



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

Economic History Working Papers

No: 236/2016

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WORKING PAPERS
NO. 236 - FEBRUARY 2016

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Abstract

This paper addresses two questions. First, when and to what extent did capital markets integrate north and south of the Alps? Second, how mobile was capital? Analysing a unique new dataset on pre-modern urban annuities, we find that northern markets were consistently better integrated than Italian markets. Long-term integration was driven by initially peripheral places in the Netherlands and Upper Germany integrating with the rest of the Holy Roman Empire where the distance and volume of inter-urban investments grew primarily in the sixteenth century. The institutions of the Empire contributed to stronger market integration north of the Alps.

Keywords: capital markets, market integration, early modern Europe
JEL Codes: N23, N93

¹ We would like to thank the Leverhulme Trust for funding the research (grant RPG-133), and Alexandra Sapoznik and Angela Ling Huang for collecting and preparing the archival data. The paper benefitted from critical comments from participants at the EHES Conference in Pisa, the Symposium in Business and Economic History in Lisbon and the Berlin Colloquium in Economic History at Humboldt University.

Introduction

In June 1437, Hans and Else Ketzels, burghers of Nuremberg in Franconia, concluded a contract with the town of Schweinfurt. In confirmation, they received a document which solemnly noted that ‘we, the members of the council and likewise all other burghers, rich as well as poor, of the town of Schweinfurt confess openly with this letter on behalf of ourselves, all our heirs and descendants that we sell ... 50 guldens of good usual Rhenish money, current and common in this land of Franconia, as yearly and perpetual interest and rent, for 900 guldens of the above mentioned currency, which we have completely and entirely received from the buyers, whom we therefore hold for free and absolved of all obligations ...’ and so on, in yet more resounding phrases that were to make the contract unambiguous and legally watertight (Winter 1970: 129). The document testified that the Ketzels had ‘bought a rent’, as it was called: They had lent 900 rhineguldens to Schweinfurt, a place quite distant – about 100 kilometres – from their home. In return, they and their descendants in perpetuity received a title to a yearly pay-out of 50 guldens. This was a tidy sum: The annual salary of Nuremberg’s chief justice was about as high.² The Ketzels had done well for themselves. Schweinfurt, too, had done well. A few generations earlier, when interest rates were higher than the c. 5.5 per cent the town’s burgomaster and council agreed with the buyers, the town would have had to offer annuities far in excess of 50 guldens in return for a loan of 900 guldens. The case serves to illustrate what this paper is about: inter-urban investment and the integration of pre-modern capital markets.

Historical research has considered contracts such as that of the Ketzels in Schweinfurt from a number of angles, examining for example the social background of the buyers of rents and the role such instruments played in constitutional development and public finance

² Salary c. 1440: £65.13s.0d. p.a. (Sander 1902: 202); exchange rate 1437: 1 rhineguldens = £1.5s.3d. (Scholler 1916: 239). For the patrician Ketzels family see Aign (1961).

(Gabrielsson 1971; Sprandel 1971; Rosen 1978; Gilomen 1982; Alter and Riley 1986; Brown *et al.* 2001; Tracy 2003; Poitras 2006; Zuiderduijn 2009; van der Heiden 2006).³ Our questions are different: We ask first, to what extent did urban capital markets integrate in the long run? And, second, how mobile was capital between markets? As money had a favourable weight-value ratio, transport costs played a small role for the integration of capital markets. Transaction costs, by contrast, which are widely seen as the key determinant of pre-modern growth but are notoriously hard to measure (North and Thomas 1973: 52; North 1987: *passim*; Epstein 2000: 152; Volckart 2002: 15, Wang 2003: *passim*), were relatively more important than in practically any other market. Hence, examining capital market integration sheds light on how these costs developed.⁴ Compared to previous studies of pre-modern financial markets, the scope of analysis is greatly expanded: we draw on a new dataset of about 29,000 interest rate observations from between the fourteenth and eighteenth centuries.⁵

We consider markets from across the Holy Roman Empire north of the Alps, augmented by a few in eastern France where urban annuities first appeared in the thirteenth century. The patterns identified in these regions are contrasted with evidence from Italy where an open market developed from the sixteenth century.⁶ Comparing these regions is exceptionally fruitful. Italy gave birth to a large number of financial innovations that earned it the

³ Bateman (2012: 120) looks at a few scattered spreads in the cost of capital across Genoa, the Low Countries, England and Germany that suggest that capital markets were integrated by the fifteenth century.

⁴ The main proxy of transaction costs used by pre-modern historians is, of course, the interest rate. As North (1990: 69) puts it: the interest rate provides ‘the most evident quantitative dimension of the efficiency of the institutional framework’. Spreads between them have the advantages that they are in some respects more precise (they do not directly depend on other factors, like e.g. wealth, economic growth or taxation cf. Gelderblom and Jonker 2004, 2011; Dinuccio 2009) and capture the spatial dimension of transaction costs.

⁵ Most of these studies focus on selected pairs of markets, such as Flanders-Lübeck in the fifteenth century (Volckart and Wolf 2006) or London-Amsterdam in the eighteenth century (Neal 1987). Exceptions are Chilosi and Volckart (2011), who examine the Holy Roman Empire in the fifteenth century and Flandreau *et al.* (2009), who analyse the European money market in the eighteenth century.

⁶ The term ‘Empire’ is used with reference to the Holy Roman Empire north of the Alps and, unless stated otherwise, includes also a few markets in eastern France close to the Empire’s border.

reputation as the financially most advanced part of Europe until the seventeenth century. By contrast, the historiography tends to regard Germany as financially backward (de Vries 1976: 221; Denzel 2008: 105 f., 121). Politically, the Empire and Italy give a superficially similar impression of having been fragmented. However, from at least the early sixteenth century onwards, the Empire had an overarching constitutional structure – embodied in central institutions such as the Imperial diet, the high courts of justice and, after the Thirty-Years War, the Imperial debit commissions – from all of which the Imperial fiefs in Italy were as much excluded as the rest of the Italian peninsula. Moreover, in the Empire non-state forms of political organisations such as urban leagues survived for much longer than elsewhere in Europe (Spruyt 1994: 109 ff.). Analysing capital markets in this setting allows gauging the potential effects of institutional differences on capital market integration.

The new interest rate data are presented in Section 2. Section 3 examines trends in the development of interest rate spreads, which in the long run shrank only north of the Alps. In Italy, integration was much weaker. Section 4 analyses where investors in the Empire came from and how much capital they invested. The key finding here is that both the distance and size of investments grew at the same time as the spreads between distant places declined. The regional analysis (Section 5) finds that northern capital markets had a number of centres. The cluster of cities around Lübeck and Hamburg was particularly developed. The long-term erosion in interest differentials north of the Alps was in the main driven by integration between initially peripheral markets in the Netherlands and Upper Germany with the rest. Section 6 argues that competition for capital between cities under the constitution of the Holy Roman Empire is a likely cause of capital market integration. Section 7 concludes.

Data and Sources

Most of the primary data used here have been collected from archival sources (Appendix B). The analysis is based on urban life-annuity and perpetuity contracts of the kind which the Ketzels and the town of Schweinfurt entered into. The two types of contract differed in that perpetuities were paid for an indefinite period and could be bequeathed, whereas the payment of a life-annuity stopped with the death of the beneficiary. As commonly the price of neither was related to the age or health or any other biological characteristics of the buyer,⁷ the ratio between the yearly pay-out and the purchase price equals the interest rate.

The analysis uses nominal rates because price data sufficient to compute real rates are available only for a small number of cities. Using these to deflate all interest rates in the sample would introduce severe distortions. Moreover, pre-modern investors usually lacked the information needed to anticipate price changes. When deciding where and at what interest to invest their capital, they took into account nominal rather than real rates (Chilosi 2014: 903).⁸

Pre-modern life-annuities and perpetuities may sometimes have been sold below or above par. For the present analysis, this matters little. Where Germany is concerned, the data used stem from actual sale of annuities or perpetuities. Unless discounts were concealed in some unknown fashion, they therefore provide information about market yields. In most cases, these were primary yields. German urban authorities were selling annuities not only in times of fiscal need or when there was a particularly strong demand by prospective buyers but continuously. Moreover, both the law codes of many German cities and the contracts

⁷ We found only very few exceptions and excluded these instances.

⁸ Price indices reveal that in the long-run pre-modern price movements were similar over relatively large areas, with common shocks, like the 'price revolution' of the sixteenth century, trumping synchronic differences (cf. Allen 2001: online database; Malanima 2002: Appendix). Hence, differences between local inflation rates do not materially affect the picture.

themselves made redeeming invested capital relatively easy.⁹ Investors therefore faced few incentives to sell their annuities at a discount or buying them at a premium on the secondary market, and where there was a secondary market it is likely that rates paid there did not differ much from primary yields.¹⁰ Where non-German – i.e. for example Dutch or Flemish – markets are concerned, the analysis also includes rates determined by law and published in edicts. This, too, seems unproblematic because whenever it is possible to compare such rates with those paid on the market, both match.¹¹ Finally, Chilosì (2014: 889 ff., 2015: Section 5) has shown that if the issue arose in Italy, it affected forced loans far more than openly sold rents. Rates derived from forced loans were not used here.

Sometimes authorities taxed the pay-out of annuities or offered benefits to buyers. As a rule, and in the interest of data comparability, we excluded those observations where taxes or subsidies made a difference that was impossible to measure precisely. It is only in Nuremberg and Brunswick that the evidence allows assessing this difference at least for some periods. In Nuremberg, taxation affected annuities in different periods to a different extent, with a stable ratio of around 1:1.21 between untaxed and taxed rates existing only between 1490 and 1500. In Brunswick life annuities were exempted from taxation and other civic burdens, but this had a tiny impact on interest rates. We compared 186 rates on such annuities from between

⁹ Gilomen (1984: 195 f.); Hanover City Archives, NAB 8242; Urkunden Abteilung III.

¹⁰ The sale of annuities is documented in sources from as early as the thirteenth century; in Lüneburg, Hamburg and Bern urban public annuity letters gave the right to sell on the secondary market since the second half of the fourteenth century (Gilomen 1984: 193 ff.). We have been able to compare 23 yields from the same place and year on the primary and the secondary markets. The yields are from Nuremberg, Hanover and Münster between 1412 and 1680. Hanover City Archives, NAB 8242, p. 127/3 & 202/2, 441/1; Münster City Archives A IX 139 & 392, 393 & 395; State Archives Nuremberg, Bestand Losungsamt, vol. 69, fol. 66v, 80v, 81v, 91r, 133v, 217r, 219r, 220r, 222r; vol. 70, fol. 9r-v, 11r, 93v, 106r, 109r, 115v, 117r, 121r. Differences between yields on the primary and secondary market are on average 0.28 percentage points. Feenstra (2014: 15 f.), too, finds that for bonds issued by the Dutch province of Zeeland in the second half of the eighteenth century the secondary market yields were very close to the official rates.

¹¹ The markets in question are Lille and Amsterdam.

1396 and 1590 and found that tax-free rates differed on average only by 0.37 percentage points from others.¹²

As a measure of capital market integration, the dispersion of yields has two limitations. First, similar conditions of supply and demand can produce similar interest rates even if there is no arbitrage between markets. It is therefore useful also to analyse capital flows.¹³ Such flows highlight that, despite most transactions being local, cities within the Empire were linked through fairly dense ties. Thus, the twelve best-covered cities in the sample show a network density – i.e. a proportion of actual to potential links – of 42 per cent. This is a much higher value than that of the mid-eighteenth century European money market (12 per cent, Flandreau *et al.* 2009: 160) and roughly matches that existing between nation-states in today's bond market (57 per cent, Schiavo *et al.* 2010: 392).¹⁴

The second issue is that inter-urban differences in yields may reflect not only transaction costs between markets but also differences in the risk of default. However, if cities discriminated between domestic and foreign investors, exposing them to *different* risks, as was often the case in Italy, then the differences between the risk premia did indeed become part of inter-urban transaction costs.¹⁵ The main types of data sources are shown in the following table (Table 1):

¹² In the other places, we had to assume that the pay-out was not affected by taxes or benefits. While violations of this assumption are bound to create noise, this should bias the results *against* finding that capital markets in the Empire were well-integrated.

