DEATH AND GRAIN

Rye trade and mortality in Amsterdam in the 18th century

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Contents

Introduction

Globalization and global trade have had a significant influence in our world. The recent French presidential election did not show a traditional left-right divide in politics, but rather a divide between those that want an open economy and those that favour a closed economy.[1] United Kingdom's departure from the European Union, more commonly known as Brexit, is dominated by discussions on global and regional trade. [2] In politics, a fierce discussion continues on the positive and negative effects of trade.

Not only does globalization affect politics, it also touches our daily lives. The choices of meals available to the average American have grown substantially, and they have adapted foreign recipes to suit their own tastes. Words such as spaghetti and teriyaki are widely used in English-American language. Along with this adaption, foreign foods are now readily available on the American market. While in the past food such as tofu and chilli peppers were a rare sight, they are now freely available in American supermarkets.[3]

Meals such as pizza, teriyaki and fast food have become symbolic of globalized food. However, food is not merely an indicator of globalisation. Food and food supply have become an important means to explain mortality and mortality crises. Questions on the direct relationship between nutrition and disease and between food supply and starvation-related mortality have been pondered upon by historians.[4]

Global trade might be linked through the supply of food with mortality. The Dutch Baltic grain trade, known as the *moedernegotie,* was an important trade network and is the focus of this paper. Large volumes of grain were imported from the Baltic area to the Dutch Republic. The Baltic trade was considered as important as the Dutch-Asian trade, generating both jobs and wealth for the Dutch.[5] Amsterdam, in particular, was a Dutch city that enjoyed a substantial share of active trade within the Baltic grain trade, importing large volumes of grain.[6] With the importance of the Baltic grain trade to Amsterdam, it opens the question to what extent this trade affected the mortality rate of the population of Amsterdam.

Additionally, Amsterdam has accurate records of the volume of grain imported as well as the number of deaths in the 18th century. This provides a timeframe to examine the relation between trade and mortality. This paper therefore examines the relationship between the Baltic grain trade and mortality with the following research question:

What influence did the Baltic grain trade have on the mortality of the population of Amsterdam in the period 1700-1805?

By answering the research question, this paper will demonstrate how volumes of the Baltic grain trade may have influenced the mortality rate of the population of Amsterdam in the 18th Century. It will contribute to our knowledge of how food supply affects mortality and introduces the importance of trade into the discussion.

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[1] Liz Alderman & Elian Peltier, 'Marine le Pen and Emmanuel Macron: Where France's candidates stand', *The New York Times* (4 May 2017) < https://www.nytimes.com/2017/05/04/world/europe/marine-le-pen-emmanuel-macron.html> [Geraadpleegd op 2-6-2017].

[2] Ishaan Tharoor, 'Brexit and Britain's delusions of empire', *The Washington Post* (31 March 2017), <https://www.washingtonpost.com/news/worldviews/wp/2017/03/31/brexit-and-britains-delusions-of-empire/?utm_term=.31df59b878fe> [Geraadpleegd op 2-6-2017].

[3] Kenneth Kiple, *A moveable feast: ten millennia of food globalization* (Cambridge, 2007), 271-273.

[4] John Walter & Roger Schofield, 'Famine, disease and crisis mortality in early modern society', in: John Walter & Roger Schofield, *Famine, disease and the social order in early modern society* (Cambridge, 1989), 1-74, alhier 4-7.

[5] Milja van Tielhof, *The 'Mother of all Trades': the Baltic grain trade in Amsterdam from the late 16th to the early 19th century* (Brill, 2002), 1-5.

[6] Van Tielhof, *The 'Mother of all Trades'*, 9.

Status Quaestionis

The examination of the manner in which food supply affects mortality knows a long history, dating back as early as the 18th century, when a Frenchman, La Michodière, gathered the mortality rates of several French cities and of London. He also researched the grain prices of these cities. While correlating the grain prices with the mortality rates, La Michodière discovered a strong relationship between the grain prices and the cities' mortality rates. He noticed that when grain prices were high, mortality was also high. Furthermore, low grain prices correlated exactly with low mortality rates. Chevet and Ó'Gráda dubbed this the La Michodière law, which became a considerable influence in French and English historiography. [7]

The method and law of Michodière are certainly evident in the works of later scholars, primarily from France and the United Kingdom. One such historian, Appleby, examined the relationship between grain prices and the mortality rate of both France and England. [8]He did so by examining the price movement of the French and English wheat and rye markets and by relating them to mortality. By examining France and England, Appleby discovered that particularly Northern France seems to have suffered from recurring subsistence crises. However, in England not all grain types rose in price, which allowed sufficient replacement of traditional wheat and rye. In France prices were more connected, meaning the prices would all rise equally, leaving no cheaper alternative to rely on. According to Appleby, if all grain prices were high, a subsistence crisis would follow within several months, along with high mortality and low fertility. [9] In his suggestions as to why this divergence between England and France exists, Appleby primarily focuses on the regional grain production. England developed a more diverse grain agriculture, focusing not solely on spring grains but also by adding more winter grains. In addition, the English Poor Laws are suggested to have helped mitigate malnourishment by providing some basic security against hunger.[10] According to Appleby, these difference between France and England explain why France appears to suffer from frequent subsistence crises, while England is barely affected. Influences of international or regional grain trades are not mentioned and Appleby admits that they may play a more crucial role. Though focusing on England and France, Appleby states that the relationship between prices and demography may be less valid elsewhere.[11]

Appleby not only compared France and England but also compared northern and southern England. In his study, Appleby examined price ranges on a local level and noted that the grain prices were an important aspect when examining the food intake of a population. Grain was by far the dominant form of food and the lower the income of a household the greater their dependency on grain. [12] Appleby also demonstrated the importance of local and regional research on mortality. Subsistence crises in northern England did not always correlate to national price ranges, or they were mitigated in national mortality rates. The local and regional context in which a subsistence crisis occurred was of great importance. Poor grain production and a low demand for workers pushed northern England into a subsistence crisis, whereas the southern parts of England managed to prevent such crisis.[13]

While Appleby primarily focused on local and regional research, others such as Wrigley and Schofield focused on examining England as a whole. One issue in the structural examination of grain prices on mortality is the accuracy of population growth over an extended period. Wrigley and Schofield broke new ground by applying Back Projection to accurately determine the population of England between 1541 and 1871. Building on the work of Robert Lee, Wrigley and Schofield managed to accurately reconstruct the population of England not only in size but also according to age groups.[14] Their calculations were not entirely conclusive and debate continues on the accuracy of the Back Projection in comparison to other inverse projection methods.[15] The detailed projection gave Wrigley and Schofield the ability to do a long-term examination of the relation

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[7] Jean-Michel Chevet & Cormac Ó Gráda, 'Grain prices and mortality: a note on La Michodière's Law' (onuitgegeven dissertatie, University College Dublin, 2004), 4-6.
[8] Andrew Appleby, 'Grain prices and subsistence crises in England and France, 1590-1740', *The journal of Economic History* 39:4 (1979), 865-887.
[9] Appleby, 'Grain prices', 865-887, alhier 882.
[10] Ibidem, 886-887.
[11] Ibidem, 887.
[12] John Walter & Roger Schofield, 'Famine, disease and crisis mortality in early modern society', 4-7.
[13] Walter en Schofield, 'Famine, disease and crisis mortality in early modern society', 21-25.
[14] Edward Anthony Wrigley & Roger Schofield, *The population history of England 1541-1871* (Cambridge, 1981).
[15] Elisabetta Barbi & Jim Oeppen 'Comparing the results from generalised inverse projection and stochastic inversed projection', *Inverse Projection* Techniques (Berlin, 2004), 95-105.

between the grain prices and the mortality and fertility of the English population. The short-term relationship between grain prices and mortality rates were built on a mathematical approach by taking a set of price ranges calculated on the mean plus a set of standard deviations. With their calculations, Wrigley and Schofield demonstrate that grain prices do have a notable effect on mortality. However, there is a lag effect of 2-3 years with a peak correlation at 16 months. This does complicate a structural analyses because of the existence of echoes wherein the price variations may strengthen previous changes.[16] Wrigley and Schofield argue that the link between grain trade and grain prices in England is insignificant considering the low number of grain imports. It is estimated that grain imports were between 1-2% of the total grain production of England.[17]

Continuing on the work of Wrigley and Schofield, Campbell and O'Gráda examined the influence of grain prices on mortality. Responding to the earlier theories of Malthus rather than Michodière, they re-examine the divergence between England and the continent, questioning whether grain shortages had less of an impact in England than on the continent. In examining the price elasticity of three periods (1268-1480, 1750-1850 and 1884-1939), Campbell and O'Grada notice a decreasing price elasticity. Because of lower storage costs and increasing access to foreign markets, they view an increasing influence from growing imports of grain as a price stabilizer.[18] However, Braudel would disagree with this argument. He states that the national market was far more important than the international trade in grain. Market integration was not important; rather, an increasing overall production of the national market was key.[19] Braudel uses this argument with the mounting Industrial Revolution in mind, while explaining the factors that contribute to (or negate) the rise of the Industrial Revolution. Campbell and O'Gráda, however, focus more on calculating price elasticities without a set goal in sight.

