we provide an overview of different ways researchers

³ Glaeser (2022) argues that the power of transport to determine urban fortunes has declined more recently, both for transport across cities and within cities. Instead, institutions have become increasingly important in determining urban trajectories (see also Jedwab et al 2022 and Johnson and Koyama 2017).

have measured travel times and inferred transport costs based on different datasets.⁴ Table 1 provides an overview of different travel times.

2.1.1 Archaeological records

A simple method of accessing proxy data to infer travel times and other economic information in the distant past, is to consult archaeological records or reconstructed maps from the past. Archaeological data are readily available and increasingly used in economics. A key reference is the 'Barrington Atlas', a publication unifying information on public buildings, roads, bridges, temples, mines, cities, provinces and other infrastructure in antiquity in the form of detailed maps (Talbert et al 2000). There are also separate datasets on deposits of precious metals in antiquity (Hobbs 2006) and the location and characteristics of ancient ports (de Graaw 2022). Such information, and more, is summarized in the Mapping Past Societies (MAPS 2025) project, formerly known as the Digital Atlas of Roman and Medieval Civilizations (DARMC). The Pleiades (2025) database is also a valuable resource, providing extensive coverage of archaeological records of the Greek and Roman world while the earlier Whitehouse Atlas (Whitehouse and Whitehouse 1975) is more focused on the pre-classical era.

Some ancient data even come in bilateral form. Barjamovic et al (2019) study Bronze Age clay tablets from 4000 years ago, detailing economic interactions between Assyrian merchants and Anatolian cities, providing an ancient data source that is bilateral in nature. These tablets represent the oldest consistent archive of trade data. Using an inverted gravity model, the authors make predictions on the location of lost cities. These predictions will be tested by archaeologists in the decades to come. Flueckiger et al (2022) use spatially disaggregated data on excavated Roman ceramics that contain information on their location of production. This data comes from the Samian Research database maintained by a Museum in Mainz. Based on this bilateral data set they show that the Roman trade pattern is predictive of the degree of price correlation in the pre-industrial era and firm ownership structures today. In a similar vein, Boehm and Chaney (2025) use archeological findings of coins, whose source can be identified, to estimate a dynamic model of trade and trace out the sources of the shift of economic activity away from the Mediterranean towards northern Europe and the Middle East from Late Antiquity through the Middle Ages. Vedel (2024) uses a market access approach to study the storm-induced opening and closing of a fjord in Denmark. The historic episode is the closing of this passage in the 11th century. Market access measures in combination with archaeological records reveal that the reduction of trade decreased the quantity of archaeological findings and coins in affected regions.

There are several additional archaeological records that could be fruitfully applied by economists studying suitable questions. For example, Oxford historians have compiled a database of 1784 shipwrecks from antiquity in the Mediterranean (Strauss 2013, Strauss, Wilson and Flohr 2017 and More et al 2013). To our knowledge, this database has not yet been used in economics, apart perhaps from aggregate summary statistics (Geraghty 2007, Izdebski et al 2020). It could be employed to test and compare gravity style models of trade. An analysis of the content of shipwrecks, also listed in this database, could provide evidence on the production structure and wealth of some ancient cities. There are also historic wastage sites that could provide unique information on consumption and imports of ancient cities. An example would be Monte Testaccio in Rome, hill containing waste of ancient Romans including millions of disregarded amphorae in which oil from all over the Empire was imported (Ward-Perkins 2005).

Similar to archaeological records, pollen data have been used to time structural change and trade in ancient history. Palynologists study pollen found in sediment cores taken from lakes, lagoons and other environments where organic material can be preserved for thousands of years. Samples are taken at regular intervals, ranging from a few millimeters to a dozen centimeters and then processed to count pollen grains within each sample. This provides a snapshot of the vegetation structure surrounding a given site at a certain moment in time. The sequence of such

⁴ Additional references on recent data innovations in Urban Economics, including historic ones, have been recently reviewed by Abramitzky et al (2025).

snapshots builds a pollen profile, which provides a detailed image of the landscape change in a given locality over time. These data have been used to measure changes in agricultural production across crops to demonstrate and date the emergence of market economies and trade expansions in ancient Greece (Izdebski et al 2020).