¹³ See Sections 4 and 5.

¹⁴ The analysis is based on the 12 cities with at least 80 observations on the origin of foreign investors (Basel, Bremen, Brunswick, Erfurt, Frankfurt, Halle, Hamburg, Hanover, Hildesheim, Leiden, Lüneburg and Nuremberg). Although this sample is biased towards North Germany, it includes important centres from other areas and mitigates the negative bias on the connectivity implied by failure to record existing links. The network distance (the average number of links one needed to pass to reach another node) for the same sample is 1.6, after excluding Leiden which had only indirect links (through Amsterdam) with the main network. This figure also signals a dense network: Most cities were connected either directly or through a third place.

¹⁵ Moreover, in the sample used here differences in risk should be relatively small or at any rate stable: The focus on urban annuities implies a similar institutional setting across places and typically political regimes only rarely change.

Table 1: Observations by source type and annuity type

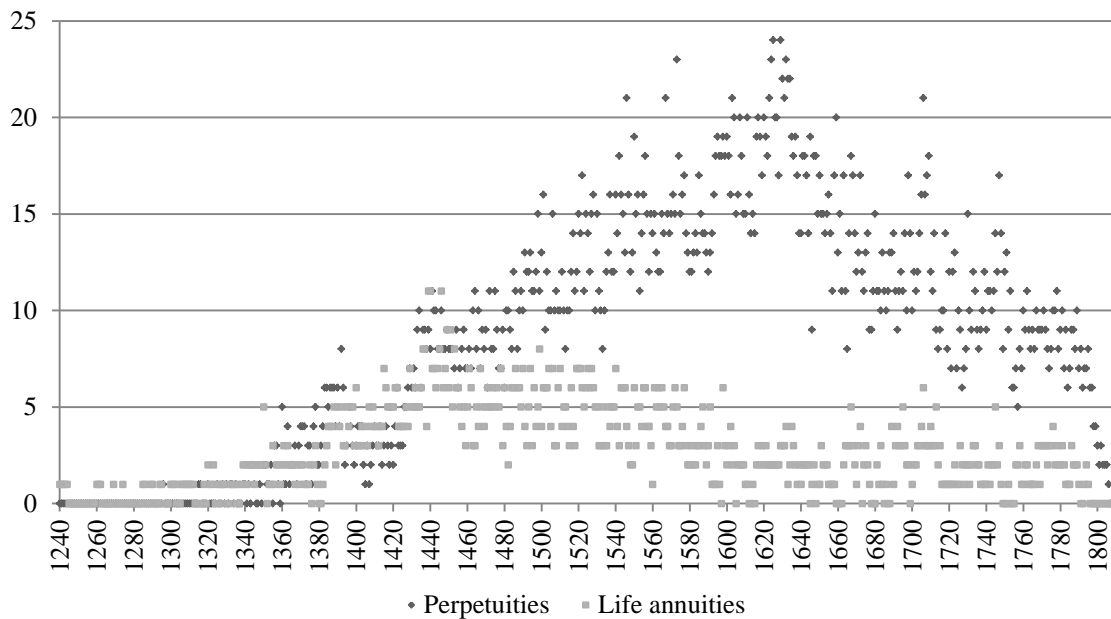
Annuity Type	Perpetuity	Life Annuity	Total
Source Type			
Letters	9,179	1,422	10,601
Ledgers	6,862	719	7,581
Urban Accounts	5,001	2,820	7,821
Edicts	360	78	438
Secondary sources	2,272	314	2,586
Total	23,674	5,353	29,027

Sources: Appendix B.

Letters contain the most comprehensive information. They state the contract, and margin and dorsal notes sometimes give additional information, e.g. on later changes and redemptions. Ledgers, including all books and documents kept to administer urban annuities, are the most heterogeneous type of sources. At best, they record all sold annuities, briefly listing the conditions of the contract, as well as transfers, conversions and redemptions (e.g. the Nuremberg ledgers). However, most ledgers contain only partial information on the contract and its history. Pay-out ledgers, for example, sometimes omit the original interest rate but record a later conversion. In a few cases, we had to infer the date of the conversion by checking whether different types of sources were consistent with each other. Urban accounts record sold annuities as part of the revenues of a town. As several departments in urban administrations could sell annuities, the main accounts (that we predominantly used) do not necessarily document all annuities sold in a year. They contain only very brief information on the contract, stating the name, capital and pay-out or interest rate, sometimes the date, but mostly only the fiscal year. In such cases we assumed that the annuity was sold in the first calendar year (e.g. when the fiscal year was 1525/26, we assumed the sale to have taken place in 1525). Data from edicts that reported the official rate and (in varying levels of detail) the conditions of purchase were included from Northern France, the Netherlands and Italy only.

As there were few cases where it was possible to identify the date of a transaction with greater than yearly precision, the analyses uses yearly means. Figure 1 shows their distribution over time, distinguishing between life annuities and perpetuities.

Figure 1: Interest rate observations (yearly means), 1240-1809: temporal distribution

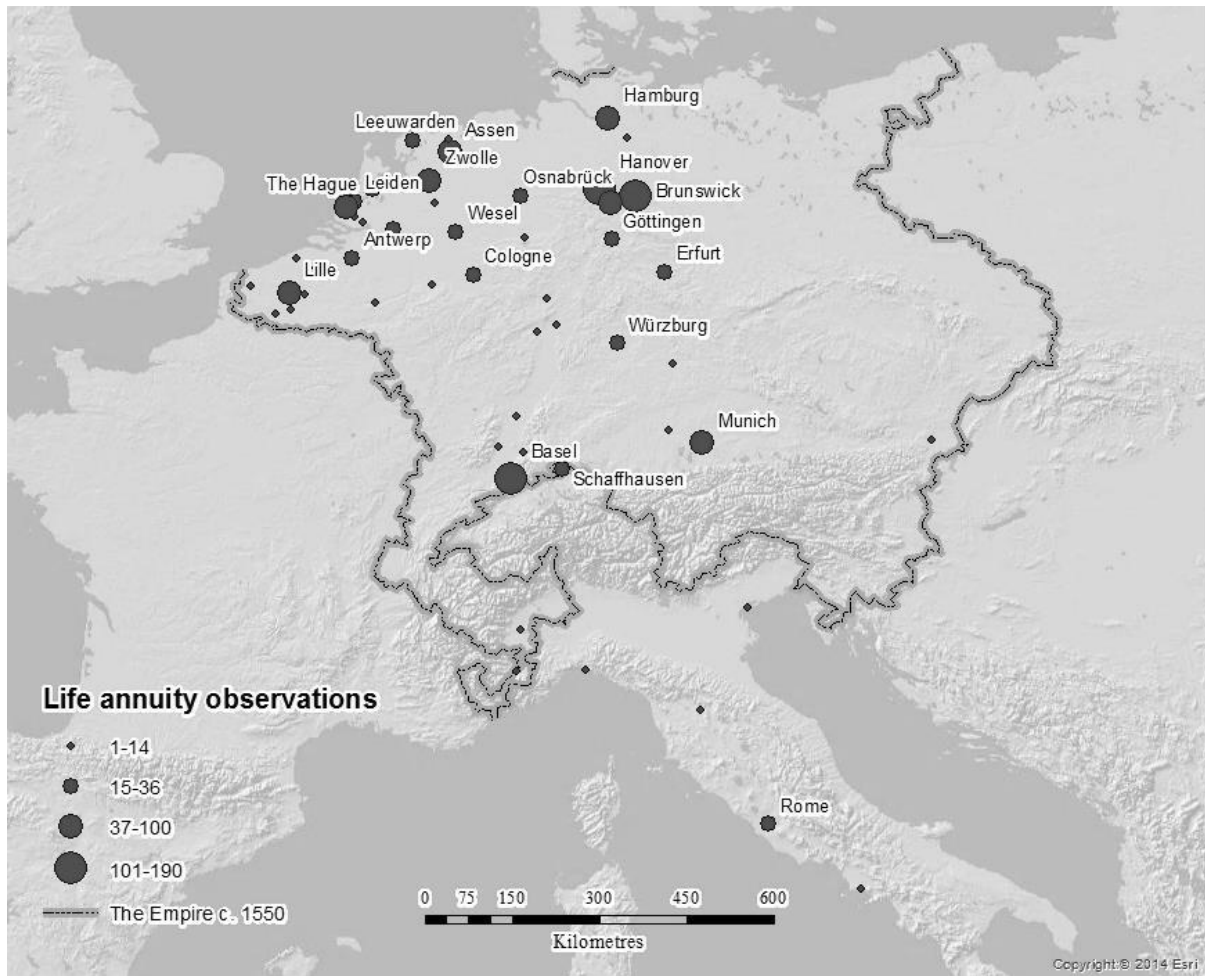


Sources: Appendix B.

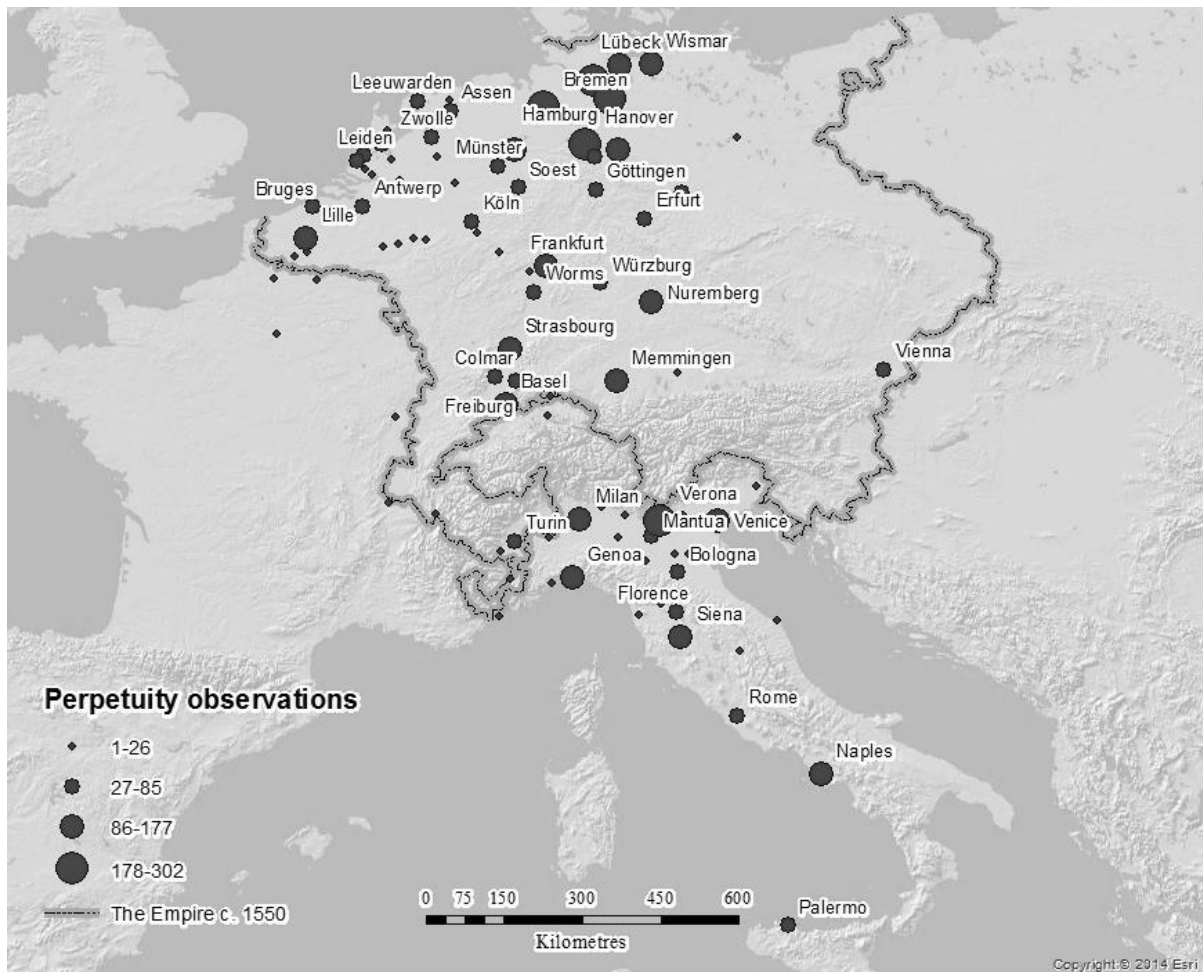
Altogether, there are 4,865 yearly means for perpetuities and 1,520 for life annuities. While in the very early stages of development life annuities were the more important instrument, over time they became less popular. Possibly this reflected a learning process on the part of the sellers: Perpetuities did not require the authorities to periodically check that the beneficiary was still alive and therefore implied lower administrative costs than life annuities. The data allow analysing the spreads between local yields from the first half of the fourteenth century onward. There is an increasing number of observations from the fifteenth and even more from the sixteenth century, when Italian data join the data set. However, the number of observations declines for the eighteenth century, when there are fewer surviving data from the Empire than before. Cities at that time lost their fiscal autonomy and ceased raising urban debts. Figure 2 shows the geographical distribution of the yearly means.