Aside from the examination of the relationship between grain prices and mortality in England, considerable research examined this relationship in France. Similar to what Appleby did for England, Weir examined the different variations in the French grain market. Weir finds that there was no national market but that grain prices had a local effect.[20] By dividing the national market of France into various regional grain markets, Weir demonstrates that price correlations do exist but they exist in a regional area. Thus, regional markets correlate with the mortality rate while national markets do not. Spikes in mortality can have an effect of up to five years, although sometimes the effect accumulated at one year.[21] While prices influenced mortality, the relationship weakened over time, which Weir attributes to climate changes. As the climate became more temperate, prices stabilized and the relationship with mortality decreased.[22]

Weir also raises the question of whether subsistence crises were at times averted by the availability of a substitute.[23] In examining the grain culture of Paris, Kaplan notes that the citizens of Paris preferred wheat as subsistence. Any replacement of wheat as the preferred grain was unthinkable. If forced to choose between eating rye and barley or to starve, the Parisians would have preferred to starve.[24] The effects of shortages and rising prices were a cause of concern for even the king. While increases in the grain price may not have led to direct starvation, they certainly led to a variety of social issues including riots. [25] Kaplan demonstrates throughout his work how fluctuating prices caused tension between severe government involvement in the wheat market and the free marketplace.

Though most work concentrates on France and England, some historians have attempted to examine the relationship between grain prices and mortality outside these two spheres. Post demonstrates that the

[16] Wrigley & Schofield, *The population history of England,* 371-373.
[17] Ibidem, 404.
[18] Bruce Campbell & Cormac O'Gráda, 'Harvest shortfalls, grain prices, and famines in preindustrial England', *The Journal of Economic History* 71:4 (2011) 858-886.

[19] Fernand Braudel, *Civilization and Capitalism, 15th-18th century: the perspective of the world*, 3 dln (London, 1984) III.

[20] David Weir, 'Markets and mortality in France, 1600-1789', John Walter & Roger Schofield (red.) *Famine, disease and the social order in early modern society* (Cambridge, 1989), 201-234 alhier 215-217.
[21] Weir, 'Markets and mortality in France, 1600-1789', 210-212.
[22] Ibidem, 229-231.
[23] Ibidem, 231.
[24] Steven Kaplan, *Provisioning Paris: merchants and millers in the grain and flour trade* (Cornell, 1984) 45-46.
[25] Kaplan, *Provisioning Paris,* 24.

divergence of mortality crises between England and Continental Europe continues in the 18th century.[26] With the help of various previous studies, Post maps the mortality crises in Europe during the 18th century. Post differs from Appleby not only in scope but also in approach. Where Appleby connects grain prices to mortality, Post examines mortality peaks and attempts to explain their cause and the reason for the divergence between England and the rest of Europe. According to Post, food shortages followed by epidemics drastically increased mortality across Europe.[27] However, Post does not argue that a direct link exists between subsistence crises and epidemics. He insists that most of the causes of epidemics such as smallpox are not caused by malnourishment. Instead, Post stresses an indirect link: food shortages lead to changed social patterns such as increased migration, vagrancy and food riots, which increases direct bodily contact and spreads diseases. In this manner, Post does find a link between subsistence crises and epidemics.[28] The primary cause of preventing subsistence crises, according to Post, was government involvement such as the Poor Laws and strict control. However, government involvement occurred after the fact. Food imports by government often came too little too late, although the English Crown was most active in importing food. This is an import of grain after a subsistence crisis. An examination of the structural import of grain in an area leading to a subsistence crisis is not present in the work of Post. Post remains on the surface when exploring the possible importance of food imports, focusing on governmental involvement in local and regional food production.[29]

With regard to the Dutch Republic, Schellekens examined the relationship between mortality and malnutrition within two small Dutch villages near Breda.[30] Unlike in Paris, where wheat was the preferred grain, rye was the most consumed grain in the two small villages. Schellekens demonstrates that mortality did not correlate with the rye price series, as these two villages did not demonstrate a direct correlation or a lagged correlation up to two years after the prices rose.[31] Other causes such as the epidemics of smallpox and measles were, according to Schellekens, the result of social factors, including overcrowding or recent wars.[32]

Mortality of rural villages, such as those examined by Schellekens, forms a stark contrast to the larger cities such as Amsterdam. Jansen and de Meere examined causes of death in Amsterdam.[33] They conclude that the high grain prices had a strong influence on mortality until 1814. After 1814, the Dutch population developed a more diverse diet and were less reliant on grains.[34] Their examination for mortality in the 18th century remains relatively short, as they were primarily focusing on the latter half of the 19th century. Nevertheless, Van Woude argues that through the 18th century mortality became relatively stable. The extent to which grain prices affected the mortality rates was not demonstrated by Van Woude.[35]

The population of Amsterdam has been reconstructed by Van Leeuwen and Oeppen, with the use of the generalized inverse projection method, which is a variant on the back projection of Wrigley and Schofield with inverse projection traits.[36] Their research was based on the results of Nusteling who examined the deaths and births of those in Amsterdam. In his work, Nusteling created accurate five-year averages over an extended period for the population of Amsterdam, being often critical of the existing estimates by other scholars.[37] These studies are, however, primarily concerned with the accuracy of the reconstruction of the population of Amsterdam. Influences of grain prices or the trade in grains on population changes had not yet been examined by either Nusteling or Van Leeuwen and Oeppen.

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[26] John Post, 'The mortality crises of the early 1770's and European Demographic trend', *The Journal of Interdisciplinary History* 21:1 (1990), 29-62.
[27] Post, 'The mortality crises of the early 1770's', 29-62 alhier 37-38.
[28] Ibidem, 47-48.
[29] Ibidem, 50-59.
[30] Jona Schellekens, 'Mortality and Socio-economic Status in Two Eighteenth-century Dutch Villages', *Population Studies* 43:3 (1989), 391-404.
[31] Schellekens, 'Mortality and Socio-economic Status in Two Eighteenth-century Dutch Villages', 396-397.
[32] Ibidem, 402.
[33] P.C. Jansen & J.M.M. de Meere, 'Het Sterftepatroon in Amsterdam 1774-1930: een analyse van de doodsoorzaken', *Tijdschrift voor Sociale Geschiedenis* 8:26 (1982) 180-223.
[34] Jansen & De Meere, 'Het sterftepatroon van Amsterdam', 180-223, alhier 217.
[35] A.M. van Woude, 'Population developments in Northern Netherlands (1500-1800 and the validity of the "urban graveyard" effect', *Annales de démographie historique* (1982).
[36] Marco van Leeuwen & J. E. Oeppen. 'Reconstructing the demographic regime of Amsterdam 1681–1920.' *Economic and Social History in the Netherlands* 5 (1993): 61-102.
[37]Huibert Pieter Hyginus Nusteling, *Welvaart en werkgelegenheid in Amsterdam, 1540-1860: een relaas over demografie, economie en sociale politiek van een wereldstad* (Amsterdam, 1985).

The importance of the Baltic trade for Amsterdam is demonstrated by Van Tielhof who suggests that the Baltic trade was far more important for the Dutch than Braudel would have argued. However, she does not relate the trade to mortality patterns in Amsterdam and predominantly presents an in-depth economic view of the Baltic grain trade.[38] Van Tielhof demonstrates the importance of the Baltic grain trade by showing the impressive amounts of grain traded to the Dutch Republic. [39] However, not everyone concurs with the assumption that the Baltic trade was as important for the Dutch Republic as Van Tielhof argues. According to Israel, the Dutch commercial primacy of the Baltic grain trade began to wane during the second half of the seventeenth century. Political upheaval and Swedish ambitions threatened the Baltic grain trade. [40] From the 18th century onwards, the Dutch Republic lost its dominant position in the Baltic grain trade.[41]

Within the debate on the relation between grain prices and mortality, the focus has mostly remained on England and France. Post attempts to create a broader field but does so by examining mortality crises and not the structural focus on the grain prices – mortality relationship. In the case of Amsterdam, studies have addressed the direct causes of mortality and the mortality trend, but they have yet to examine the structural relationship between grain price and mortality. Van Tielhof shows that Amsterdam was profoundly reliant on the Baltic grain trade. Within the possibility of the examination of the structural grain prices-mortality relationship exists the opportunity to study the influence of trade volumes on grain prices and their influence on mortality. Were the merchants of the Baltic grain trade merchants of life?