2.1.2 Inferring trade through distances and maps

Ancient Europe offers a rich laboratory to study the effects of changes in market access on the development of cities and regions. One reason that makes this period particularly attractive is that trade beyond an agglomeration was overwhelmingly conducted on ships or roads, with hardly any substitution to other modes of transport over longer distances. This makes it easier to estimate how a given shock to a transport channel affects trade compared to a world in which substitution to other means of transportation is more easily available.

Since there are limited resources to measure trade directly, most economists studying trade in antiquity have relied on geographical proxy data such as distances over water. There is evidence that inverse distance weighted population, or proxy measures for population data, can serve as a useful proxy variable to substitute for trade (Chaney 2018, Rauch 2016, Disdier and Head 2008). Bakker et al (2021) show that higher sea connectedness across the Mediterranean is associated with more archeological settlements. Bosker et al (2013) also use inverse distance weights to study divergence between Europe, the Middle East and North Africa between 800-1800. They also state the speed of a fully loaded camel as 30 miles a day, about 48km. General ruggedness of an area also influences its economic development (Nunn and Puga 2012, Accetturo et al 2024).

More sophisticated approaches have computed travel costs taking wind and currents into account, which are thought to have been constant over the last two millennia (Abulafia 2011). The locations of most ancient roads are known and can also be used in such simulations. A key reference to simulate travel speeds around 200 AD is the ORBIS (2025) database (The Stanford Geospatial Network Model of the Roman World). This project simulates travel speeds and travel costs for a variety of transport options in antiquity. For sailing it takes weather conditions, currents and wind into account as well as travel on boats along rivers. The sailing model was developed based on 117 recorded sea routes with reported sailing times in ancient sources. The site also models the speed for fourteen different modes of road transport, which are calibrated from ancient sources. Mean daily travel distances are estimated as 12 kilometers per day for ox carts, 20km/day for porters or heavily loaded mules, 30km/day for foot travelers, pack animals with moderate loads, mule carts, and camel caravans, 36km/day for routine private vehicular travel with convenient rest stops, 50km/day for accelerated private vehicular travel, 56km/day for routine travel on horseback, 60km/day for rapid short-term military marches without baggage, 67km/day for fast carriages, and 250km/day for continuous horse relays. A separate attempt to model shipping times in antiquity taking winds and currents into account that keeps the seasons separate was developed by Chen et al (2024). There are also historic journey planner tools for England and Wales for 1680, 1830 and 1911 (Shaw-Taylor et al 2018), France for the period 1632-1833 (Mimeur et al 2025) and China (Berman et al 2017) that provide estimates of travel times, that have so far not been extensively used in economics. Similar maps of Premodern Europe including documentation on transport and mobility are also available from Holterman (2022). Borner and Severgnini (2012) estimate the speed of spread of the Plague using infection data and a gravity model, see also Jedwab et al (2024).

The use of maps as data sources has experienced an additional boost with the increased availability of machine learning techniques that can help to infer information about cities and transport infrastructure in history (see Combes et al 2022 for a longer discussion and as examples Heblich et al 2024, Heblich et al 2025, Zaragozi et al 2019). A risk in using historic maps to compute transport costs is that institutions also influence transport infrastructure, not just geography alone (Bogard 2022).

2.1.3 Measuring speeds directly from written records

Travel diaries are a known method to measure travel costs in Medieval times. Diaries of Kings reveal bounds on their travel speeds. Using this method for kings of England and France, average travel speed along the Roman roads is estimated to be around 40 kilometers per day, while riverine travel speed was about 60 kilometers per day (Hall 2023). These speeds seem to stay fairly constant for the entire Medieval period. Similarly, administrative accounts of sheriffs involved in royal purveyancing suggest that travel times barely changed between 1400 and 1800. Sheriffs travelled twice as fast on rivers than on roads (Masschaele 1993).

Occasionally, historic shipping routes can be reconstructed from archives. For example, Arteaga et al (2024) provide a dataset of every voyage made between the Philippines and Mexico between 1564-1815. De Graauw (2022) combines historic literary sources with inspection of coastal shapes to locate ancient ports around the Mediterranean, a dataset used by Hornbeck et al (2024) to study agglomeration shadows.