Figure 2: Interest rate observations (yearly means), 1240-1809: geographical distribution

a) Life annuities



b) Perpetuities



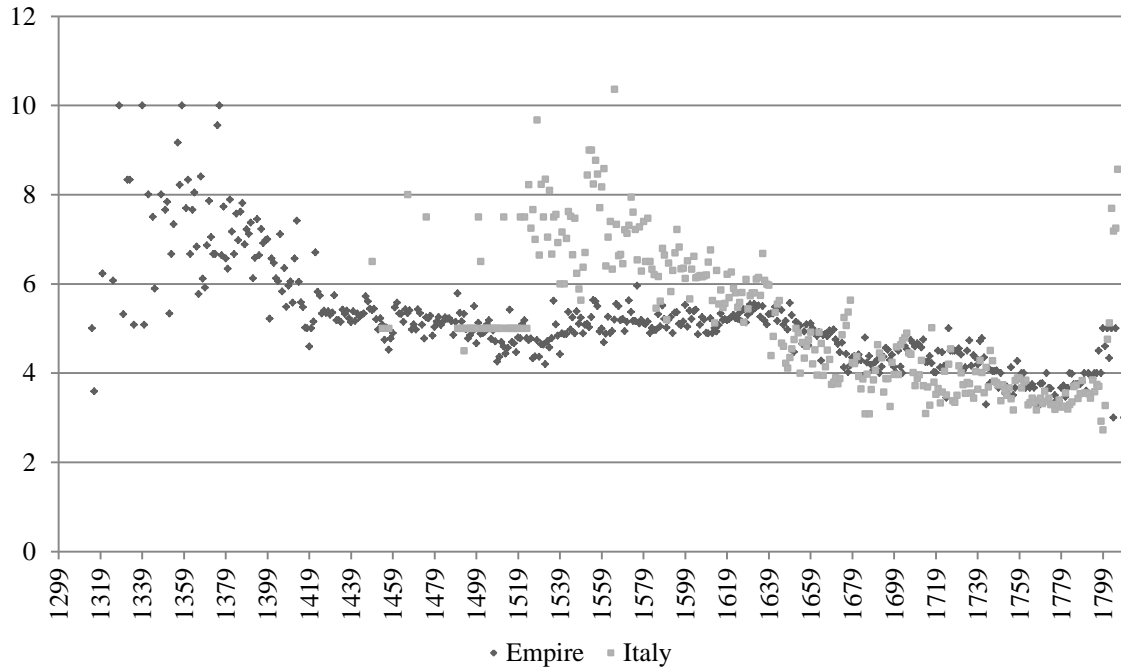
Sources: Appendix B.

The interest rates are from 103 cities, 72 of which are located north of the Alps and 32 in Italy.¹⁶ While the coverage is uneven, the archival research allowed extending it far beyond what was available to previous studies of urban annuities or pre-modern financial integration in Europe. The north of the Empire is particularly well-covered, as are Central and Northern Italy. Figure 2 a) also shows that life annuities were clearly much less common in Italy than north of the Alps. For this reason, life annuities are examined only for the whole sample and the northern sub-sample.

¹⁶ While Chambery is beyond the Alps, it belonged to Savoy. Thus, the data for Chambery are used to investigate patterns of capital integration both in Italy and north of the Alps.

Figure 3 shows how the nominal yield on perpetuities developed north and south of the Alps.¹⁷

Figure 3: Nominal interest rates on perpetuities in the Holy Roman Empire and Italy, 1296-1809 (yearly means, in per cent)



Sources: Appendix B.

In the long run nominal interest rates in the Empire declined, though in contrast to what prior research implied (Homer and Sylla 2005: 135, 153, 176), their fall was not steady. Two periods of decline stand out particularly clearly: the early fourteenth to the early fifteenth and the second half of the seventeenth centuries. In between and after these periods the rates stagnated. Italian interest rates, by contrast, fell continuously from the late fifteenth and early sixteenth to the late eighteenth centuries. Despite the country's precocious financial development in the middle ages, their initial level was much higher than north of the Alps. However, they reached values lower than those in the Empire in the mid-seventeenth century and from then on stayed slightly lower until the end of the period analysed here.

¹⁷ The results are robust to controlling for potential bias due to composition effects by including fixed effects. The rates paid on life annuities show a similar pattern.

Integration Trends: North versus South

The standard measure of price or interest rate dispersion used in historical studies of market integration is the coefficient of variation: The smaller it is, the more alike were local interest rates and the greater the level of integration. However, as the coefficient is affected by changes in the sample's composition of markets, gaps in the interest rate series may introduce a bias. To address this issue when considering trends, we use city fixed effects and regress the absolute value of the natural logarithm of the ratio between the interest rate in each market and the average interest rate on a time-trend (Table 2).¹⁸ The result shows that the initial spreads were much larger in Italy than in the Empire. Moreover, the yearly rates of change and the associated cumulated changes indicate a long-term advance in integration north but not south of the Alps.

Table 2: Long term trends in capital market integration

Sample	Asset	Years	Sample size	Initial spread	Yearly rate of change*100	Cumulated change*100
All	Perpetuity	1344-1805	4837	1.198	-0.002	-1.10
All	Life annuity	1320-1794	1412	1.142	-0.011***	-5.29
Empire	Perpetuity	1344-1802	3428	1.170	-0.014***	-6.00
Empire	Life annuity	1320-1794	1330	1.144	-0.015***	-6.97
Italy	Perpetuity	1493-1800	1365	1.247	0.008	2.55

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level.
City fixed effects.

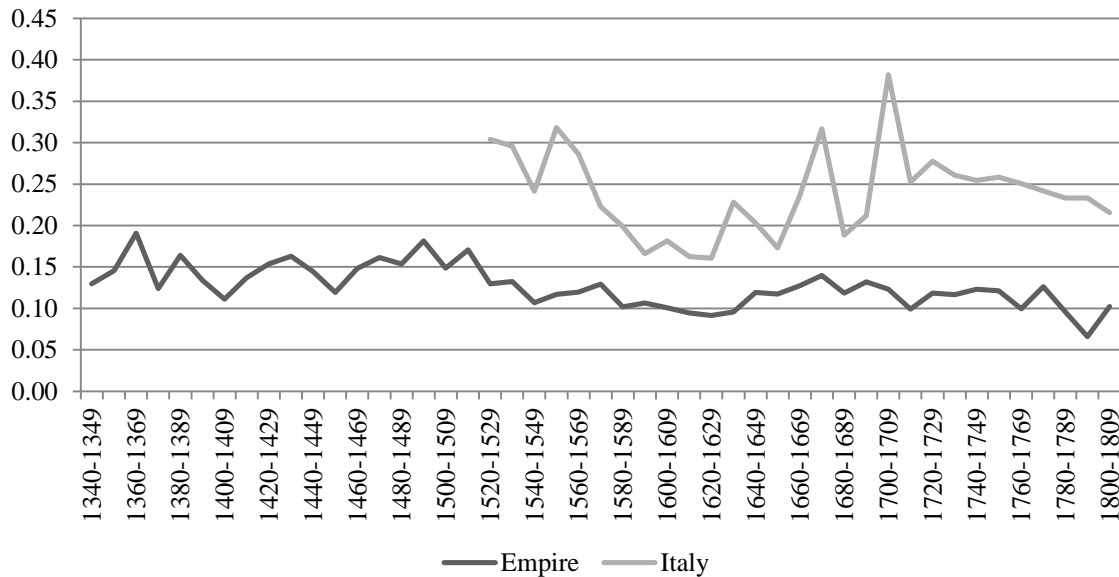
Sources: Appendix B.

Long-term trends such as these may obscure non-linear patterns of convergence and divergence. To examine such patterns, we use again a fixed effects panel analysis of the dispersion around the mean, but now with 10-years dummies rather than a time trend (cf.

¹⁸ Here and subsequently, 'spread' or 'ratio' refers to the exponent of the dependent variable, unless otherwise indicated. The alternative use of pairwise spreads produces similar results.

Bateman 2011). As the analysis requires a large sample, we consider perpetuities only (Figure 4).¹⁹

Figure 4: Capital market integration in Italy and the Empire: panel trends (logs of the spreads around the mean)



Sources: Appendix B.

While in both regions spreads shrank in the sixteenth and grew in the seventeenth century, in Italy they were always much larger than in the Empire. Further, fluctuations tended to be significantly less strong north of the Alps. Both findings suggest that northern capital markets were significantly better integrated than those in the supposedly more developed south.

In Italy differences between local risk-levels contributed to keeping spreads large. Assets issued in the Spanish territories (the Duchy of Milan and the Kingdoms of Naples and Sicily) were particularly risky (Chilosi 2014: 900). Still, even if observations from these territories are excluded, in Italy spreads remain wider than in the Empire.²⁰ The difference is especially startling considering that the average distance between the cities north of the Alps in the

¹⁹ For the same reason, we neglect the few isolated instances of Italian perpetuity issues from before the 1520s.

²⁰ In some respects the Italian sample is also comparatively heterogenous in terms of assets; thus, it was not always possible to identify the term of the *monte di pietà* deposits; yet excluding these assets and the *censi* does not significantly alter the patterns observed.

sample (379 km) is much larger than that between the Italian cities (280 km). Looking at where the owners of the debts came from confirms that the Empire was better integrated than Italy. In the middle ages, bonds issued by the Italian city-states were mostly held locally (Molho 1995: 107 f.; Pezzolo 2005: 156 f.). Capital flows between Italian cities did intensify in the early modern era, but most bonds still remained in local hands. The Italian city where foreigners owned the greatest share of the debt was probably Venice: By the later seventeenth century, about one-third of its debt was owned by people from outside the republic, mostly from Genoa (Felloni 1971: *passim*; Masini 2007: 205 ff.; Stumpo 2007: 149 ff.). By contrast, in Flanders, Holland and Germany a large part of the urban debt – half or more – was owned by non-locals from the very beginning (Fryde and Fryde 1963: 528 f., 540, 545, 547, 553; Munro 2007: 10, 21 f.; Zuijderduin 2009: 178 f.).