[38] Tielhof, *The 'mother of all trades',* 94.
[39] Ibidem*,* 60-61.
[40] Jonathan Israel, *Dutch primacy in world trade, 1585-1740* (Oxford, 2002), 213-216.
[41] Israel, *Dutch primacy* 359.

The Dutch 18th Century

Embedded between the Dutch Golden Age and the Industrial Age, the eighteenth century was perhaps not the most remarkable era of trade or economic activity in the Dutch Republic. The Dutch elite no longer considered themselves as traders blessed with tolerance and discretion in displays of wealth. Instead, the Dutch elite withdrew from economic activity and subsisted on capital surpluses. The Dutch trade spirit was replaced by French culture and gardens as the elite invested increasingly more time in their country estates.[42] Following the economic bloom of the Dutch Golden Age, the 18th century portrayed a period of torpor of the Dutch economy. Wages had stagnated despite high productivity compared to other nations. Furthermore, the Dutch lost their dominant trading position to growing nations such as England.[43]

Following the war of the Spanish succession from 1702 until 1713, the Dutch Republic started the eighteenth century rather roughly. The war was won and demonstrated the strength of the Dutch Republic, but at what cost? Decades of war against Louis XIV left the Dutch with a mountain of debt. While struggling to keep its finances in order in a period of economic stagnation, the Dutch retreated from the political theatre. Few of the elite were interested in an ambitious foreign policy and expressed their desire to remain neutral in conflicts. In the 1740s, when the Dutch were once again at war, the marginal position into which the Dutch Republic had fallen was now quite apparent. Debt added to the economic stagnation and wars remained a cause for concern throughout the century.[44]

Economic stagnation, substantial debt and political marginalization not only affected the Dutch Republic but also its citizens. Populations of the Dutch cities stagnated or declined. While elsewhere in Europe cities grew ever larger after 1750, the Dutch cities remained lagging behind, stagnating or even declining in population. After a long period of boasting a rapidly growing population during the seventeenth century, the Dutch population remained constant until 1815. [45] In its final years, depopulation, de-urbanization and pauperization dominated the cities of Holland. This only changed in 1815, when the Republic was laid to rest and the new Kingdom of the Netherlands arose. [46]

In the meantime, another problem plagued the Dutch population: epidemics. In the highly urbanized Dutch Republic, disease was common, and especially smallpox frequently plagued the Dutch. In cities such as Amsterdam, a smallpox epidemic would occur once every three or four years. Smallpox was widespread and only a quarter of the urban population would remain untouched by the disease. Unfortunately, smallpox was frequently regarded as an 'innocent' childhood disease and, as such, was considered a natural part of growing up. The disease took the lives of many children under the age of 10. Between 14 to 18 percent of child mortalities are attributed to the smallpox epidemics that were prevalent in the 18th century. Despite the fact that smallpox was responsible for relatively high child mortality, it did not lead to a significant increase in overall mortality, but was nonetheless a common sight in the Dutch cities. [47]

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[42] Fernand Braudel, *Civilization and Capitalism*, 197.

[43] Jan de Vries, 'Dutch economic growth in comparative-historical perspective, 1500-2000', *De Economist* 148:4 (2000), 443-467, alhier 457-460.

[44] Hamish Scott, 'The fiscal-military state and international rivalry during the long eighteenth century', in: Christopher Storrs (red.), *The fiscal-military state in eighteenth century Europe* (London, 2009), 23-54, alhier 33-36.

[45] Jan de Vries & Ad van der Woude, *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy, 1500–1815* (Cambridge, 1997), 49.

[46] De Vries & Van der Woude, *The First Modern Economy,* 686.

[47] Willibrord Rutten, *De vreselijkste aller harpijen: pokkenepidemieën en pokkenbestrijding in Nederland in de 18e en 19e eeuw* (Wageningen, 1997), 82.

Sources

For this paper, a variety of sources were used to gather data for trade volumes, prices, mortality and population numbers. These datasets will assist in determining the relationship between the trade volumes and mortality rates. One of these sources is the online Sound Toll Registers.[48] The Sound Toll registers are a well-known source for the gathering of data on the Baltic trade, and its usage is present in the aforementioned works of Israel and Van Tielhof. It is an impressive source that registered all voyages travelling to and from the Baltic Sea from 1497 to 1857. All ships travelling from the Baltic Sea to cities such as Amsterdam and London had to pay a toll to the king of Denmark before crossing the Sound, a narrow strait between Denmark and Sweden.[49] From 1669, the Sound Toll registers listed a standardized set of information including the destination port, port of origin, cargo contents and the size of the cargo contents. It registered all ships passing through the Sound in an unbroken series from 1569 onwards. [50] The Sound Toll registers are a valuable resource to examine the Baltic grain trade to Amsterdam.

Gathering the data in the online Sound Toll registers was not without complications. One such complication in the Sound Toll registers is the listing of rye. There was no standard spelling format for rye. As such, the Danish variant could differ between Rug or Ruug or a variant such a Roeg. Most of these variants were considered while examining the Sound Toll Registers. However, variants deviating too greatly from these forms may have not been taken into account, as they were not found.

Another complication was the variety of various measurements used to determine the volumes of rye. The most common measurement used was the *laester* or *last,* which was certainly the most listed measurement for volumes of rye. This weight measurement is the equivalent of approximately 4000 pounds. However, other common forms of measurements included *scheffel, wispel, skippund* and *tonder,* which in English meant, among others, bushel and barrel. *Scheffel* listings were problematic as they could vary greatly depending on the port of origin. A total of 97 *Scheffel* and several unknown measurements were removed from 15408 individual ship listings. *Wispel, barrel* and *skippund* listings were converted, which leaves a total of 15329 valid entries

The cargo volume a ship would carry could vary greatly. A ship could transport a single bushel's worth of rye to Amsterdam or as many as 206 laester. Ships could also be listed with more than one measurement; a ship could, for example, carry rye in both bushel and barrel forms, each with its own separate listings. These listings were all converted to laester, which was the most common measurement. These entries had to be combined based on the ship's identification. This resulted in 14964 ships in the period 1700-1805 carrying various amounts of rye.

Sources for grain prices

The grain prices and related CPI rates were sourced from the dataset of Van Zanden on the consumer goods and cost of living on the IISG.nl website. [51] The datafile is an adaptation of the work of Posthumus and adds rents to the price series of Posthumus, which enabled the creation of an accurate CPI. [52] One limitation of the dataset is that the price series only continues until 1800; other datasets had to be sourced to add the last five years. This was achieved by combining two other databases: an online database of Posthumus' original price series and the database on prices of consumer and producer goods of Van Riel. From the online database of Posthumus, the price series for rye were taken for the years 1800-1805.[53] The CPI for the corresponding years

[48] Sound Toll Registers, <http://www.soundtoll.nl/index.php/nl/>, [geraadpleegd op 19-5-2017].

[49] Erik Gøbel, 'The Sound Toll registers online project, 1497-1857', *International Journal of Maritime History* 22:2 (2010), 305-324 alhier, 305-306.

[50] Gøbel, 'The Sound Toll registers online project, 1497-1857', 308-309.

[51] Jan Luiten van Zanden,' *The prices of the most important consumer goods, and indices of wages and the cost of living in the western part of the Netherlands, 1450-1800', in:* International Institute of Social History, *List of datafiles,* <http://www.iisg.nl/hpw/data.php>, [geraadpleegd op 6--2017].

[52] Jan Luiten van Zanden, 'Prices and wages and the cost of living in the western part of the Netherlands', <http://www.iisg.nl/hpw/brenv.php>, [geraadpleegd op 6-6-2017].

[53] MEMDB [Rutgers University], '*Prices (posthumus)*' <http://www2.scc.rutgers.edu/memdb/search_form_postpr.php> [geraadpleegd op 6-6-2017].

were taken from the database of Van Riel.[54] The combination of these datasets provides an accurate image of the price of rye in the period of 1700-1805.

