

The marine chronometer: A key to global transformation

by Martina Miotto

A new perspective on the way an advanced clock influenced urbanisation, reshaped world geography and transformed global trade.



Until the 18th century, navigation across the open seas was a perilous challenge. Sailors could travel long distances but faced an impossible task: determining longitude, or their exact east-west position.

Without a reliable method to calculate longitude, travelling was very inefficient thus increasing total costs, and many ships became lost, resulting in dangerous voyages and countless lost lives. The invention of the marine chronometer revolutionised navigation, making it safer and faster, and opening new sea routes.

In practice, the chronometer was an advanced clock that could keep time accurately on the high seas. This invention became one of the most important breakthroughs of the Industrial Revolution, alongside other pivotal technologies like the steam engine and the spinning jenny. According to historian William Andrewes, the ability to measure longitude more accurately was revolutionary as it resulted in greater intercontinental trade, the creation of new markets, and altered population movements across the globe.

Despite its historical importance, few studies have investigated the direct impact of the chronometer on navigation and urbanisation. Our research aims to fill this gap, offering a new perspective on how the chronometer reshaped global sea routes, and by extension, urban development. By using a combination of global data, including

information on climate, colonial history, and urbanisation, this study explores how the chronometer's adoption affected world geography and population distribution.

Solving the longitude puzzle

In theory, determining a ship's longitude is straightforward: by comparing the time at a fixed location (such as Greenwich) with the local time, sailors can calculate their position. The Earth rotates at 15 degrees per hour, so differences in time allow navigators to determine how far east or west they are. While local time can be calculated by observing the sun's position, the challenge was knowing the exact time at a fixed reference point while far out at sea.

it unreliable in cloudy or overcast conditions. This is where the marine chronometer came in. A precise timepiece that kept accurate time even at sea, it allowed sailors to measure longitude regardless of weather conditions.

The East India Company, one of the major players in the British Empire's expansion, was among the first to widely adopt the chronometer by the mid-1790s. Over the next century, the chronometer became standard equipment on ships, particularly during the 19th century.

Impact on navigation and sea routes

Our research first studies how the chronometer transformed navigation. We analysed around

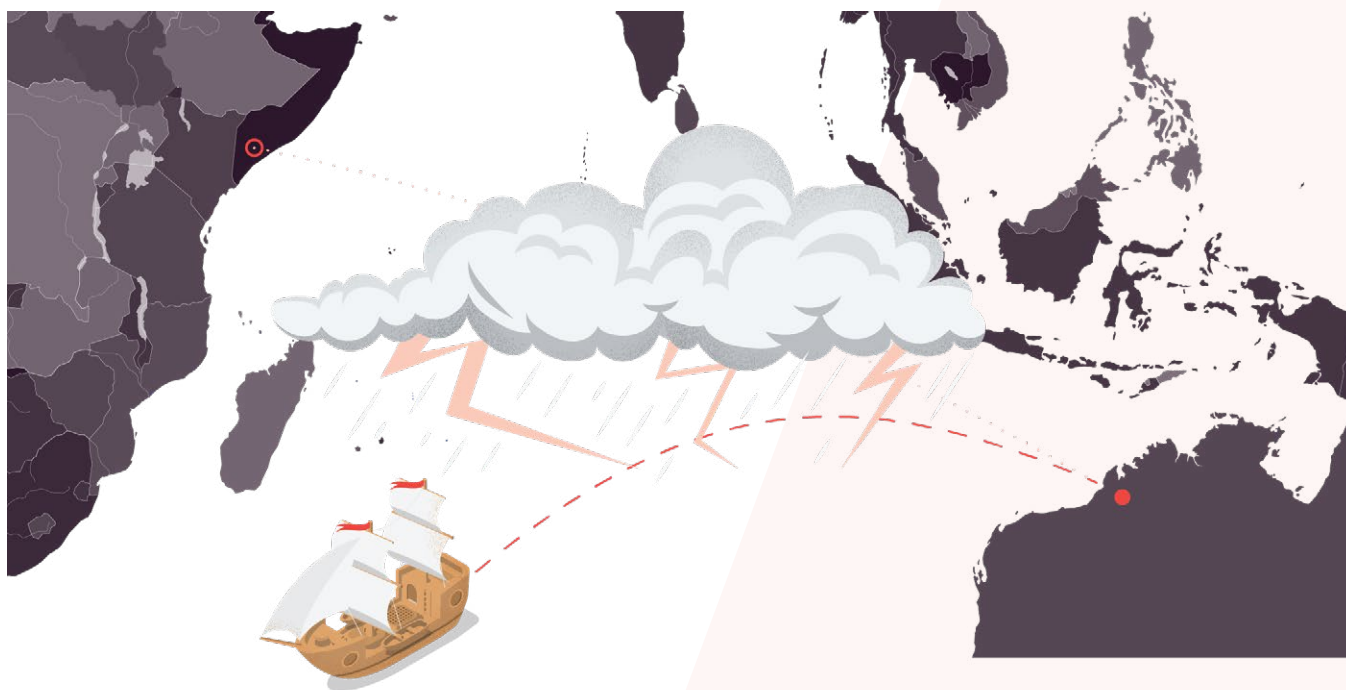
4,700 historical ship logbooks from the British, French, Dutch, and Spanish navies, focusing on voyages between 1750 and 1855. By comparing the sailing speeds of ships before and after the chronometer's introduction, we find significant changes.

The most notable improvement was in

vessels navigating through cloudy regions, where the lunar method would be ineffective. These ships, now equipped with the chronometer, could navigate faster and more efficiently across the open sea compared to their counterparts in clearer skies.

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The first solution to the longitude problem was the lunar distance method in the 1750s, which measured the moon's position relative to other celestial bodies. However, this method had limitations – it only worked when the stars were visible, which made



Moreover, the chronometer led to a reorganisation of sea routes. While the 19th century generally witnessed an increase in shipping and sea-travel, we find a disproportionally higher increase of travels taking place especially under cloudy regions, highlighting once again the important aid that the marine chronometer offered to sailors.

The chronometer's impact was especially evident on open-sea routes, which had been more challenging to navigate. The introduction of the chronometer allowed sailors to avoid navigating strictly along coastlines and to explore new routes across the open ocean. All these changes led to a more globalised world, as ships could now travel more directly and safely between continents.

Urbanisation and population shifts

The final part of the study explores how these changes in sea travel influenced urbanisation. We analysed data on urban population from 1750 to 1900, examining the correlation between faster travel

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times to Europe and the growth of cities in various regions. In particular, this analysis looks at roundtrip voyages from Europe, within the 150 years of European colonial expansion. We find that coastal areas with reduced sailing times induced by the adoption of the chronometer saw a substantial increase in urban population density during the 19th century and a parallel increase in the probability of becoming a British (or, in general, European) colony.

A remarkable innovation

In conclusion, the marine chronometer had a profound effect on the world. By making long-distance sea travel more reliable, it transformed global trade, reshaped world geography, and led to significant shifts in urbanisation. The chronometer not only enabled faster and safer

voyages but also played a key role in the expansion of European colonial empires. This research shows that this seemingly simple invention was as influential as other major innovations of the Industrial Revolution, such as the steam engine or the spinning jenny, in shaping the modern world.

It is estimated that the chronometer helped fuel about a fifth of the increase in urban populations outside of Europe during the 19th century – a testament to the far-reaching consequences of this remarkable invention. ◀

About the author

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References

Miotto, Martina and Pascali, Luigi (2025). Solving the longitude puzzle: A story of clocks, ships and cities. *Journal of International Economics*