Capital Flows and Distance

How large were the distances over which investors in the Empire placed their capital, and how did these distances and the invested sums change over time? For 52 markets north of the Alps, the sources contain information on the origin of investors from other places. After excluding trivial links with markets within their hinterland,²¹ we retain 4,541 observations of inter-city investments across 915 city pairs. Comparing investments from different periods requires converting the invested sums into some constant measure. This measure is the cost of a yearly ‘respectable’ consumption basket.²² Excluding those cases where missing capital or (in a few instances) coinage data prevented conversion, the analysis builds on 4,095

²¹ A place is considered to belong to the hinterland of the closest other place that had at least 5000 inhabitants at some point in time during the period covered here (1228 to 1802). There are 670 observations referring to villages within the hinterlands of our cities; the average distance from the city is 20 km; the maximum is 56 km.

²² The consumption basket is based on price data from Strasbourg which are the most comprehensive of all price series available for the Empire (1326-1875). We used a smoothed trend obtained with an Epanechnikov kernel for the conversions. To avoid boundary problems, London price data have been used for extrapolating the series backwards to 1264, the first year London prices are available for. Both the Strasbourg and the London price indices are from the Allen (2001) database.

investment observations. A first way to gain insights into how capital flows evolved is to investigate trends in the distance and size of investments. To control for changes in the composition of the sample over time, as before, we run fixed-effect panel regressions of the natural logarithm of the yearly means against a time-trend (Table 3).

Table 3: Inter-city investment in the Empire: trends in average distance (in km) and average capital invested (in consumption baskets)

Variable	Years	Sample Size	Yearly rate of change*100	Cumulated change*100	Initial value	Final value
Distance	1228-1802	1434	0.159***	148	47	116
Capital	1328-1798	1320	0.222***	183	31	87

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level. Importer city fixed effects.

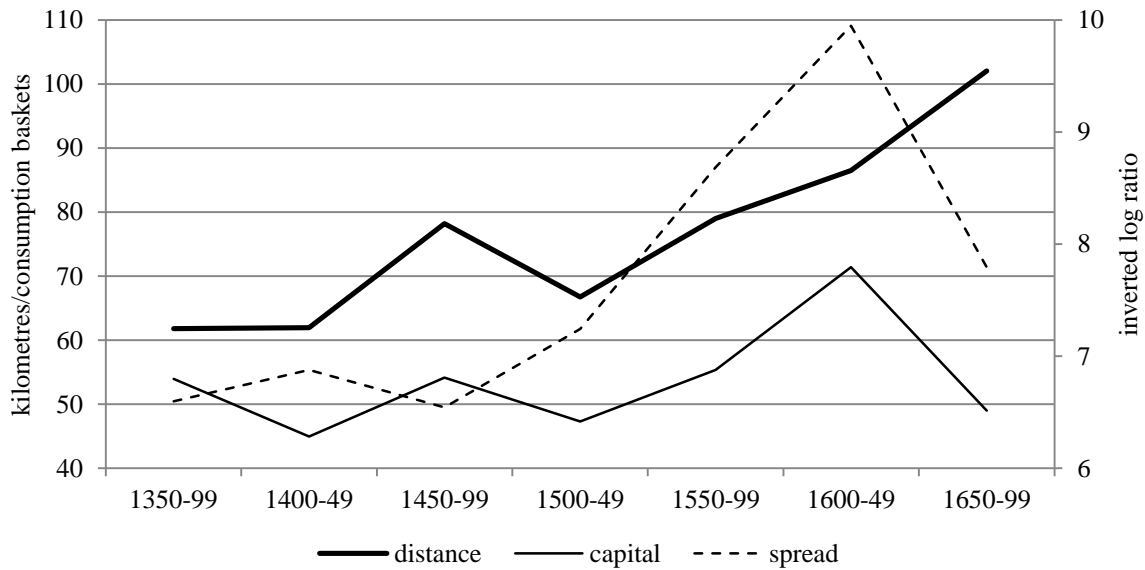
Sources: Appendix B.

Clearly, in the long run the distance and size of investments grew significantly: The average values of both are more than twice as large at the end of the period under study as at its beginning. This supports the finding that the Empire's capital markets became increasingly integrated. The analysis also reveals that while most investors placed their capital relatively close to home, the sums in question were anything but small. On average and at the prevailing interest rates (see Figure 3), the yearly return on the sums invested in perpetuities was sufficient to feed, clothe and house about three people, i.e. a small family.

To gauge *when* the distance and size of inter-city investments grew, we regress their means against 50-years dummies that cover the period 1350-1699 (there are not enough eighteenth century observations to produce reliable estimates).²³ The trends so obtained are compared with the inverted trend of the spreads within the Empire, where a higher value signals increased capital market integration (Figure 5).

²³ As these variables are much more volatile than the spreads, more observations are needed to produce reliable estimates, which is why 50-years rather than 10-years dummies are used here. For distance, there are only 18 means in 1700-1749 and 8 means in 1750-1799 as compared to 68 in 1650-1699 and 297 in 1550-1599.

Figure 5: Inter-city investment in the Empire: trends in distance (in kilometres) and capital (in consumption baskets) compared to the spread (inverted log ratio)



Sources: Appendix B.

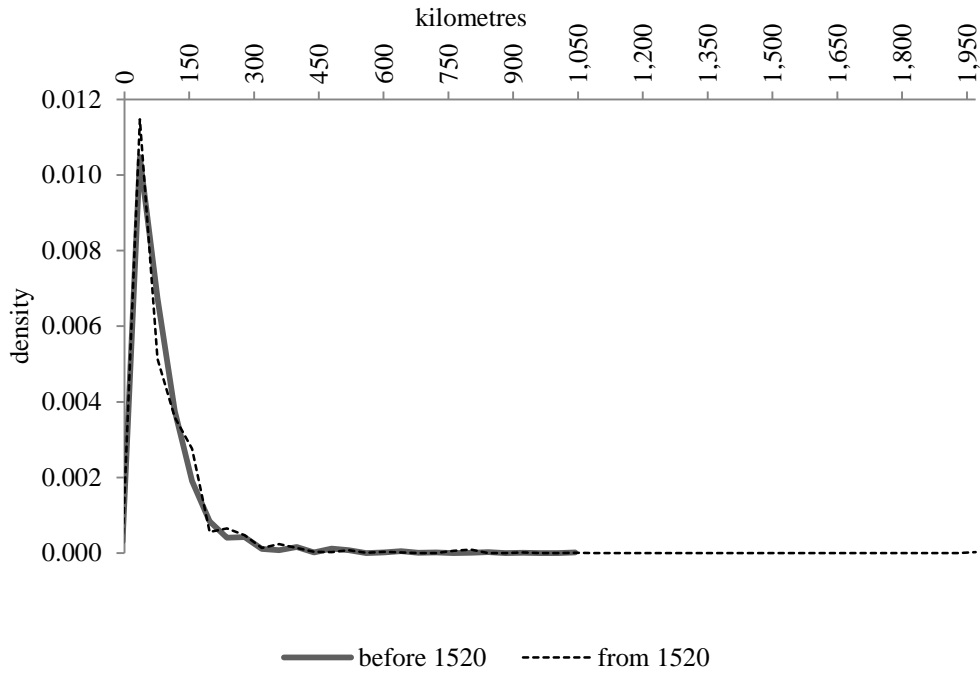
From the early sixteenth to the first half of the seventeenth century, there seems to be a fairly close association between a decline in interest-rate differentials and a growth in both the invested sums and the distance of investments. In the second half of the seventeenth century, however, the capital figures and the spreads indicate disintegration – the distance measure does not. A likely explanation of this pattern can be found in the in the spatially uneven effects of the Thirty-Years-War. The demand for capital probably grew relative to its supply as the need to finance post-war reconstruction led to a decline in sums invested in the bond market. At the same time, distances over which capital was placed continued to increase as urban authorities - in the face of diminished local supply - were seeking to attract capital from farther away, i.e. areas less affected by the war.

Another way to gain insights in how inter-city investment developed is to compare how distance and capital were distributed in the periods before and after 1520, as estimated by Epanechnikov kernels (Figure 6). 1520 is a suitable cut-off point because the year marks the start of the sixteenth-century spurt in convergence between interest rate spreads. Moreover, it

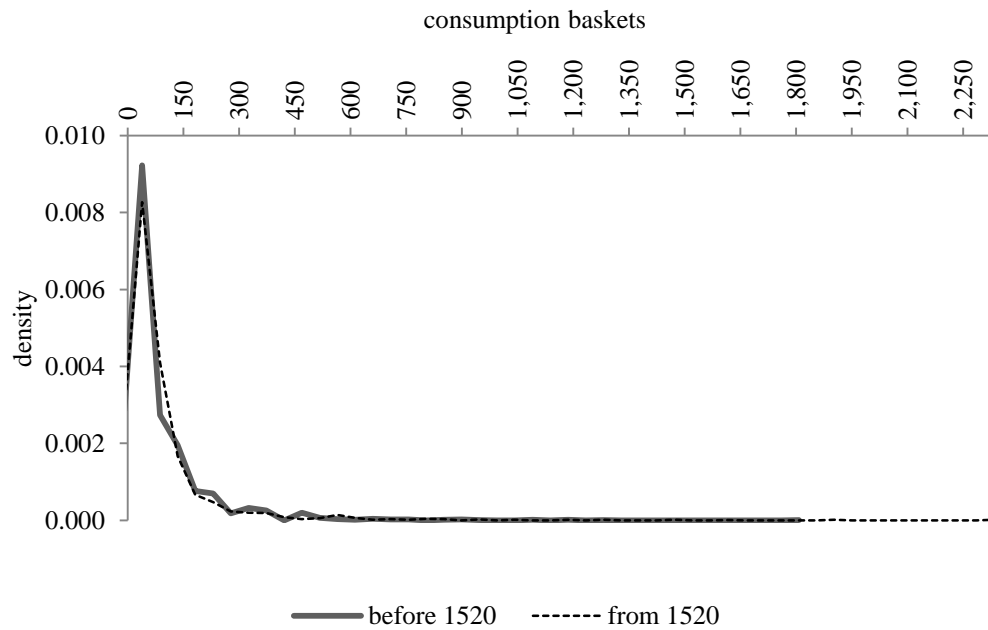
splits the sample into two more or less equally-sized sub-samples: there are 2,545 observations from before 1520 and 1,998 from that date onwards.

Figure 6: Inter-city investment in the Empire: the distribution of distance and capital before and after 1520

a) Distance



b) Capital



Sources: Appendix B.

The patterns are remarkably similar. Both before and after 1520, most capital was invested within a radius of 200 kilometres and rarely exceeded 200 consumption baskets. While the core remained unchanged, longer right tails after 1520 show that the reach of the market increased at the high margin: investment reached previously unattained sizes and distances. It is this dynamic that drove the average values upwards from the sixteenth century.

To what extent did long-distance investment drive capital market integration?²⁴ Since we find that the frequency of inter-city investments drops sharply beyond c. 200 kilometres, this is a suitable cut-off point for comparing long-term trends. Table 4 shows the results of a fixed effects panel regression of the pairwise spreads on the distance between the relevant two markets.

Table 4: The integration of capital markets in the Empire: the role of distance (in km)

Distance	Sample size	Years	Yearly rate of change*100	fitted pairwise spread at start	fitted pairwise spread at end	Cumulated change*100
<200	6258	1333-1795	-0.023***	1.225	1.100	-10.181
>200	15183	1320-1804	-0.042***	1.360	1.109	-18.435

*=Significant at 10 percent level; **=Significant at 5 percent level; ***=Significant at 1 percent level. City-pair fixed effects.