Sources for Mortality and Population

To ascertain the mortality rate of the population of Amsterdam in the 18th century, a variety of sources were used. One source was the *'Memorieboekje van de zieken, doden, ingekomen en uitgegane personen in het S. Pieters Gasthuys en Pesthuys',* which detailed the number of deaths in the city of Amsterdam for each month. [55] One complication with this source was that it was not complete and had several gaps of a few months or years, especially in the earlier entries. At other times, only the total number of deaths of each year was recorded. To complete the total number of deaths, the *Zieken- en doodenboek van Gast- en Pesthuis* was used to supplement the *memorieboekje.* [56] The *doodenboek* only continued until 1780 and the *memorieboekje* stopped in 1795. The register of the Collegium Medicum was used to complement the other two sources and complete the data.[57] This register contained not only the total number of deaths each month but also contained the causes of death. Unfortunately, the register of the Collegium Medicum was only created in 1774. Combining the three sources proved feasible as they matched fairly well, provided the deaths were listed. According to Nusteling, the three sources are reliable.[58]

To ascertain the mortality rate, a population at risk was also needed. The population at risk was taken from Van Leeuwen and Oeppen. Van Leeuwen and Oeppen used a Generalized Inversed Projection to adjust the earlier population estimates of Nusteling, and they then added an accurate distribution of age groups. [59] The construction of the population by Van Leeuwen and Oeppen provided an accurate set of data for population of Amsterdam in the period 1700-1805, though their complete data set ranges from 1681 to 1920.

Methodology

The relationship between grain trade and mortality can be examined by scrutinising the correlation between three key variable: volumes of Baltic grain trade, grain prices and mortality rates. It is expected that the trade volumes will influence grain prices, which will in turn affect mortality. Two correlations had to be proven to demonstrate an influence of grain trade on mortality: a correlation between volumes of trade and prices and a correlation between prices and mortality. Grain prices are an important indicator of consumer access to the food supply and therefore were added as a third variable. [60]

The two correlations have been divided into two hypotheses: a trade-price hypothesis and a price-mortality hypothesis. For the trade-price hypothesis, it is expected that the volumes of Baltic grain trade have a negative correlation with the grain prices, meaning that if the amount of grain being traded increased the price of grain will drop. For the price-mortality hypothesis, it is expected that the grain price has a positive correlation with mortality, meaning that if the grain price rises the mortality will also rise. The results of both hypotheses were used to determine a relationship between the rye trade and the mortality rate of Amsterdam.

Rather than focusing on wheat as the grain to explore, as done by Wrigley and Schofield, rye was selected. Rye was cheaper than wheat in the Dutch Republic and became the staple food for the poor. Though wheat was preferred, rye was the replacement food if one was unable to afford wheat.[61] While a high price of

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[54] Arthur van Riel, ''*Prices of consumer and producer goods, 1800-1913', in: International Institute of Social History, List of datafiles*', <http://www.iisg.nl/hpw/data.php>, [geraadpleegd op 6-6-2017].

[55] *'Memorieboekje van de zieken, doden, ingekomen en uitgegane personen in het S. Pieters Gasthuys en Pesthuys. Item 't getal der dooden in Amsterdam, 1700'* (1700-1795), Amsterdam, Stadsarchief Amsterdam, (342) Archief van Gasthuizen, inv. Nr. 1270.

[56] '*Zieken- en doodenboek van Gast- en Pesthuis, sedert Anno 1652 tot 1780'* (1652-1780), Amsterdam, Stadsarchief Amsterdam, (342) Archief van Gasthuizen, inv. Nr. 1264.

[57] *Register bevattende maandelijkse opgave van het aantal sterfgevallen in Amsterdam, met vermelding van de doodsoorzaak* (1774-1805)., Amsterdam, Stadsarchief Amsterdam, (27) Archief van het Collegium Medicum, Collegium Obstetricium en Plaatselijke Commissie van Geneeskundig Toevoorzicht, inventarisnummer 66.

[58] Nusteling, *Welvaart en werkgelegenheid in Amsterdam,* 244.

[59] Van Leeuwen & Oeppen. 'Reconstructing the demographic regime of Amsterdam', 63-64.

[60] Walter & Schofield, 'Famine, disease and crisis mortality in early modern society', 10-11.

[61] De Vries & Van der Woude, *The First Modern Economy,* 626.

wheat may result in substituting wheat for rye, rye could not be replaced as easily for wheat. A high rye price may therefore correlate more with a high mortality rate than a high wheat price.

All data was made uniform into single year intervals from the years 1700 until 1805. For each year, volumes of rye trade were calculated per last. The rye price was adjusted for the CPI and also listed per year. Lastly, the crude mortality rate was calculated based on the yearly mortality from the sources on mortality and the population estimates by Van Leeuwen en Oeppen. Price and trade fluctuations, such as significant price increases, may have also have had an influence. Therefore, the year-on-year change for each variable was also calculated to determine whether the severity of fluctuations might correlate.

For both hypotheses, a short correlation summary was made, which included Pearson's *R* and *P*-value. The correlation summary was also made for the fluctuations. A cross correlation was made for each hypothesis with a lag range of -5 to 5. A cross correlation between rye trade and rye prices with a lag of 2 would mean that the price of rye lags 2 years behind the rye trade. A negative lag of -2 would indicate the opposite: rye trade would lag 2 years behind the rye prices. Cross correlations were also made for the trade and price variables with similar lag ranges.

The law of La Michodière states that high prices correlate with high mortality and low prices with low mortality. The law consists of two parts: correlation between high price and high mortality and a correlation between low prices and low mortality. However, this could also mean that high prices do not correlate with high mortality, but that low prices may correlate with low mortality. A cross correlation without making the distinction between low and high categories would lead to randomness and would hide any possible correlation. For that reason, Rye trade and price were also divided into various categories. The division in categories was done with the mean and the standard deviation. Any prices and volumes of trade above the mean were considered 'high', whereas any prices and volumes of trade below the mean were considered 'low'. Initially, a similar division in categories as used by Wrigley and Schofield was considered.[62] However, the price ranges of Amsterdam were relatively stable. This meant that large deviations of the mean were rare and would not be usable for an accurate correlation model. For categorizing the variable changes, the standard deviation was used to indicate high and low fluctuations.

[62] Wrigley & Schofield, *The population history of England*, 377-378.

Initial results

The presentation of the data in a matrix proved fruitful. Most of the data was present in the sources with the exception of the mortality of 1703. The calculations with the crude mortality rate had to exclude the year 1703 from all calculations. All other data for each year is complete. The three variables were plotted on three graphs.

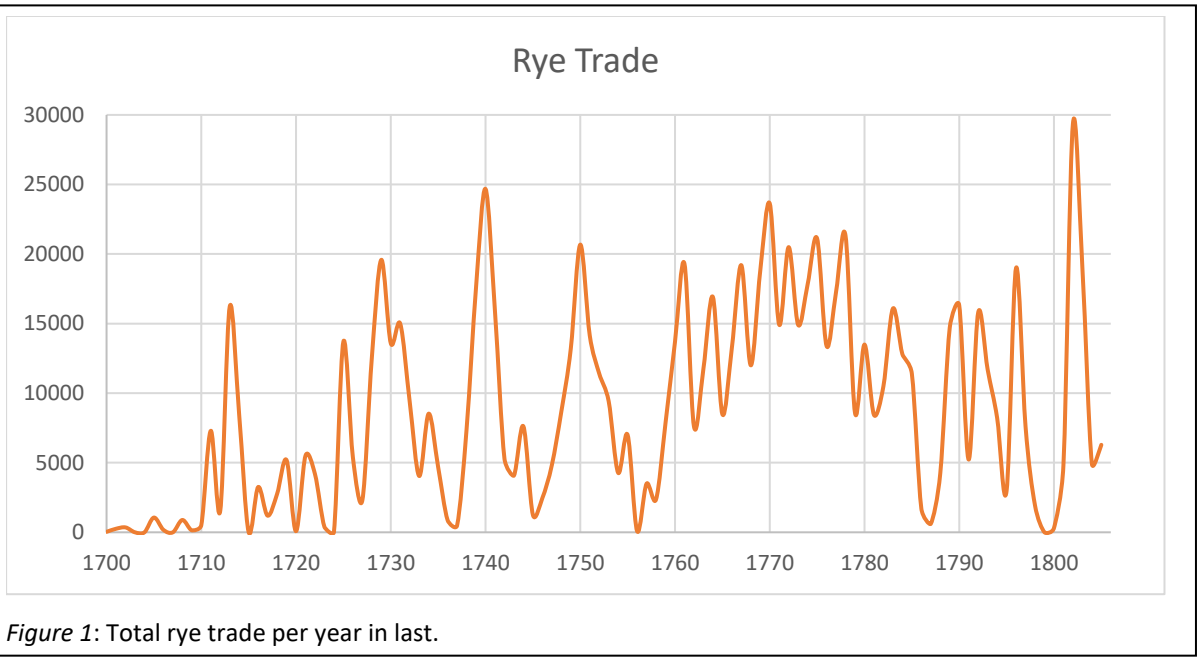


Figure 1: Total rye trade per year in last.