There are other historic archives that contain data on trade and travel that have been used for measurement of travel costs in a similar way. For example, the Cairo Geniza contains commercial letters that are fairly standardized (Goldberg 2012) and gives evidence on trade practices in the 11th century around the Mediterranean (Goldberg 2005). These documents have been used to study contractual arrangements between traders in the 11th century (Greif 1989, 1993). The entire span of records dates from the 2nd to the 19th century and provides a rich and accessible data source for the quantitative analysis of long run changes in trade flows and practices, given contemporary tools for digitization and text analysis. Similar archives exist in Perugia (Perani et al 2022) and Afghanistan (Haim 2019).

Bilateral data on cultural proximity in the past might be inferred from given first names where such records are available. They have been used in the case of Germany from around 1700 (Cantoni et al 2024). Similarly, relationships between dialects might contain useful information on historic interactions (Falck et al 2012).

2.1.4 Tax records

Transit taxes were an important source of income for Medieval states and can sometimes serve as useful resources to gather information on trade. A key example for this is the Soundtoll registry. All ships passing Øresund near Copenhagen were forced to stop and pay a transit tax. Cannons covering the narrow sea were under orders to sink ships refusing to comply. The tax was calculated as a percentage of the value of the cargo. To measure the value of cargo, captains of ships had to declare the value separately for each good category, and the Danish crown assumed the right to purchase the cargo at the stated value (van Vollenhoven 1927). Danish authorities kept meticulous records of these journeys, including the date, name of shipmaster, domicile of shipmaster, origin and destination of the journey, composition of cargo and value of the cargo. These records, which are stored in the Danish National Archives in Copenhagen were recently digitized by a team of researchers based at the University of Groningen (Soundtoll, 2021). These records describe 1.8 million passages which give a nearly complete picture of trade in this region that spans more than four centuries. These data are unique in their richness of information that is high-resolution in geographical area, high frequency in time, contain detailed product level information and cover a long period of time. These data have been used to track trade in response to changing temperatures (Waldinger 2022), and to study the persistence of the Hanseatic League (Marczinek et al 2025). Given the unique nature of this dataset that has a high-resolution in geographic space, product space and time, many more publications using it can be expected. Historic tax data, in more aggregated form, has also been used to infer the existence of trading waterways, such as in 1077 China (Liu 2012).

2.1.5 Inferring transport costs from price gaps

There is a long tradition in economics to infer trade costs from price gaps across locations: The law of one price states that absent any other distortions the price differences of a good between two markets must reflect the trade costs between these two markets. Many studies look at changes in the wheat price differential across locations to test

market integration for the early modern periods different implied results regarding changes in transport costs over the period (Albers and Pfister 2024, Bateman 2009, Bernhofen et al 2024, Chilosi et al 2013, Federico 2011, Ljungqvist and Seim 2024, Shiue and Keller 2007 among others). Studies for the medieval period (Clark 2015, Söderberg 2007) and antiquity (Temin 2012) also exist but comparable data on prices is scarce.

2.2 Estimated travel speeds by mode of transport in the literature

As highlighted in the previous subsections there is a rich literature on transport, inter-city trade and its effects on the spatial distribution of economic activity but there is still substantial disagreement on whether transport costs actually decreased substantially over time in the pre-modern era. In Table 1, we collect different estimates for travel times from various sources. We normalize these various estimates to km/day to facilitate comparison. Parameters from this table might be useful in future related research, the table also helps to assess stability of coefficients over time. Our impression from this collection of coefficients and others is that similar means of transport exhibit similar speeds over time. Nevertheless there could have been significant changes in effective transport costs if the share of different transport modes changed significantly over time.

We mention two comparisons of relative transport costs that are also useful to complement this table. Shiue and Keller (2007) estimate the relative costs of sea versus inland waterway versus overland transport in China as 1 : 2.7 : 9.5, while the analogous figures for England are 1 : 2.4 : 7.1. Thus, while the scale of China's long-distance grain trade was larger than Western Europe's, overland transport may have been somewhat more expensive relative to water transport in China compared to Western Europe. Campbell, Galloway, Keene and Murphy (1993) estimate medieval transport costs as about one tenth of land transport costs. There are of course many additional estimates of transport times given, particularly the ORBIS site references a large collection of further estimates, but many can't easily be converted to km/day. We focus on these illustrative examples which include all the main means of transport for the various periods.