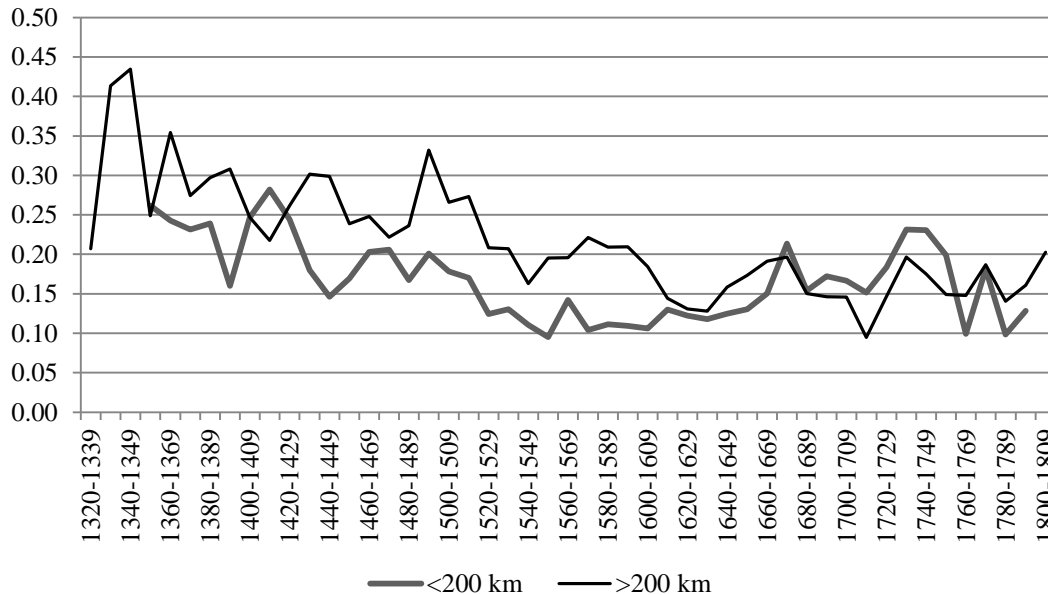
Sources: Appendix B.

The results confirm that long-distance integration played the key role: The yearly rates of change and the associated cumulated changes indicate that it advanced almost twice as fast as local integration. By the end of the period, pairwise spreads between distant places were on average hardly larger than between close markets. To show *when* spreads between long-

²⁴ To make a good use of the available interest rates data, here and in the subsequent analysis we extrapolate missing years from the perpetuities' series on the basis of the rates paid on life annuities in the same place at around the same time. Normalising yields on assets with different terms to maturity is standard practice in financial history (e.g. Flandreau and Flores 2009; Chilosi 2014). This is a safe procedure for the data from around the mid-fifteenth century when pricing became systematic and less subject to idiosyncrasy. In addition, we linearly interpolate missing observations when both the adjacent years are covered. Such interpolations are expected to be very precise, given that the series exhibit very little volatility. In these ways we augment the overall sample of yearly means by about 12 per cent. Reassuringly, the overall trends detected by the perpetuity and the augmented samples are identical.

distant places shrank, Figure 7 compares the pairwise spreads across distance groups over consecutive 10-year periods.

Figure 7: Pairwise spreads by distance in the Empire: panel trends (logs)



Sources: Appendix B.

Again we find substantial accord with the previous analysis. *Short-distance* integration (<200km) advanced significantly from the early fifteenth to the mid-sixteenth centuries. Major improvements in *long-distance* integration began several decades later, following a phase of strong volatility in spreads: Spreads between places over 200 kilometres apart fell steadily from about 1500 to 1630. From the early seventeenth century, interest rates spreads differed little between both distance groups, being about on average 10 to 15 per cent. Put differently, given that at the time the cost of capital was about 4 per cent, we are looking at differences in spreads of about half a percentage point, which suggests a capital market that was well-integrated by any standard.

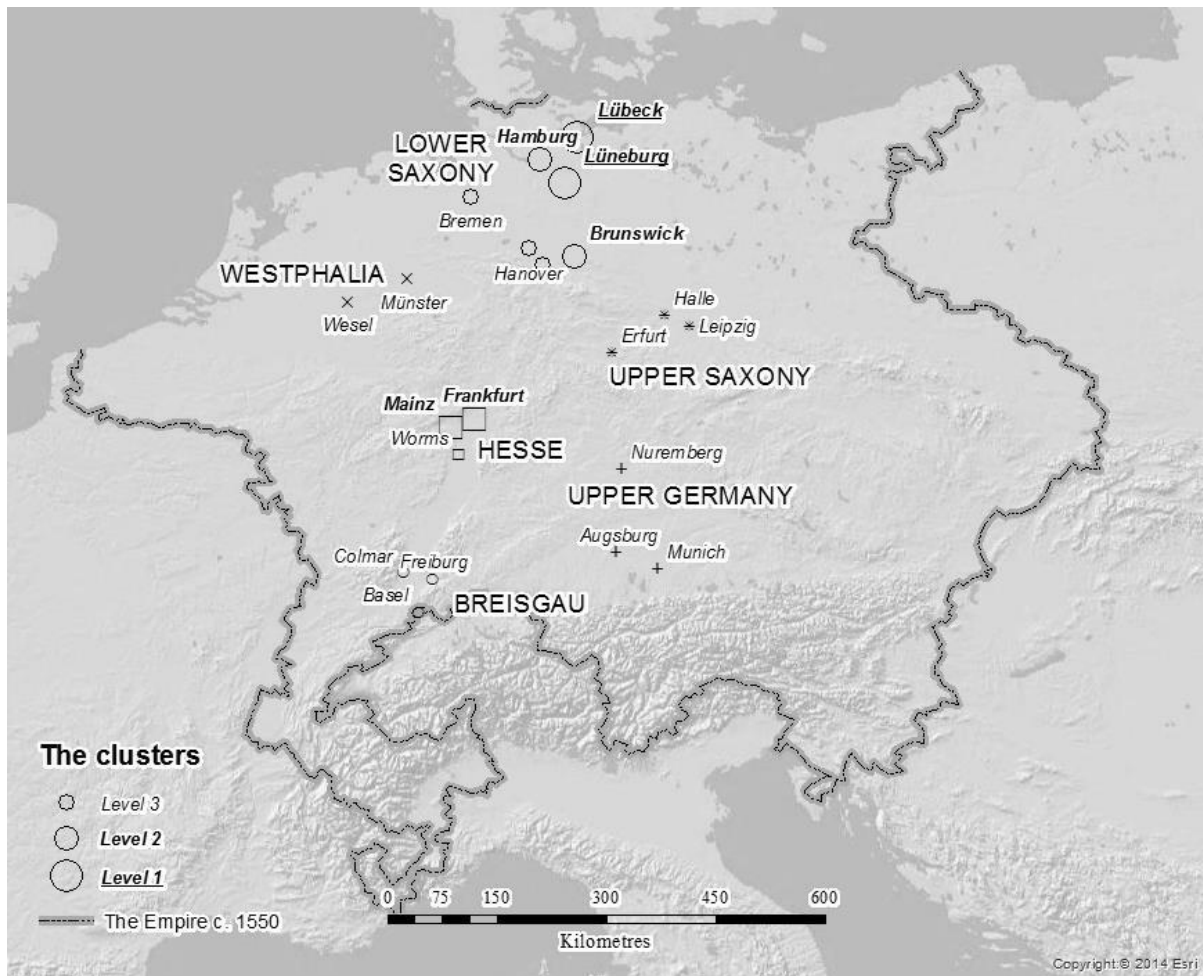
Regional Integration

This section has a double purpose. First, we investigate how the capital markets north of the Alps were clustered, i.e. which cities were linked by particularly strong capital flows.

Second, we use the insights emerging from this analysis to divide our sample and study how capital market integration evolved *between* and *within* regions in the Empire.

To identify clusters of cities, we rely on the model developed by Schweinberger and Snijders (2003). Their technique allows detecting such clusters across various levels of capital flow intensity, defined in a descending order where level 1 is the highest. The likelihood that all the actual links between cities in the sample are recorded does of course increase with the number of observations from each capital-importing city. However, the fewer well-recorded cities are included, the smaller is the geographical area covered. Concentrating on the 28 cities with at least 10 observations on capital imports is a compromise between the desire to include as many markets and as wide an area as possible and the need to focus on those cities which are sufficiently well-documented. Sample bias is addressed by econometrically estimating the capital flows that would be observed if all the linked cities had the same number of observations on capital imports. The measure of capital flow intensity is an index that ranges from 0 to 1 (see Appendix A for technical details). Figure 8 shows the clusters found in this way.

Figure 8: Capital market networks: clusters of cities



Sources: Appendix B.

Capital flows were exceptionally strong between Lübeck and Lüneburg: these are the only cities where we observe the highest level of capital flows. Already at the next lower level, capital flow intensity drops by two thirds (from 1 to 0.364). At this level, we find two clusters: one is an expanded group in Lower Saxony (Hamburg and Brunswick, together with Lübeck and Lüneburg); the other is the Frankfurt-Mainz pair in Hesse. Expected capital flows at the third level remain relatively high (0.15). Here, Bremen, Hanover and Hildesheim join the cluster in Lower Saxony, Worms the one in Hesse that so far was formed by Frankfurt and Mainz only. Moreover, at the third level a Breisgau-cluster (Basel, Colmar and Freiburg), an Upper Germany-cluster (Augsburg, Munich, Nuremberg), a cluster in Upper Saxony (Erfurt, Leipzig, Halle) and another in Westphalia (Münster, Wesel) emerge. The last level

encompasses all the 28 cities examined but is characterised by very weak capital flows (0.009).²⁵

The Empire thus appears as a polycentric network. Consistent with the previous findings on the role of distance (cf. Section 4), all cities with strong links between them are relatively close to each other, with clusters developing around important financial centres such as Frankfurt, Leipzig, Nuremberg and Hamburg. Outside these clusters, investment tended to be much less frequent. The clusters in Lower Saxony reached particularly high levels of capital flows and were significantly wider than the others at the same level of network intensity.²⁶

To include interest rates data from the remaining unclustered cities and from markets with few or no observations on capital imports in the analysis of regional integration, these cities have been assigned to the clusters on the basis of geographical proximity. This approach does not work well for the cities in the Northern and Southern Netherlands and Northern France, as these areas are too distant from the clusters detected endogenously on the basis of capital flow data. The available data confirm only weak links between these regions and the rest of the Empire. They also show that Dutch cities imported capital mainly from other Dutch markets²⁷ and thus allow adding a separate group for the Northern Netherlands. A final group of markets can be identified by drawing on insights from the endogeneity analysis: market clusters formed around cores of particularly strongly linked cities and were characterised by geographical proximity of their members. In all likelihood, the Antwerp-Bruges pair was such a core (for the annuity market in Antwerp and Bruges see e.g. Munro

²⁵ For clarity we do not show this clustering level in the figure. The cities not shown in the figure are Osnabrück, Soest, Schaffhausen, Memmingen, Vienna, Wismar and Würzburg.

²⁶ Node degree analysis also finds that capital markets were particularly developed in Lübeck (before 1520) and Hamburg (from 1520), even after econometrically controlling for sample bias.

²⁷ Thus, the only city within these regions that exported capital into other parts of the Empire is Amsterdam, whose link with Northern Germany still tended to be significantly weaker than links between cities belonging to the same cluster: Amsterdam's strongest links were with Bremen (0.15), Münster, Lübeck and Hamburg (0.07). On capital imports into Dutch cities see Zijlenderdijn (2009: 157, 178 f.).

2003: 541 f.), with the other cities in Brabant, Flanders and Northern France forming the group they dominated.²⁸ Effectively, the expansion of the groups shown in Figure 8 implies that plausible strong links with at least another city, rather than expected strong links with all the other cities in a region are sufficient for inclusion in a group. The findings are robust to violations of our assumptions: Limiting the analysis to the cities identified by the clustering procedure or treating Northern France as a separate group simply strengthens our results. Table 5 shows long-term trends in the dispersion around the mean within each cluster and between cities in each cluster and the mean in the Empire; as before, we rely on city fixed effects estimation.

²⁸ Here, ‘Northern France’ consists of Amiens, Arras, Douai, Lille, St. Quentin and Paris. The borders of France were shifting, and all these cities except Paris were at some point ruled by the Dukes of Burgundy. Paris accounts for less than 7 per cent of the observations from Northern France and just over 3 per cent of the observations from the Southern Netherlands.