In figure 1, the total amount of rye traded to Amsterdam each year has been plotted. The amount of rye arriving in Amsterdam could vary significantly for each year. In the first decade of the 18th century, the amount of rye traded to Amsterdam was relatively small. From 1711, trade appears to occur in large spikes. Trade activity would rise rapidly and fall just as quickly. The year 1758 marks a brief turning point in this pattern as the amount of rye traded rises and remains fairly high until 1787, when trade rapidly falls again and expresses a new patterns of high spikes. Figure 1 indicates that Amsterdam was buzzing with rye trade activity in the 18th century. On average, 8729 last of rye was transported to Amsterdam, which was about 16 million litres of rye each year. Particularly the years 1740, 1770 and 1802 were peak years of trade activity.

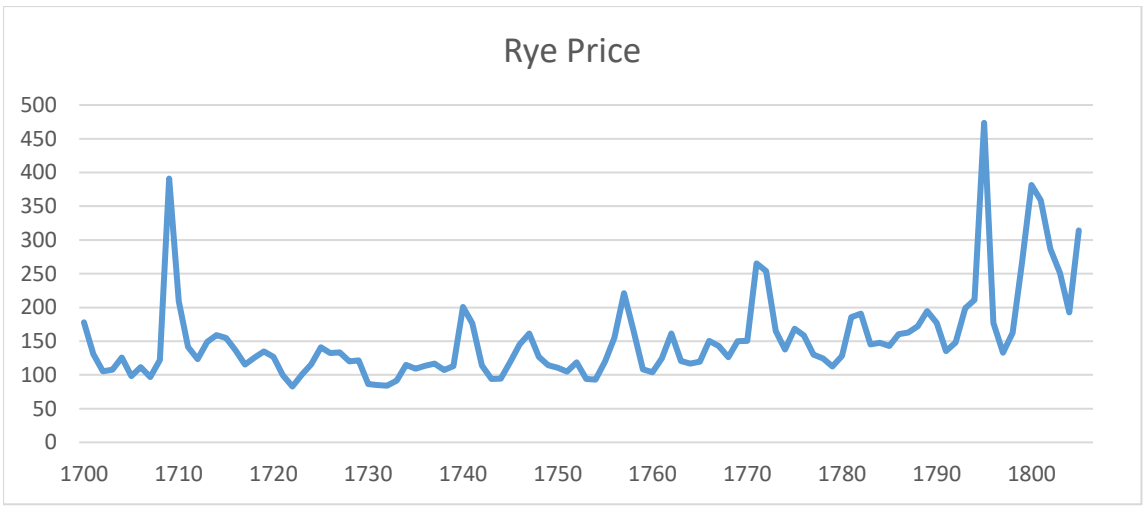


Figure 2: Rye price, adjusted for CPI

The rye price throughout the 18th century is shown in figure 2. The prices in the 18th century did not fluctuate significantly, with the exception of certain years such as 1709. Most prices (95 of the 106) remained below the mean + standard deviation, which means that the prices were relatively stable. Substantial spikes in rye prices were not frequent, with the three highest price years being 1709, 1795 and 1800. Prices in most years remained close to the mean of 153. Patterns such as those in rye trade do not appear to be as evident in the rye prices.

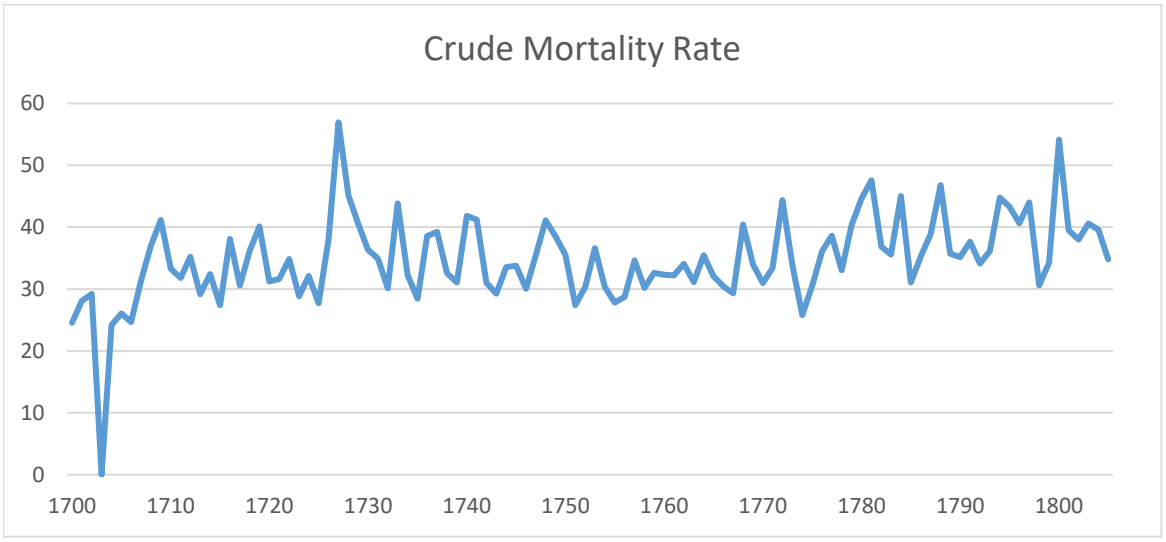


Figure 3: Crude Mortality Rate (CMR) per 1000 inhabitants of Amsterdam

Figure 3 presents the crude mortality rate or CMR of Amsterdam. In 1703, it drops to 0 because no data was found for that particular year and was then omitted from any calculations. The average mortality rate was about 35. The CMR was highest in the years 1727, 1781 and 1800. As with the prices, no pattern could be found in the CMR.

One interesting year from the graphs is the year 1709. This particular year is known to have had a particularly harsh and long winter with excessive cold. [63] This is reflected in the rye price that significantly increased to 391 from 121 in the previous year. The CMR also rose to 41 but the rise was less significant compared to rise in rye price, as the previous year had a CMR of 37. Nonetheless, the CMR spiked in that year 1709. The trade in rye meanwhile halted with only 145 last of rye being transported to Amsterdam that year. The year 1709 indicates some early correlation although a single year is not enough to establish such a relationship.

[63] J. Neuman, 'Great historical events that were significantly affected by weather: 2, the year leading to the revolution of 1789 in France', *Bulleting American Meteorological Society,* 58:2 (1977), 163-168, alhier 164.

The Rye Trade-Price Hypothesis

To reiterate, for the trade-price hypothesis, it is expected that the volumes of Baltic grain trade have a negative correlation with the grain prices. Some initial results on the graphs indicated some early promise, but a correlation method had to be applied to calculate any definitive answer.

Table 1: Cross correlation between rye trade and rye price.

	Pearson R	P-Value
Absolute	0.01517699	0.8773
Variation	0.02158616	0.8262

After the initial results showed promise, a correlation calculation was made using the Pearson method. The results are listed in table 1, with absolute numbers indicating the correlation between the total amounts of trade each year and the price (adjusted for CPI). The variation numbers show the correlation between the year-on-year difference for each variable.

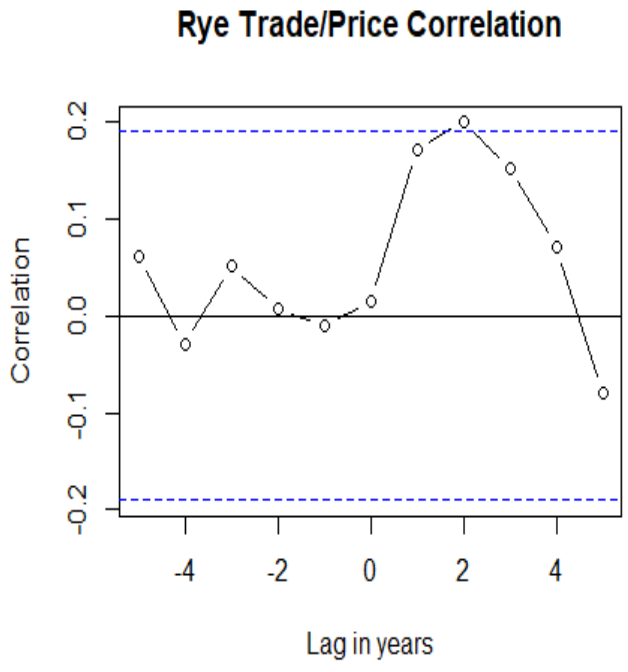
An immediate result between the rye trade and rye price resulted in a correlation value of about 0.015. For even a weak Pearson correlation, a value of 0.3 would be needed. A value of 1 would indicate an absolute and direct correlation, and a value of 0 would mean absolute randomness. A P-value would ideally be below 0.05 to show a strong significance of the correlation. With an R-value below even 0.3 and a P-value above the 0.05, the correlation between the amount of rye traded and the rye price is deemed insignificant. The relationship is entirely random and does not demonstrate any correlation between the two variables. This would mean that rye prices and rye trade behave independently from each other. Rye trade does not directly affect the rye prices in the same year. Likewise, the grain prices do not affect the grain trade in any way, at least not in the same year.