2.3 Historic transport links as Instrumental Variables

Historic transport links and transport networks from the past provide useful variation that has been used to create instrumental variables, to instrument for variation both across cities and within cities. Planned infrastructure projects that were later abandoned as instruments for actual projects were used by Baum-Snow (2007) and Michaels et al (2012) for the interstate highway system in the US. Historic transport routes, such as expedition or exploration maps, were used as instruments for later infrastructure. See for example Duranton and Turner (2011), Duranton et al (2014) and Garcia-Lopez et al (2015) using Roman and Bourbon roads in Spain, and Martincus et al (2017) using a pre-Columbian Inca road network. Longer discussions of these methods are in Duranton and Turner (2012) and Redding and Turner (2015). These instruments make use of variation provided by geography, which is to a great extent exogenous to human activity, and partially they make use of the fact that trade and cultural connections once established last for centuries (Head et al 2010, Beestermöller and Rauch 2018, Lin and Rauch 2022, Klein and Rauch 2024, Redding and Sturm 2008). Historic transport costs can also help understand how fast early technologies such as the printing press spread, and help to generate variation in technology across space (Dittmar 2011, Dittmar and Seabold 2019).

3 Transportation and the internal structure of the pre-industrial city

3.1 The internal structure of the pre-industrial city

Compared to the large literature on historic transportation and trade, the internal structure of the pre-industrial city has received very limited attention from urban economists. It has largely remained the domain of historians (see Sjöberg (1960) and Langton (1975) for early contributions), providing many insightful case studies, but more quantitative evidence in the urban economics tradition on the spatial organization within cities and their underlying mechanisms remains scarce.

Before diving into what we know about the pre-industrial city, it is also worth highlighting that city life was the exception, most of humanity lived in the countryside. The share of the world's population living in cities grew from less than one tenth in 1300 to around one sixth in 1900 to more than half today (United Nations 2008, Michaels et al 2012). When we study cities before 1900, we study an anomaly, contrary to how the spatial economy is organized today, where a majority of people live in cities.

While cities today vary substantially in terms of size, shape and structure (Bertaud 2001, Bertaud and Malpezzi 2003),⁵ cities before the Industrial Revolution were much more similar to each other than they are today. Cities were small: taking the numbers from Bairoch (1988), there are only 19 cities listed for 1800's Europe with a population of more than 100,000 people. Zipf's Law, a robust observation in datasets on city size today, does not seem to apply to the Medieval city because of these similarities in city sizes, and only emerges between 1500 and 1800 (Dittmar 2011).

The work by economic historians suggests that forces driving the urban structure of the pre-industrial city are very different from the ones that drive modern cities. Cities emerged around a central public good such as a cathedral or a city wall (Glaeser 2024). Access to Medieval cities was limited through fees imposed on residents (Duranton 1999). The center of the city was more often dominated by buildings of religious (e.g. Cathedral in medieval Europe or principal Mosque in the Middle East) or political importance (e.g. the Forbidden City in Beijing), than of a Central Business District in the modern sense (Kostof 1991). They were often built around navigable water (Michaels and Rauch 2018), sometimes bending to its shape (Hein 2016) and had a generally circular shape unless distorted by the presence of a river, coastline, or mountain range (Harari 2020).

Commuting is a key feature driving the internal structure of modern cities. A conventional theory, referred to as the 'Marchetti constant', postulates an average travel time of people of around one hour a day (Metz 2012). At walking speed of 5 km/h, returning each day, this gives a radius of 2,5km and a territory of about 20km², which is seen as an upper limit on historic urban areas (Marchetti 1994). Placing a discrete time constant of half an hour on human commuting preferences seems a rigid modelling choice.⁶ Yet, it is certainly true that transportation costs within the city place constraints on their area and put pressure on urban density, particularly so for a medieval European city in which many activities concentrate in a central square and that contained all necessities of urban life no more than half a mile from that central square (Southworth 2005).

Most evidence suggests a limited role for commuting in pre-industrial times (e.g. Voth 2001), instead living above or next to the place of work was more common than in modern cities. For most of the pre-industrial times daily commutes were done on foot and therefore limited to 2-3 km with some minor local exceptions that involved water-based transport such as the London watermen.

Some of these features of the medieval city are considered desirable even today. There are ongoing debates among urban planners, around concepts such as the "15 minute city" (Khavarian-Garmsir, A. R et al 2023), who argue that we should limit urban sprawl and revive dense, walkable (or bikeable) cities in today's world.

⁵ This vast heterogeneity can partially be explained by transportation technology (Sturm et al 2022), and partially by governmental planning, demonstrated by differences between English and French colonial cities in Africa (Baruah et al 2021). Both these, however, are modern influences.