Table 5: The integration of capital markets in the Empire: within and between clusters

Within integration						
	sample size	Years	Yearly rate of change*100	Fitted ratio at start	Fitted ratio at end	Cumulated change*100
Breisgau	241	1396-1741	-0.016*	1.093	1.035	-5.318
Lower Saxony	1591	1351-1750	-0.022***	1.152	1.056	-8.283
Upper Germany	210	1388-1551	0.023	1.092	1.133	3.764
Hessen	108	1550-1760	-0.004	1.038	1.028	-0.922
Upper Saxony	61	1497-1621	0.002	1.052	1.055	0.259
Westphalia	236	1350-1760	-0.002	1.078	1.068	-0.992
Northern Netherlands	364	1520-1795	0.002	1.082	1.087	0.499
Southern Netherlands	167	1392-1775	0.028***	1.027	1.143	11.218
Between integration						
	sample size	Years	Yearly rate of change*100	Fitted ratio at start	Fitted ratio at end	Cumulated change*100
Breisgau	447	1383-1791	-0.008	1.136	1.101	-3.081
Lower Saxony	1653	1320-1804	-0.004*	1.138	1.114	-2.112
Upper Germany	402	1382-1804	-0.037***	1.255	1.071	-14.611
Hessen	232	1410-1797	-0.009	1.116	1.077	-3.516
Upper Saxony	196	1320-1698	-0.011	1.119	1.073	-4.04
Westphalia	415	1350-1780	-0.001	1.108	1.106	-0.225
Northern Netherlands	501	1422-1795	-0.062***	1.389	1.100	-20.771
Southern Netherlands	346	1360-1795	-0.060***	1.381	1.063	-23.056

*=Significant at the 10 percent level; **=Significant at the 5 percent level; ***=Significant at the 1 percent level. City fixed effects.

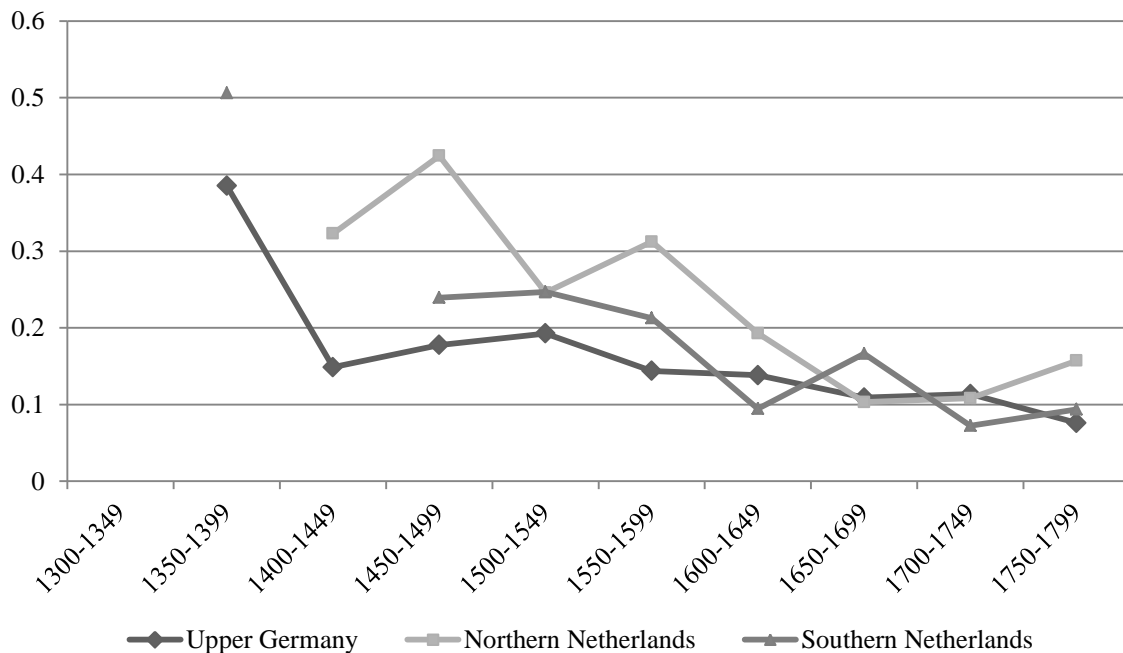
Sources: Appendix B.

Consistent with the result that market integration was more dynamic over long than short distances (cf. Section 4), the evidence for increased integration is stronger between than within clusters. The ‘within’-analysis detects very low spreads around the mean – with differences mostly within 10 per cent – both at the beginning and end of the period studied. In other words, by and large clusters were well-integrated already in the late middle ages and remained so. The only and partial exceptions are Lower Saxony, where there is some evidence of progress over time, and the Southern Netherlands, for which we find disintegration.

Progress in integration between clusters mainly concerned a few regions where the spreads were comparatively high at the beginning. Thus, the integration of Lower Saxony

with the rest of the Empire was high from the late middle ages and progressed little. By contrast, there were initially significant barriers with Upper Germany and especially the Southern and Northern Netherlands, which were eroded over time. To identify when this progress took place, the ‘between’-integration panel regression analysis is re-run, using fifty-years dummies instead of the time trend. Figure 9 shows the results for the three regions driving the action.

Figure 9: Integration between regions and the Empire as a whole: panel trends (logs)



Sources: Appendix B.

The results suggest that the key periods of integration with the Empire varied between regions: Upper Germany saw much of the progress before the mid-fifteenth century. The Southern Netherlands started off from a similarly high level of segmentation from the rest of the Empire in the second half of the fourteenth century but witnessed rapid progress also between the sixteenth and the first half of the seventeenth centuries. Finally, the main period of increased integration for the Northern Netherlands was slightly later: It coincided with the ‘Dutch golden age’ (c. 1550-1700).

Benefits of Empire?

To interpret our findings, let us return to the contrast between a highly integrated Holy Roman Empire and a poorly integrated Italy. Geography clearly did not favour the regions north of the Alps, large parts of which – unlike Italy – had no direct access to the sea. Further, it is uncontroversial that the Italians pioneered the use of sophisticated financial instruments such as the bill of exchange that allowed cashless capital transfers at low cost (see, for example, Day 1987: *passim*; Felloni 2008: *passim*; Denzel 2008: 51 ff.). Thus, neither geography nor financial development can account for the edge in capital market integration that the late medieval and early modern Empire enjoyed.

Italy's fragmented capital markets can be traced back to the times of forced loans in the middle ages, when local authorities compelled the well-to-do to buy bonds and at the same time restricted the participation of foreigners in the secondary market. In fact, outsiders could buy bonds only if they were granted exemptions in form of a privilege. These restrictions were partly designed to prevent collective reprisals in case of default (Sieveking 1905: 29; Molho 1995: 107 f.; Pezzolo 2005: 156 f.). In other words, because medieval Italian urban governments valued their fiscal autonomy (e.g. the right to transform a loan into a tax at will) higher than access to foreign capital, urban collective liability hindered rather than helped the development of inter-city financial links. Keeping high returns for the local oligarchs was arguably another reason for closure (cf. Chilosi 2014: 910; 2015: Section 5). When bonds sold on the market began to replace forced loans in the sixteenth century, governments relaxed the restrictions on the participation of foreigners. At that time the contribution of foreigners was often explicitly called for and the spreads shrank (see Figure 4).²⁹

²⁹ For example, on 14 March 1599 the Florentine Senate stated that 'buyers ... can be ... subjects as well as foreigners ... of whatever fate, grade or condition' (Archivio di Stato di Firenze, Monte Comune o delle Graticole, parte I, pezzo 3: 261).

Nevertheless, any gains were short-lived. Foreign investment remained more costly than local, outsiders being discriminated against with partial defaults, taxation, and liquidations (cf. Pugliese 1924: 339-76; Felloni 1971: 146 f., 214-7, 289, 304 ff., 315 ff.; Calabria 1991: 128 f.).

The difference to the regions north of the Alps is stark. Within the Empire, several mechanisms encouraged transactions over time and space, including those between polities. Many markets used similar systems of law, having been granted that of an already existing town when they were founded in the high middle ages or having modelled their law codes on that of a neighbouring city: The laws of Aachen, Frankfurt, Nuremberg, Vienna, Brunswick and in particular Magdeburg and Lübeck played important roles in this context. In effect, ‘urban law families’ emerged whose members frequently referred to the court of law of the same town as their central or ‘upper’ court (Kroeschell 2003: 25; Weitzel 2003: 1331 f.). Legal fragmentation was therefore far less pronounced than a look at the map of the late medieval Empire would suggest. The widespread use of collective liability may have further helped co-ordinating inter-urban exchange (Fryde and Fryde 1963: 528 f., 533; Zuijderduin 2009: ch. 3; Boerner and Ritschl 2002: *passim*). Indeed, Fryde and Fryde (1963: 528, 533) argue that as a result of collective liability foreign investment in the Empire was less risky than domestic investment.

Competition between political authorities for scarce capital encouraged governments to improve their supply of institutions with the aim of attracting outside investors (Volckart 2002: 184 ff.). Thus, both urban officials and private agents acted as intermediaries, facilitating inter-city investment from the early fifteenth century onward.³⁰ Sometimes cities even arranged the pay-out to be delivered at the place of residence of the buyer, apparently at

³⁰ Staatsarchiv Nürnberg, Bestand Losungsamt Vol. 69, fol. 21 r (no.117), 26 v (no. 136), 28r (no. 137), Stadtarchiv Hannover, NAB 7228, fol. 19 v; Zuijderduijn (2009: 113 ff.).

no extra cost.³¹ There were also contracts that stipulated that the payment of the annual payout, of the invested capital or, in cases of redemption, of both should occur in a place convenient for both parties. Occasionally financial fairs such as those in Frankfurt and Leipzig and specialised markets like Hildesheim were used for this purpose.³² By contrast, early modern Genoese capitalists, for example, investing in other Italian cities had to pay a fee to a private agent to have the pay-outs delivered to them at financial fairs or at the local public bank (Felloni 1971: 96 f.).

Non-urban institutions within the Empire had overall similar effects. Universally recognised legal mechanisms such as feuds provided incentives not to violate contracts, thereby contributing to relatively low costs of transactions over space (Volckart 2004). Furthermore, particularly since the reforms of the late fifteenth and early sixteenth centuries, the Imperial constitution functioned as a coordinating framework (Volckart 1999: 12 ff.; Angermeier 1984, *passim*; Burkhardt 2002: 195-9). It protected and helped the mobility of capital by allowing the creation of debit commissions that took over the administration of estates that threatened to default on their debts (Westphal 2002: 265 ff.). This implied a fall in monitoring costs. Since these costs sharply increased with distance (Stasavage 2011: *passim*),

³¹ Regionaal Archief Dordrecht (formerly ‚Gemeente Archief Dordrecht‘), GAD 1, no. 434, fol. 50v-53r, Stadtarchiv Braunschweig, B I 11 Leibgedingebücher, vol. 4, fol. 36v-39r, Stadtarchiv Hannover, NAB 8242, Stadtoobligationsbuch 1387-1533, 108/2, 110/1, 118/12, 130/1, 137/3, 140/2, 141/4, 156/1, 163/2, 164/2, 177/1, 184/1, 192/1, 197/1, 227/3, 267/2, 268/1, 275/1, 284/1, 287/2, 364/2, 434/1, 437/2, 542/2, 554/2, 571/2, 755/1; NAB Nr. 7228 p.2; Urkunden Abteilung 3 - Schuldurkunden des Rates, nos. 43, 46, 51, 55, 56, 57, 60, 132, 172, 248, 269, 275, 293, 298, 307, 309, 310, 314, 315, 317, 318, 321, 323, 334, 340, 342, 346, 347, 350, 354, 357, 358, 361, 363, 366, 367, 373, 537, Albers (1930, 49 f.), Zuijderduijn (2009, 115).