For the correlation on year-on-year changes, the same conclusion can be drawn. Here, Pearson's R only demonstrates a value of 0.02 with a P value of 0.83. With these values, there appears to be no correlation between the yearly changes either. This would mean that the annual variation is not correlated either and that growth or decline of trade does not significantly affect the price of rye.

The results of the Pearson correlation method show no relationship between rye trade and rye prices. However, to conclude that no relationship exists between the two variables would be a premature conclusion. With Pearson's correlation method, only the direct relationship between both variables within the same year over the entire 1700-1805 period is shown.

The cross correlation, displayed in figure 4, shows the correlation within a band of ten years. Similar to the Pearson correlation, the strength of the cross correlation is determined by a number between -1 and 1. Contrary to the Pearson correlation tested earlier, there is a weak positive correlation between rye trade and rye price at a lag of 2. At a lag of 2, the

Figure 4: Rye trade-Rye price correlation with lag.



correlation is at its strongest with a number of 0.2. While the value is higher than the value in the Pearson correlation shown earlier, the relationship between trade and prices is still weak though not random as with the Pearson correlation.

Figure 5: Rye trade-Rye price correlation with lag.

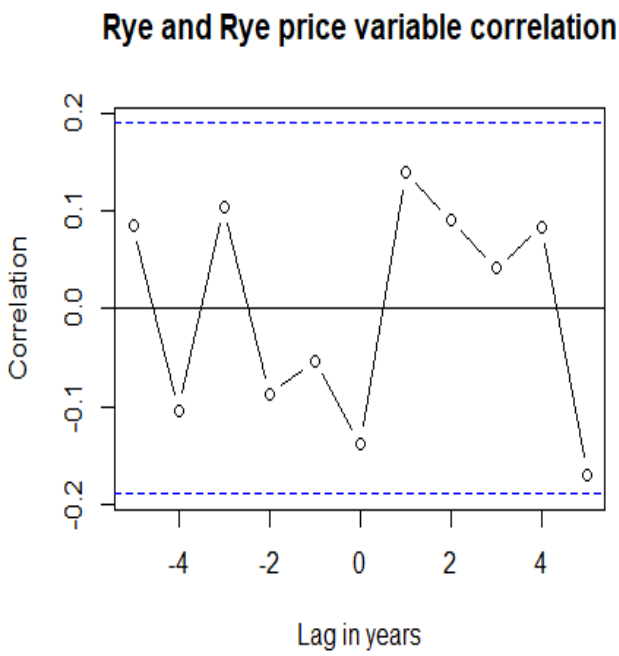
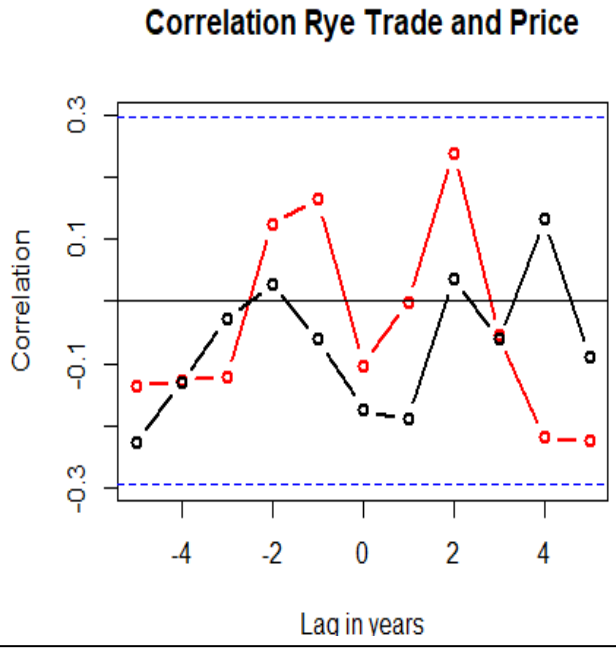


Figure 6: The red markings show the correlation above the mean, while black indicates the correlation below the mean.



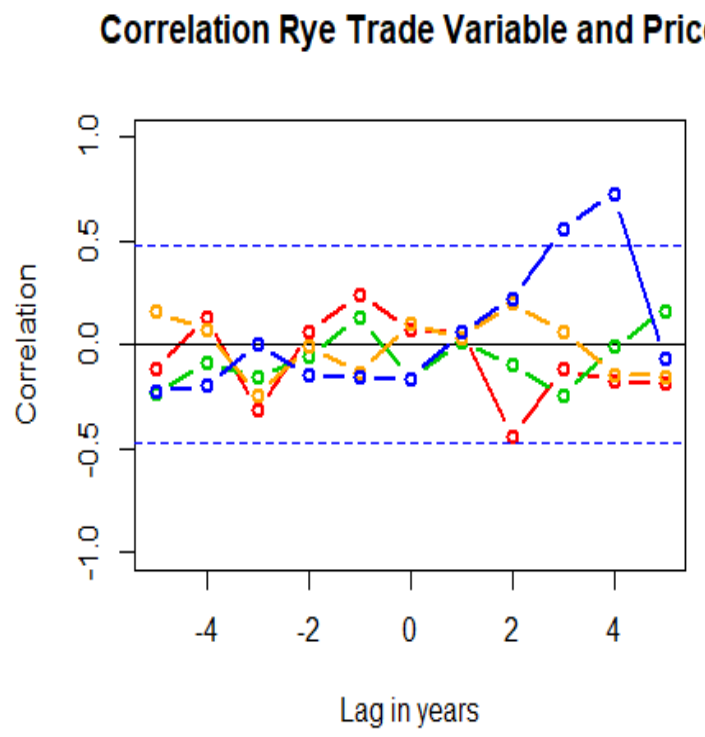
As with the Pearson correlation, a cross correlation was also made with the yearly changes of trade in rye and the rye price. The results of this cross correlation are shown in figure 5. The relationship between the two variable is significantly weak and even indicates no relationship at all. The correlation is strongest at a lag of 4 years with -0.17. This would indicate no relationship between the two variables.

Neither the cross correlation nor the initial Pearson correlation indicate an immediate and direct relationship between the volumes of rye traded and the price of rye. However, it is possible that a certain threshold exists. If the amount of rye traded to Amsterdam were below that threshold, then the Baltic rye trade would have no influence on the price. If trade surpasses the threshold, it would influence the rye price. To examine whether such a threshold exists, the rye trade was divided into two categories: one below the mean of rye trade and one above the mean.

The results of both categories are plotted in figure 6. The results of all trade below the mean show considerable randomness. The rye trade-price correlation is not present for any trade below the mean. The correlation is at its strongest at a lag of 1 with -0.19. The correlation between rye trade above the mean and the rye price demonstrates some similar randomness. However, at a 2-year lag the correlation shows a correlation of 0.24, and at a 4- and 5-year lag a correlation of -0.22 and -0.23. This would indicate that two years after a large shipment of rye arrived, the price of rye rises but after 4 years, it drops. The relationship is, however, too weak to confirm such a relationship. There appears to be no significant relationship between the amount of trade conducted and the rye prices. However, can the same be said for the changes in rye trade and prices?

For the correlation between changes in rye trade and the rye prices, four new categories were made by using the standard deviation. All rye trade between 0 and 6677 last (the standard deviation) was considered a 'small increase', and rye trade that increased above the 6677 last was considered a 'large increase'. Additionally, any trade between -6677 and 0 was considered a 'small decrease' with any number lower than the standard deviation marked as 'large decrease'. The results are shown in figure 7.

Figure 7: Correlation between the rye trade changes and rye price



As can be seen in figure 7, the small decrease (in orange) and the small increase (in green) indicate no significant correlation between the rye trade and the rye prices. Correlations in all lags in both 'small' categories show no signs of a strong relationship between the rye trade and rye price. However, the large increase (in blue) and the large decrease (in red) show some interesting correlations.

For the 'large increase' category, there exists a strong correlation between the rye trade and price. With a lag of 3 and a lag of 4 the correlations are 0.57 and 0.73. This would indicate a strong relationship between changes in rye trade and rye prices. Three or four years after rye trade rapidly grew, the prices of rye would also rise. While it demonstrates a strong correlation between rye trade and rye price, it does not show the negative relationship that was expected. A negative relationship would indicate a drop in prices if the grain trade increased, but this does not appear to be the case.