⁶ There are famous models of discrete rings around units in space, for example Christaller (1933), Lösch (1940) and more recently Rauch (2014). For empirical evidence on commuting behavior, see Monte et al (2018) or Larcom et al (2017).

Pre-industrial cities also featured a high degree of spatial sorting – as is still evident in modern street names such as “Goldsmiths’ Row” in London – leading to combined occupational and residential sorting. In some settings this sorting was the equilibrium outcome of market forces (such as input-output linkages or other agglomeration forces) or real estate prices, while other times it was driven by non-economic forces such as guild enforcement or social stratification. Likely these clusters influenced local economic development, a point that has not been exhaustively studied in Urban Economics but might prove valuable. Colson (2016) provides an attempt to disentangle the different forces driving occupational sorting in London from the 1370s to the 1550s emphasizing the influence of both ossified guild structures and locational economics.

Just as intra-urban transportation costs determine the length of commutes and thereby the size of cities, local transportation costs affect the effective area of agricultural supply surrounding a city (Von Thünen 1826), limiting the size of cities, and constraining the distance between two neighboring towns.

3.2 The pre-industrial city structure as Instrumental Variable

The internal organization of pre-industrial cities is not only of interest in its own right, but – given the high amount of path dependency – likely still shapes the internal structure of modern cities and might provide useful exogenous variation to understand modern phenomena (see Heblich et al 2021 for an example of path dependency in neighborhood sorting in the modern era). Brandily and Rauch (2024) show that in Africa, the age of a city correlates with its road density as cities were built differently when transportation technology advanced. Garcia-Lopez and Viladecans-Marsal (2024) show that historic buildings in European cities, from Roman, Medieval and Renaissance periods, continue to influence population density gradients, compactness and suburbanization centuries later. Note that these papers focus on outcomes at the city level, highlighting the lack of scholarship on the persistence of the internal structure of the city.

4 Insights for urban economics and open questions

4.1. Economic geography and inter-city transport

There is now a vast literature showing, example after example, that more trade leads to population growth and urbanization. However, it is less clear what the mechanisms are that underlie these effects, several distinct channels have been proposed: Trade theory suggests productivity gains from specialization according to comparative advantage or economies of scale as underlying mechanisms. Lower trade costs also work as insurance mechanism against negative local supply shocks (see Burgess and Donaldson 2012 and various papers from above on volatility in grain prices). Trade also promotes the diffusion of technology and ideas (see De la Croix et al 2018 for the role of journeymanship for pre-industrial growth). Lower transport costs facilitate migration and the efficient allocation of labor as well as capital through financial flows. Most papers studying changes in transport cost throughout history provide convincing evidence on the importance of connectedness but different mechanisms have not been robustly quantified.

The literature has largely focused on the effects of transport infrastructure on various outcomes today. We know much less about what drove the endogenous placement of infrastructure in historical periods and how it was shaped by the institutional setting or the technological state of its time.

4.2. Urban form and intra-city transport

As highlighted above the role of commuting – and therefore intra-urban transport – was more limited in the pre-industrial city, largely due to the lack of affordable commuting technology, and only started to shape modern cities with the development of commuter trains (Heblich et al 2020). Hence, the shape and form of the pre-industrial city need to be understood through different models and mechanisms than the modern city, and our understanding of these remains limited as best.

4.3. The particularities of the pre-industrial city

The standard urban models we use to think about the economic geography of modern countries and cities, city size and the spatial distribution of economic activity are generally determined by the interplay of agglomeration and congestion forces – i.e. purely economic forces. Yet, in pre-industrial times cities faced additional constraints and tasks that shaped urban development. For example, with costly trade over longer distances, cities needed sufficient hinterlands to produce their own food. These additional forces and their interaction with more standard economic forces remain underexplored.

Security concerns played a much larger role for city location and size in the pre-modern world. Cities were more likely to emerge and prosper in locations that could be defended more easily due to geographic features such as rivers (e.g. Paris), mountain tops (e.g. Edinburgh) or shallow water lagoons (e.g. Venice). The location of cities was also often driven by strategic concerns, guarding a border (e.g. Cologne guarding the Roman border on the Rhine), a shipping route (e.g. Istanbul to control the Bosphorus), or a pass (e.g. Innsbruck). Since such strategic concerns often coincided with the importance of trade routes, economic and non-economic motives often re-enforced each other. The presence of the military could itself be an important economic factor driving the size of cities, especially in early-state or imperial frontier regions, even though over time economic or cultural motives dominated also in pre-industrial times.