³² Stadtarchiv Hannover, NAB 8242, Stadtoobligationsbuch (1387-1533), 118/12; Abteilung 3 - Schuldurkunden des Rates nos. 43, 46, 51, 57; Staatsarchiv Nürnberg, Bestand: Losungsamt, vol. 69, fol. 97r-v (no. 444), 98r (no. 447), 99r (no. 450), 103r (no. 468), 112r (nos. 499-500), 126r (no. 567); vol. 70, fol. 125r (no. 386); Stadtarchiv Erfurt, 1-1/21 10 Libri ordinationum, vol. 1, fol. 1v, 8v; 1-1/21-12/1 Obligationen, 70ff, 75ff, 147ff; 1-1/22, 2 Hauptrechnungen no. 1, 0-1/4- 121 (1); Stadtarchiv Lüneburg, AB 55 Kopie von Rentenbriefen (1441-1492), fol. 20r, 76r f., 90r, 93r-94r, 98v f; Landeshauptarchiv Magdeburg, Copiar der Obligationen der Stadt Halle, Cop. 395a, fol. 27v, 29v, 38v, 315r; Cop. 396, fol. 30r, 131r, 134v, 159r; Klinger 2011: 336 ff.; Archives de la ville Strasbourg, Série IV No. 71, p. 148; Stadtarchiv Münster, Ratsarchiv A IX, Findbuch zu den Rentenverschreibungen aus Abt. A IX des ‚Alten Archivs‘, no. 43.

their reduction is expected to mainly affect long-distance investment. Inter-urban investment north of the Alps was far better protected than in Italy, where rivalries between polities increased the costs of transactions between towns. In sum, institutional differences between Italy and the Empire suggest that legal practice and constitutional policy within the Empire – helped solving coordination problems and facilitated inter-city investment (cf. Chilosi and Volckart 2011: 784). The fall in the cost of long-distance investment during the sixteenth century was no accident: it was aided by constitutional reforms in the Empire that improved security and helped market integration.

However, there is evidence suggesting that the role of the Empire should not be overstated. First, the best-integrated group of markets – the Lower-Saxon cluster centred on the leading Hanseatic towns of Lübeck and Lüneburg – was located in an area where the Empire was always relatively weak (Dollinger 1981: 151; Press 1991: 380). Here, it seems more likely that it was the Hanseatic League that helped integration.³³ Still, it would be rash to conclude that the Empire was irrelevant for the functioning of city-leagues. Emperor Charles IV (1316-78) aimed at formalising the co-operation between the Hansa and the Empire in the 1370s, while Sigismund (1368-1437) intervened in Lübeck's internal policies (Dollinger 1981: 151 f.). Similarly, the Swabian League of 1488, formed by both cities and feudal lords, was actively promoted by Frederick III to resist the expansionary ambitions of the Bavarian dukes (Carl 2000: esp. 402 ff.). Moreover, capital market integration across the Empire continued after the demise of the late medieval urban leagues. Indeed, our results suggest that Ogilvie's (1992: 437 f.) negative assessment on the effects of the 'seventeenth-century crisis' for the Imperial market needs to be qualified: Inter-state rivalries appear to

³³ See Spruyt (1994: 142 ff.) for an explanation of why urban leagues developed in Germany but not in Italy.

have had a much less disruptive effect in the Empire than in Italy (cf. figure 4).³⁴ Promoting peace and prosperity was the Empire's core function, and its internal political borders evidently remained relatively open to exchange between cities in different states. It is reasonable to assume that policies pursued at the Imperial level played a role in ensuring that this remained the case: Research is stressing how resilient Imperial institutions were even after the Peace of Westphalia (Press 1991: 379-84).

Second, the regions mostly responsible for increased integration in the long run, i.e. the Northern and Southern Netherlands were located in areas where Imperial institutions were either non-existent or weak, and becoming increasingly weaker from the sixteenth century (Press 1986). That this happened at exactly the time when integration was advancing suggests that financial technology played a core role. The sixteenth century saw the development of the bill of exchange to a fully negotiable financial instrument; in effect, the bill became a form of paper money, thus greatly decreasing the cost of transferring capital and facilitating long-distance transactions. Closely matching our patterns of integration, this financial innovation was centered in Antwerp, from where it spread to Northern Europe (Munro 2003: 553 ff.). Still, we also observe increased integration of Upper Germany, where obviously the Empire was a strong presence, with the rest. Moreover, the rise of Antwerp as the dominant financial centre of the sixteenth century was tied to Emperor Charles V (1500-58): he chose Antwerp to remit American silver across the Empire and to raise loans from the Fuggers of Augsburg (Braudel 1982: 150 f.). Hence, Imperial politics – if not the Empire's constitutional and legal structures – helped the development of the inter-regional links that we observe.

³⁴ On the changing conditions affecting urban rivalries in Italy see Spruyt (1994: 172 ff.) who argues that by the seventeenth century medieval constraints on inter-urban cooperation had lost much of their force. Italian historians emphasises the role of Genoese capitalists, who became particularly active within the peninsula from the seventeenth century, in integrating the Italian markets (Felloni 1971: *passim*; Pezzolo 1995: 288; Masini 2007: 206 ff.). Our trends suggest that capital investments from Genoa intensified in spite of rising transaction costs and were driven by the supply shock implied by the severance of the Genoese's links with Spain, following the defaults of the crown, and a growing demand, in the wake of expanding debts (Chilosi, 2014: 897), which were themselves signals of intensified inter-state rivalries.

Conclusion

The analysis indicates how typical Hans and Else Ketzels experience of 1437 was: They decided to invest their 900 rhinegulden not in their hometown of Nuremberg but in Schweinfurt, a place well within the usual radius of inter-city investment at that time and later. The sum they placed there was nothing out of the ordinary, either. While the example was chosen because it is representative for what was happening all over the late medieval Holy Roman Empire, the comparative focus of the analysis allowed gaining further insights. Specifically, comparing conditions in the Empire with those in Italy showed that capital markets north of the Alps were functioning much better: Despite the undisputed edge of Italian merchants and financiers in the development of financial technologies, Central European markets were more closely connected and better integrated than their Italian counterparts. Moreover, comparing conditions in both regions over time reveals that only in the Empire integration in terms of interest rate dispersion advanced in the long run. Both in Italy and north of the Alps there was progress in the sixteenth century, but in Italy the gains were short-lived. Within the Empire, places such as Nuremberg and Schweinfurt – less than 200 kilometres apart – were well integrated from the start; the advances in integration that took place from the fifteenth century onward concerned markets more distant from each other. The size and depth of the market reached particularly high levels around Lübeck and Hamburg, and it was initially poorly integrated clusters of cities in the Netherlands and Upper Germany that improved their integration over time. The proximate cause of integration in the Empire was institutional competition: Cities north of the Alps were far better than Italian markets at credibly committing not to discriminate against foreign investors and competing for foreign capital. The institutions of the Holy Roman Empire, which never applied to the Imperial fiefs in Italy, are a credible deep cause of this contrast, though spatial patterns of integration within Central Europe imply that they fall short of being sufficient.

Two implications follow. First, the timing of capital market integration in the Empire and Italy differed significantly from that of western European cities such as London and Amsterdam.³⁵ In short, the latter's experience is atypical rather than representative of pre-modern Europe. Second, institutional competition between and co-ordination among the cities in the Empire calls into question the idea that state formation is necessary to prevent rent-seeking and the formation of barriers to entry by urban elites (cf. Epstein 2000: 167; Volckart 2002: 213, 217; Stasavage 2011: 162 ff., 2014: *passim*). The new evidence on capital market integration in the Empire casts doubt on the argument that transaction costs are necessarily lower within territorial states than between cities in different polities (cf. Epstein 2000: 159). Given a constitutional framework that fostered co-operation between polities and induced them to compete by improving their protection of property rights, political fragmentation does not necessarily have adverse effects on the development and integration of capital markets.

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³⁵ See footnote 5.

Stadtarchiv Münster, Ratsarchiv A IX, Findbuch zu den Rentenverschreibungen aus Abt. A IX des ‚Alten Archivs‘, no. 43.396.

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Appendix A: Clustering Technique

Model-based clustering with an ultrametric space is a technique to identify groups of nodes in a network (groups of cities and their hinterlands³⁶ in our case) that are linked by a tie (in our case capital flows) (Schweinberger and Snijders 2003). It assumes that observed links are the product of a stochastic process. It is particularly suited to our context since this method identifies clusters across various levels of network intensity and thus it makes it possible to fully exploit the information provided by capital flows.

The likelihood that we recorded all the links between cities in the sample increases with the number of observations on imports per city. This implies that it is desirable to include in the analysis only relatively well-covered cities, or else we are bound to miss a non-trivial number of existing links. Yet, the fewer cities are included, the smaller is the area covered by the analysis. With this trade-off in mind, we focus on the 28 cities for each of which we have at least 10 observations on investments made from other cities and their hinterlands.

For robustness, we re-run the analysis with the following two other samples: one with the 12 cities with at least 80 observations on imports and one with all the 210 places named in the sources. In addition, to investigate possible changes in the clusters over time, we also run the analysis including only observations from before 1520 and from 1520 onwards, for cities with at least 10 observations on imports.

Recorded capital flows between linked cities are bound to increase with their numbers of observations. This sample bias is econometrically addressed by regressing capital flows between city-pairs against the log of the sum of their numbers of observations on imports,

³⁶ A place is considered to belong to the hinterland of the closest other place that had at least 5000 inhabitants at some point in time during the period covered here (1228 to 1802). Using links between places instead worsens the results as the adjacency matrix becomes too sparse. In most cases, the distance between the hinterland-place and its 'central' town is small: less than 20 km in 85 per cent of the cases, and 70 km at most.

using a negative-binomial specification. We use this technique because count regressions have desirable properties for estimating the determinants of bilateral flows (they do not suffer from the bias created by the logarithmic transformation and from the failure of the homoskedasticity assumption) and over-dispersion turns out to be a problem, thus cautioning against the use of a Poisson specification (Burger, Van Oort and Linders 2009). The capital flows that would have taken place if all linked cities were evenly covered are then estimated with the residuals. These are subsequently normalised to take values between 0 and 1. Hence, our measure of network intensity is capital flows compared to that of the pair with the highest value: This is Lübeck-Lüneburg, where we find that capital flows (18,799 consumption baskets) were 17,514 consumption baskets greater than expected on the basis of their combined coverage (698 observations).

The model assumes that links within a cluster are symmetric and that clusters are not overlapping at any given level of capital flows. These assumptions are bound to be violated to some extent. However, they are shared by other clustering procedures and imply that groups are identified where the assumption of direct arbitrage between cities is closely approximated. Clusters can be identified either with a maximum likelihood or a Bayesian estimator. While the Bayesian estimator provides a more elegant model selection procedure, it yields in the present case unstable and occasionally implausible settings that suggest a poor fit with the data. We therefore use the maximum likelihood estimator. As our measure of strength is continuous, we assume a Gaussian distribution. To investigate possible non-convergence, we run ten sequences. Given that there are 28 cities in the main sample we allow up to seven different levels of clustering. The results are reported in table A.1, where the second to the seventh columns report the expected network intensity at each clustering level for each total number of levels.

Table A1: Network clustering: expected network intensity by level and number of levels

Level	7	6	5	4	3	2
N. of levels						
1	1.000	1.000	1.000	1.000	1.000	0.275
2	0.476	0.364	0.364	0.364	0.206	0.013
3	0.297	0.163	0.163	0.150	0.010	
4	0.148	0.025	0.039	0.009		
5	0.009	0.005	0.008			
6	0.009	0.000				
7	0.009					
Log likelihood	-0.491	-0.516	-0.520	-0.531	-0.734	-1.3191

Sources: Appendix B.