When examining the large decrease category in figure 7, there is a noticeable negative correlation between the decreasing trade and the grain prices. With a correlation of -0.44, it is a reasonable relationship between the rye trade and rye prices. A large decrease in the amount of rye traded resulted in a price increase. For this particular category, there appears to be a relationship as expected in the hypothesis. It does, however, take a specific threshold and a lag of two years before the price increase is noticed.

By re-examining figure 1, the relationship in the large increase can be explained in combination with the large decreases. Figure 1 demonstrates that the rye trade would occasionally rapidly grow and collapse just as quickly. A high increase, with a lagged correlation of three to four years, would be followed by a large decrease, with a lagged correlation of two years. This indicates that if the rye trade were considerably volatile it would have a significant effect on the rye prices. After a significant increase in the volume of rye traded to Amsterdam, a large decrease would take place, which resulted in an influence on the rye price.

The hypothesis for rye trade-price relationship has been partially rejected and partially confirmed. Trade did not appear to affect the rye price, unless certain conditions were present. Trade would affect the rye prices two to three years after a large increase and decrease of trade in rye. When this specific threshold was reached, the prices would follow the trade in rye. In all other instances, there appears to be no relationship between the trade in rye and the rye price in Amsterdam.

The Rye Price-Mortality Hypothesis.

The rye price-mortality hypothesis is the expectation that the rye price has a strong positive correlation with the crude mortality rate (CMR). To test the hypothesis, the same methods were used as with the rye trade-price hypothesis. An initial correlation has been made in table 2 with the Pearson method.

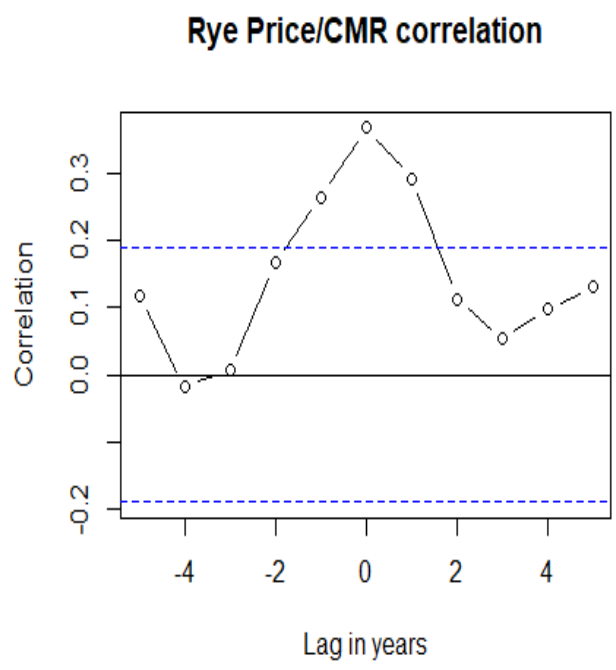
Table 2: Cross correlation between rye price and CMR

	Pearson R	P-value
Absolute	0.3693502	0.0001056
Variation	0.1395324	0.1557

As with the rye trade-price hypothesis, a Pearson correlation with the P-value was made. Table 2 indicates that the rye price and the CMR have a correlation of 0.37 with a P-value of 0.0001. This would indicate a relatively weak relationship but one that is still relevant. The price of rye had some influence on the crude mortality rate of the population of Amsterdam. Yearly changes in prices indicate a 0.14 correlation with the CMR. This would indicate that yearly rye prices changes have no correlation with the crude mortality rate.

Figure 8 displays the Rye price-CMR relationship within a lag of 5. As can been seen, the relationship is strongest when no lag effect occurs. This would indicate that rye prices have a direct influence on the mortality rate. Beyond or before the point, no strong relationship is visible between the two variables. There appears to be no lag effect, contrary to what was the case for France and England. The influence of yearly rye price changes on mortality proved insignificant, as no relationship between rye price changes and mortality was found.

Figure 8:



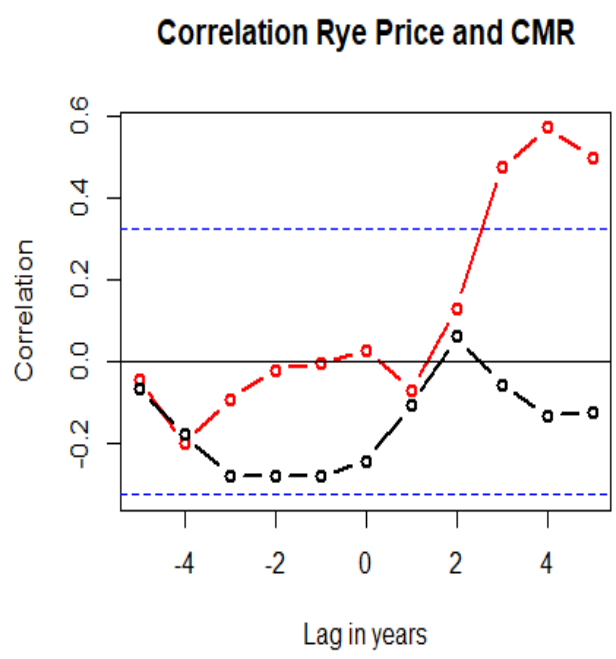
Again, the question arises whether certain thresholds exist for the price of rye. Initially, a division in categories similar to the categories of Wrigley and Schofield seemed to be a solid approach.[64] However, the prices of rye were relatively stable, which means that a division of the data over similar categories would result in data sets too small to be usable. Instead, only two categories were made – one for the prices above the mean of 153 and one for prices below the 153. The results were plotted in the graph displayed in figure 9.

Between the rye prices below the mean and the mortality rate there appears to be no significant relationship. Some weak negative correlation can be seen in the lag of -3 until 0, which would indicate that a drop in mortality would result in rising prices several years later, perhaps as a result of rising demand. However, the relationship is not significant enough to draw a direct relationship as all correlations are smaller than 0.3. Nonetheless, the results are interesting and may indicate a minor influence of mortality rates on the rye prices.

For the price above the mean, a significant relationship can be found at a lag of 3, 4 and 5 years. The correlation is at its strongest in year 4, with a correlation of 0.57, which is a strong relationship between the rye price and mortality. When prices were high, the mortality rate would be influenced three to four years later and begin to recover five years after the high price. The relationship between rye prices and the crude mortality rate appear to be at their strongest with a lag of 4.

Price changes were again taken into consideration. However, these provided no significant results. Price changes had no relationship to the mortality rate. Only the rye prices demonstrated a correlation with mortality. As such, the hypothesis can be confirmed, although with some notes. In particular, the mortality is most affected three to four years after high prices but does not appear to be affected by low prices. A certain threshold had to be reached before prices started to affect the crude mortality rate of Amsterdam.

Figure 9: The red markings indicate the correlation above the mean, while black shows the correlation below the mean.



[64] Wrigley & Schofield, *The population history of England*, 370.

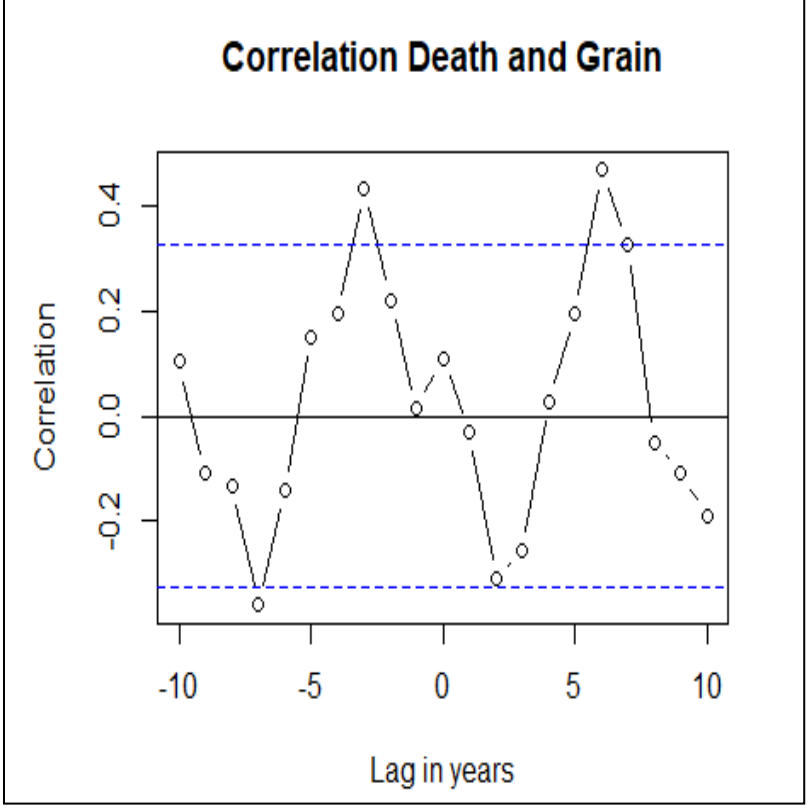
The Rye Trade-Mortality Relationship

After exploring both hypotheses, a synthesis of both can now be produced to demonstrate the relationship between the Baltic rye trade and the crude mortality rate of Amsterdam. Neither hypothesis has shown to be completely proven, but indicate a strong relationship if the right conditions are applied. A rapid change in the volume of rye that was traded indicates a significant relationship with rye prices – with a lagged effect of between two to four years. High prices have a strong relationship with the crude mortality. These conditions were considered when performing the cross correlation between the rye trade and the crude mortality rate. The results of this are illustrated in figure 10.