While there are notable examples of long-distance trade in food, especially wheat (see section 2.1.5), and cities that heavily relied on intricate systems of long-distance imports for their food supply (e.g. Rome in antiquity, see Erdkamp 2005), these remained the exception rather than the rule. Given the high transport costs – especially via land – and the lack of conservation methods the local food supply put a natural barrier on their size for most cities, such that local agricultural productivity is a good predictor of historical city size (see Bakker et al 2025 for evidence for China and France). While a large hinterland might help support a city, it creates other costs by isolating it from other cities. The important role of this “food constraint” for the city size distribution and therefore its implications for the spatial distribution of economic activity and other aggregate outcomes remains underexplored. While these ideas have been around since the seminal work of von Thünen (1826), they have not been explored using modern quantitative tools.

5 Conclusion

Transport infrastructure has shaped human development and the size, location and structure of cities for millennia. This paper reviews the literature in urban economics on the relationship between transportation and cities before the Industrial Revolution. We discuss how transportation costs can be estimated, and we collect estimates for transportation speeds for the most important means of transport. We highlight the relationship between transport and cities as discussed in the literature. Finally, we discuss under-explored particularities of the pre-industrial city such as their role for security and the food constraints that open interesting avenues for future research. Questions regarding path dependence of city structure within the city, and how the ancient past shapes and constraints cities today leave room for future research. Maps from ancient cities and their trading networks can also serve as useful tools to build instrumental variables for the structure of cities today, perhaps in combination with historic shocks.

Regarding research questions, there is ample evidence that shows how improvements in transport technology or infrastructure managed to reduce the cost of transport between cities and had positive effects on urban development.

Yet we argue that more work is required to understand the importance on different underlying mechanisms, and the constraints lingering from the past. For the pre-industrial city transport technology has mostly been confined to walking until the emergence of the railway, limiting the role of commuting in shaping the internal structure of cities. Understanding the important forces shaping the internal structure beyond transport remains an interesting open question. The application of modern methods such as quantitative spatial equilibrium models to cities in the past might be a particularly useful exercise for future research, to illuminate where cities emerged and the factors that shape their distances from each other. Also, technological advances in tools to digitize ancient documents will open new sources of historic data and thus new possibilities for economic research in related contexts.

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Period	Means of transportation	Speed (km/day)	Reference
Antiquity	Ox Cart	12	ORBIS
Antiquity	Heavily loaded mules	20	ORBIS
Antiquity	Foot travelers	30	ORBIS
Antiquity	Pack animals	30	ORBIS
Antiquity	Camel caravans	30	ORBIS
Antiquity	Vehicular travel	35-50	ORBIS
Antiquity	Horseback	56	ORBIS
Antiquity	Military march without baggage	60	ORBIS
Antiquity	Fast carriages	67	ORBIS
Antiquity	Horse relays	250	ORBIS
Entire Medieval period	Along Roman roads	40	Hall 2023
Entire Medieval period	Along river	60	Hall 2023
800 to 1800	Camel caravans	48	Bosker et al 2013
1500 and 1750	Horses	max 100	Braudel 1979
1500 and 1750	Coaches ships and runners	max 100	Braudel 1979
1346-1351	Disease spread on land	3.5	Boerner and Severgnini 2014
1346-1351	Disease spread on sea	10	Boerner and Severgnini 2014
1346-1351	Disease spread on rivers	7.2	Boerner and Severgnini 2014
1346-1351	Merchant travel on land	15-30	Boerner and Severgnini 2015
1346-1351	Merchant travel on river	30	Boerner and Severgnini 2016
1346-1351	Merchant travel on sea	100-130	Boerner and Severgnini 2017
1720	Seagoing in China (including loading)	110	Shiue and Keller 2007
1580	Seagoing in Europe	50-80	Shiue and Keller 2007
1800	River transport England	10-20	Shiue and Keller 2007
1800	Canal transport in England	24	Shiue and Keller 2007

Table 1: Collection of transport speeds. Shiue and Keller speeds were transformed from miles per hour by assuming 10 hours per day of travel.