The log-likelihood function is maximised when we assume seven different levels, but the difference is big only when compared to a total of two or three levels. Inspection of the output reveals that non-convergence may be an issue, as evidenced by unstable maxima of the log-likelihood function, when we assume that there were five levels or more. Moreover, the results are qualitatively very similar for four to six levels: All detect very close values at levels 1 to 3 and sharp drops in network intensity subsequently. Hence, no important information is lost by only considering four levels, and we therefore present this model in the paper. The only new result emerging from the robustness checks is that enlarging the sample reveals a wide cluster around Nuremberg, which developed strong links with Salzburg and Maribor.

Appendix B: Data Sources

Note: Printed material is always listed first; the section on the archival material follows.

Aachen

Kraus, T.R. (ed.) 2004. *Die Aachener Stadtrechnungen des 15. Jahrhunderts*. Düsseldorf, pp. 42, 57, 93, 168.

Laurent (ed.) 1866. *Aachener Stadtrechnungen aus dem XIV. Jahrhundert nach den Stadtarchiv-Urkunden mit Einleitung, Registern und Glossar*. Aachen: P. Kaatzer, pp. 295, 369.

Amiens

- Espinas, G. 1902. *Les finances de la commune de Douai, des origines au XVe siècle*. Paris: Picard, pp. 321, 328.
- Maugis, M. E. 1899. *Essai sur le Regime Financier de la Ville d'Amiens du a la fin du XVI siècle (1356-1588)*. In *Memoires de la Societe des Antiquaires de Picardie, Quatrieme Serie, Tome III*, pp. 133-656, here pp. 563, 566.

Amsterdam

- Daston, L. 1988. *Classical Probability in the Enlightenment*. Princeton: Princeton University Press, p. 121.
- Fritschy, W. 2003a. Three centuries of urban and provincial public debt: Amsterdam and Holland. In Boone, M., Davids, K., and Janssens, P. (eds.) *Urban Public Debts: Urban Government and the Market for Annuities in Western Europe (14th-18th Centuries)*. Turnhout: Brepols Publishers, pp. 75-92, here pp. 79, 83.
- Tracy, J. D. 1985. *A Financial Revolution in the Habsburg Netherlands: Renten and Renteniers in the County of Holland, 1515-1565*. Berkeley, Los Angeles and London: University of California Press, pp. 45, 60, 133.
- Van der Burg, M. and Hart, M. 2003. Renteniers and the recovery of Amsterdam's credit (1578-1605). In Boone, M., Davids, K., and Janssens, P. (eds.) *Urban Public Debts: Urban Government and the Market for Annuities in Western Europe (14th-18th Centuries)*. Turnhout: Brepols Publishers, pp. 197-218, here pp. 200, 204.

Stadsarchief Amsterdam [Amsterdam City Archives]:

No. 5014: Stadsrekeningen. Vol. 12, fol. 38v; Vol. 19, fol. 32r; Vol. 21, fol. 38v; Vol. 22, fol. 40v; Vol. 27, fol. 42v-43r; Vol. 33, fol. 54v; Vol. 34, fol. 52r; Vol. 36, fol. 55v-56r; Vol. 39, fol. 88r-89v; Vol. 40, fol. 55v-57v; Vol. 41, fol. 55v-57v; Vol. 42, fol. 62v-63v; Vol. 43, fol. 64v-66v; Vol. 44, fol. 61r-62v; Vol. 46, fol. 89r-90v; Vol. 47, fol. 60r-61v; Vol. 48, fol. 59r-61v; Vol. 50, fol. 70r-73r; Vol. 51, fol. 71r-74r; Vol. 52, fol. 72v-74r; Vol. 53, fol. 75v-77v; Vol. 54, fol. 68r-69v; Vol. 56, fol. 45v-46r; Vol. 59, fol. 35v; Vol. 61, fol. 35r-36v; Vol. 62, fol. 35v-37r; Vol. 63, fol. 32v-33r; Vol. 65, fol. 29v; Vol. 68; Vol. 69; Vol. 71.

No. 5025: Vroedschapsresoluties. Vol. 1: 16.1.1536-7.5.1565, fol. 113v, 123v; Vol. 2: 28.5.1565-11.1.1575, fol. 33r, 56v; Vol. 3: 16.1.1575-23.5.1578, fol. 19r-v; Vol. 6: 6.5.1588-1.5.1592, pp. 265, 436-7; Vol. 8: 14.5.1594-7.10.1603, pp. 13-14, 21-23, 25-26, 106-7, 858; Vol. 9: 13.10.1603-5.7.1610, p. 285; Vol. 10: 12.7.1610-28.1.1617, p. 224, 338-40; Vol. 19: 1649 januari 12-1652 augustus 29, fol. 158v.

No. 5044: Reeckeningen van overgeleverde losrenten, lijfrenten op eene lijve ende lijfrentenop twee lijven bij de stadt Amstelredamme verkocht. Vol. 461: Ingediend bij het kantoor der Staten van Holland, 1588 maart 10, fol. 2r, 3r, 12r; Vol. 462: Ingediend bij het kantoor der Staten van Holland, 1588 aug.3, nr. 4, fol. 2r, 3r, 31r; Vol. 463: Ingediend bij het kantoor der Staten van Holland, 1599 feb.17, nr. 7, fol. 1r, 2r, 5v, 9v, 11r, 12r.

No. 5044: Register van vercoopingen van Renten. Vol. 464: 1588 5e register gemerkt G, fol. 1r-24v; Vol. 465: 1589 5e register gemerkt F, fol. 1r-10v; Vol. 466: 1590 6e register gemerkt H, fol. 1r-10v; Vol. 467: 1591 6e register gemerkt I, fol. 2r-3r; Vol. 468: -1598, fol. 1r-12v; Vol. 469: 1603 6e register gemerkt M, fol. 1r-3r.

Ancona

Palermo, L. 2007. Finanza, indebitamento e sviluppo economico a Roma nel Rinascimento. In De Luca, G. and Moiola, A. (eds.) *Debito Pubblico e Mercati Finanziari in Italia. Secoli XIII-XX*. Roma: Franco Angeli, pp. 83-102, here pp. 95-6.

Antwerp

Stadsarchieef Antwerpen [Antwerpen City Archives]:

[Registratie van erf- en lijfrenten Reductiekas, renten op de Aluinen (1640-1642).] R280: 1640-1642, rentmeester Jan van Weerden.

[Registratie van erf- en lijfrenten Reductiekas, renten op de Corpus (1748-1750).] R364: 1748-1750, erfrenten.

[Jaarlijkse rekeningen van de Reductiekas (1582).] R500: 1e rekening, alle cijzen en erfrenten.

[Erf-en lijfrenten van de consumptiekas (1646-1793).] R1513: 1646-1648, erf- en lijfrenten, rentmeester Jan Janssens; R1516: 1655-1657, erf- en lijfrenten, rentmeester Thomas de Potter; R1525: 1670-1672, erfrenten, rentmeester Jan Bruyninx; R1526: 1670-1672, lijfrenten, rentmeester Jan Bruyninx; R1527: 1673-1675, lijfrenten, rentmeester Jan Baptist Huart; R1528: 1676-1678, erfrenten, rentmeester Jan Baptist Poesson; R1533: 1685-1687, erfrenten, rentmeester Norbertus van Mockenborch; R1544: 1703-1705, erfrenten, rentmeester Jan van Miert; R1553: 1718-1720, erfrenten, rentmeester Ignatius Clouwet; R1581: 1775-1777, erf- en lijfrenten, rentmeester Jan Baptist de Wolf; R1582: 1778-1780, erf- en lijfrenten, rentmeester Jacques Jos de Moor.

[Erf- en lijfrenten op de lepel.] R1586: 1678-1681.

Arras

Bougard, P. 1988. L'apogee de la ville (1191-1340). In Bougard, P., Hilaire, Y. and Nolibos, A. (eds.) *Histoire d'Arras*. France: Editions des Beffrois, pp. 53-76, here pp. 63-4.

Munro, J. H. 2003. *The Medieval origin of the financial revolution: Usury, rentes, and negotiability*. In *International History Review*, 25:3, 505-62, here p. 525.

Munro, J. H. 2007. *The Usury Doctrine and Urban Public Finances in Late-Medieval Flanders (1220-1550): Rentes, Excise Taxes, and Income Transfers from the Poor to the Rich*. Paper to be presented to the Washington Area Economic History Seminar at the University of Maryland Baltimore County on Friday, 11 May 2007, p. 10.

Richard, J. 1880. *Une conversion de rentes à Arras en 1392*. In *Bibliothèque de l'école des chartes*, tome 41, pp. 518-536, here p. 523.

Assisi

Girelli, A. M. 1992. *La Finanza Comunale nello Stato Pontificio del Seicento. Il Caso di Assisi*. Padova: Cedam, pp. 65, 69-70, appendix.

Augsburg

Espinass, G. 1902. *Les finances de la commune de Douai, des origines au XVe siècle*. Paris: Picard, p. 328.

Stadtarchiv Augsburg [Augsburg City Archives]:

S169 (1400-1437): Baumeisterbuch 14, 37; S170 (1437-1461): Baumeisterbuch 44-47, 50; S171 (1463-1477): Baumeisterbuch 60, 65-66, 70; S172 (1477-1491): Baumeisterbuch 73, 82; S173 (1491-1501): Baumeisterbuch 87; S174 (1501-1515): Baumeisterbuch 98.

Bar-sur-Aube

Desportes, P. 1979. *Reims et les Rémois au XIIIe et XIVe siècles*. Paris: Éditions A. & J. Picard, p. 129.

Barcelona

Usher, A. P. 1943. *The Early History of Deposit Banking in Mediterranean Europe*. Cambridge, Massachusetts: Harvard University Press, pp. 171-2.

Basel

Harms, B. (ed.) 1909. *Der Stadthaushalt Basels im Ausgehenden Mittelalter. Quellen und Studien zur Basler Finanzgeschichte. Abt. 1: Die Jahresrechnungen 1360-1535. Vol. 1. Die Einnahmen*. Tübingen: Laupp, *passim*.

Staatsarchiv Basel-Stadt [Basel State Archives]:

AHA Missiven A 1: Missiven, Konzepte 1409 Oktober 12 - 1413 Dezember 18, pag. 82, 85; AHA Ratsbücher D 1: Abscheidbuch (1526-1542), fol. 135; D 2. Abscheidbuch (1541-1556), fol. 25v; AHA Städtische Urkunden (1180-1798): Nos. 1280, 2502, 2503, 2505, 2947, 2950, 2952, 3000, 3021; AHA Städtische Urkunden (Regesten) (0423-18. Jh.): Urkundenbuch VIII. fol. 95; Umschlag des Öffnungsbuches IV; Umschlag von E 45, no. 1; AHA Finanz H: Jahresrechnungen der Stadt Basel von 1444-1611, Fronfastenrechnungen von 1444-1700. Vols. 1535/36-1601/02.

Bergamo

Pulin, F. 1985. *Il Monte di Pietà di Bassano (1492-1797)*. Vicenza: Edizioni L.I.E., p. 122.

Berlin

Landesarchiv Berlin [State Archives Berlin]:

Rat zu Berlin. A Rep. 500 Berlinische Kämmereirechnungen: 1693-1694, alte Signatur R IV/3; 1697-1698, alte Signatur R IV/4); Rat zu Berlin. A Rep. 510 Coellnische Kämmereirechnungen: 1589-1590, alte Signatur R I/1; 1596-1597, alte Signatur R I/2; 1598-1599, alte Signatur R I/3.

Bologne

Carboni, M. 1995. *Il Debito della Città. Mercato del Credito, Fisco e Società a Bologna fra Cinque e Seicento*. Bologna: Il Mulino, p. 86.

Felloni, G. 1971. *Gli Investimenti Finanziari Genovesi in Europa tra il Seicento e la Restaurazione*. Milano: Dott. A. Giuffrè Editore, pp. 181-182.

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- Vietti, A. 1884. *Il Debito Pubblico nelle Provincie che hanno formato il Primo Regno d'Italia Secondo i Documenti del R. Archivio di Stato Lombardo*. Milano: Emilio Quadrio Editore, p. 137.

Bonn

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