Figure 10 demonstrates the correlation between the rye trade and the crude mortality under the aforementioned conditions. The correlation is strongest at a lag of -3 years and 6 years, with a correlation of 0.43 and 0.47 respectively. This would indicate that under certain conditions there exists a reasonably significant relationship between the rye trade and the mortality rate. Would the correlation at -3 years indicate that mortality also has a strong leading correlation with rye trade? As figure 1 has indicates, there exists some patterns within the rye trade. The correlation at -4 is possibly the result of an echo caused by earlier rye trade patterns, which would indicate that a certain recurring cycle of rye trade occurs that affects mortality. Such a recurring cycle would be about nine to ten years in length.

There appears to be a relationship between the rye trade and mortality in the 18th century. The influence of trade was noticeable through the rye prices which in turn affected the mortality rate of Amsterdam. The effect of trade was most noticeable six years after the rye passed the Sound. Whenever the rye trade was highly volatile and rye prices were higher than average, the rye trade had a noticeable effect on the mortality rate. A possible explanation based on the data would be that the rye trade became a dominant market share and began affecting prices. If the prices were high and the amount of rye traded would suddenly drop, the mortality would rise, perhaps because no other source of rye could replace the rye delivered through the Baltic trade.

Figure 10: The Rye trade-mortality correlation with the conditions of both hypotheses applied.



Discussion

The results demonstrated a relationship between the rye trade and the crude mortality in the 18th century. However, both hypothesis and the general relationship indicate that a delayed effect took place. For the correlation between prices and mortality, this is somewhat in line with results of other studies. In the results of Wrigley and Schofield, a similar pattern of lag was noted for the price-mortality relationship. [65] However, their results were most significant at a lag of 2, whereas the price-mortality relationship in Amsterdam was determined at a lag of 3 or 4. A possible explanation for this difference is that prices indirectly affect the mortality. As Post argued, the high prices did not cause immediate death through starvation but led to increased social contact that facilitated the spread of diseases. [66] Different social and cultural practices in England and Amsterdam may have resulted in an additional delay of a year before mortality was brought about in Amsterdam.

The difference between the effect of the rye price above the mean and the rye price below the mean can be partly explained because of the wheat preferences of the Dutch in Amsterdam. The Dutch preferred to eat wheat above rye and were more inclined to buy wheat instead of rye if they could afford to do so.[67] This meant that a drop in rye prices would result in the ability to purchase more wheat. However, rye was the poor man's grain and a high price for rye meant a Dutch citizen was unable to buy any grain, which is reflected in the strong relationship with the mortality rate.

The relationship between rye prices and mortality has also been demonstrated to not be a direct correlation. Rye prices alone could not account for the mortality of the population of Amsterdam. Smallpox was a frequent visitor to Amsterdam.[68] High prices caused people to move around to find a way to survive. The social unrest in combination with the frequent arrival of smallpox accounted for some of the mortality. Another epidemic that might have worked in tangent with high food price is malaria. Malaria outbreaks combined with high food prices could result in high mortality. [69] Such an outbreak would also explain the delayed effect. Adapting to higher rye prices may have brought a segment of the population more frequently into contact with malaria mosquitoes.

The relationship between rye trade and prices draws a complicated picture for the importance of trade for Amsterdam. As shown in the hypothesis on trade-price correlations, the grain trade did have some importance to Amsterdam. A high volatility would be a strong determining factor in setting prices, though a more or less stable market did not affect prices as significantly. It would indicate that neither Tielhof nor Israel were accurate regarding the importance of trade or lack thereof. Rather, the rye trade is significant if it abruptly rises or falls. As this paper only examined the rye trade, and not the entirety of Baltic trade, it does not negate the position of Tielhof or the position of Israel. Rather, it shows that Baltic trade was dynamic and somewhat complex. Thus, the relationship between trade and mortality is not straightforward. Rather than being a direct result of trade, mortality is the result of a set of factors that work in conjunction with each other.

[65] Wrigley & Schofield, *The population history of England*, 374-375.
[66] Post, 'The mortality crises of the early 1770's', 47-48.
[67] De Vries en Van der Woude, *The first modern economy,* 686.
[68] Rutten, *De vreselijkste aller harpijen*, 82.
[69] De Vries & Van der Woude, *The first modern economy,* 49.

Conclusion

At the onset of this paper, the question was asked what influence the Baltic grain trade had on the mortality of Amsterdam in the 18th century. The short answer would be as follows: 'about 0.47'. The full answer would be that a relationship between specifically the rye trade and the crude mortality rate is present and that trade has some influence but is dependent on specific conditions. It was not a clear and direct relationship. Close examination of the trade and mortality required the rye prices to act as the variable.

The relationship between the amount of rye traded and the rye prices in Amsterdam was not immediately apparent in the 18th century. An initial correlation calculation demonstrated no direct relationship between the rye trade and the rye prices. Exploration of whether the relationship had a lag showed the same answer: no immediate effect could be found. However, yearly changes in the rye trade demonstrated greater promise. A more significant relationship was present when trade either rapidly increased or fall, indicating that the price of rye was not determined by trade volumes but rather by the volatility in which the rye trade was conducted. When trade rose exceptionally high, it would correlate with the rye price three years later. When trade dropped rapidly, it would be reflected in the prices two years later. Spikes of trade that quickly collapsed had thus a stronger correlation with prices two to three years later.

Contrary to the correlation between rye trade and rye price, the correlation between the price and the crude mortality rate of Amsterdam was seen more clearly. Already during the initial correlation calculations, it was apparent that a small but significant correlation exists between the rye prices and mortality. Further calculations indicated that the correlation was exceptionally strong if the prices were higher than average. High rye prices would correlate strongly with the crude mortality rate three to four years later. Contrary to the rye trade-price correlation, the price changes did not appear to affect the crude mortality rate. The law of La Michodière did, to some extent, apply to Amsterdam: high prices correlated with the mortality, though low prices did not correlate with mortality.

Neither correlation met with the initial expectations of the comparison. The only correlations that were present existed under specific circumstances. The combination of both correlations had to consider these two circumstances and set them as conditions. A correlation between rye trade and mortality would therefore require two things. First, it would require the trade volumes to be volatile, fluctuating at a considerable pace, which it did quite frequently in the 18th century. Second, rye prices had to be above the average prices to correlate with mortality. If those conditions were applied, the rye trade would have a significant impact on the mortality rate of Amsterdam. If trade spiked and collapsed, mortality would rise five to six years later.

Mortality was not dependent on rye prices alone. Other factors, such as smallpox epidemics, also played a role. Rye prices were mostly a secondary factor leading to causes of mortality but never directly linked to it. High rye prices could lead to social unrest, vagrancy and migration, which led to a spread of diseases in the hungry populace, although the effect was never immediate.

This paper focused on the mortality rates of Amsterdam. High prices had a profound effect while low prices demonstrated no effect. For future research, it might be worthwhile to also examine the effect of low rye prices on the fertility of the Dutch population and whether the high prices caused a low fertility, and whether this caused the stagnation of Amsterdam in the 18th century.

While the influence of trade on mortality would only show under certain conditions and other factors played a part in the mortality, the rye trade was still an important factor. Rather than having an immediate effect on mortality, the rye trade was an underlying factor that affected mortality. The effect was never immediate and with stable trade likely never present. However, the Baltic rye trade to Amsterdam was not stable in the 18th century and its spikes had an influence on mortality. Though never direct, the influence of trade was noticeable and present in the mortality rate of the population of Amsterdam. Whether they had realized it or not, the merchants crossing the Sound had made trade a matter of life and death in Amsterdam.

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