European
Historical
Economics
Society

EHES Working Paper | No. 200 | November 2020

Regional market integration and the emergence of a Scottish national grain market

Daniel Cassidy,
National University of Ireland, Galway

Nick Hanley,
University of Glasgow

EHES Working Paper | No. 200 | November 2020

Regional market integration and the emergence of a Scottish national grain market*

Daniel Cassidy[1],
National University of Ireland, Galway

Nick Hanley[2],
University of Glasgow

Abstract

This article examines the integration of regional Scottish grain markets from the early seventeenth century until the end of the long eighteenth century in 1815. The Scottish economy developed rapidly in this period, with expansion driven by improvements in market structures and specialisation in agricultural production. We test for price convergence and market efficiency using grain prices collected from Scotland's fiars courts' records. Our results suggest that price convergence increased across the seventeenth and eighteenth centuries but experienced a number of setbacks in times of famine and war. The civil war and Cromwellian occupation of the Scottish Lowlands in the 1640s and 1650s, the famine years of the 1690s, the American War of Independence, and the French/Napoleonic wars all caused declines in price convergence. Using a dynamic factor model, we find that market efficiency increased substantially in regional Scottish markets from the late seventeenth century. This analysis suggests that sub-national markets existed in the late seventeenth century, in the east and west of the country, but merged in the eighteenth century to form a unified national grain market.

JEL Codes: N13, F15

Keywords: Market integration, development, prices

* We thank Eoin McLaughlin and Fiona Watson for helpful comments and suggestions, and Chris Smout for suggestions on data sources.
[1] Corresponding Author: daniel.cassidy@nuigalway.ie
[2] Corresponding Author: Nicholas.Hanley@glasgow.ac.uk

Notice
The material presented in the EHES Working Paper Series is property of the author(s) and should be quoted as such. The views expressed in this Paper are those of the author(s) and do not necessarily represent the views of the EHES or its members

1 Introduction

The development and integration of markets have been identified as an important driver of economic growth in pre-industrial economies (Chilosi et al., 2013; Federico et al., 2018; Kelly, 1997; Persson and Sharp, 2015) In regions with a segmented market structure, localised production is geared towards a broad-based subsistence level of output. Market integration occurs when local markets coalesce to form one larger unified market, with each region specialising in the production of commodities for which they have a comparative advantage. Specialisation increases labour productivity, and profit opportunities encourage producers to develop more efficient production methods, increasing output and living standards.

The Scottish economy developed rapidly in the seventeenth and eighteenth centuries, from a predominantly rural economy to a pre-industrial economy with strong market structures. From the mid-seventeenth century, a series of land clearances saw large proportions of the Scottish population lose direct access to the land, shifting a substantial proportion of the labour force towards early industries like textile manufacturing (Devine, 1989, 2000). Urbanisation increased rapidly, and by the mid-nineteenth century, Scotland was among the most urbanised regions in Europe. This transformation increased the need for formal market structures and created incentives for more efficient agricultural production methods leading to regional specialisation. The borderlands specialised in the rearing of sheep, the Highlands raised cattle, and the east of the country used its fertile lands to produce grain (Devine, 2000; Saville and Auerbach, 2006; Gibson and Smout, 1995b). Specialisation stimulated inter-regional trade in Scotland, leading to the formation of a national market structure. In this article, we measure the integration of regional markets and the emergence of a unified national grain market using fiars grain prices for regional Scottish markets from 1630 to 1815. This analysis offers a unique opportunity to examine market integration in the context of a rapidly growing pre-industrial economy, which experienced expansions in market structures, urbanisation and development in financial and physical infrastructure

Price convergence and co-movement are the empirical standards of the market integration literature. These are measures of the law of one price in first and second statistical moments, respectively (Uebele, 2011). The law of one price states that the price of a homogenous, widely traded commodity should be equal in all markets. If price differentials for the same commodity emerged across markets, they would eventually be eliminated by arbitrage. Merchants respond to price differentials by purchasing a commodity in a location where it is available at a lower price and selling it at a location where its price is higher (Isard, 1995). The law of one price never holds in an absolute sense because transport costs cause a differential between prices even in highly integrated markets. In markets where barriers to trade are high, price differentials may be larger, reflecting tariffs and other factors that increase the cost of trading (Isard, 1995).

If arbitrage efficiently eliminates price differentials, the volatility level of price changes across markets should be low. Market efficiency, a variance measure of the law of one price, tests this by measuring the co-movement of price changes across markets. These trends may indicate the degree to which information about developments in supply and demand conditions across all markets is reflected in local markets' price changes. If price movements

are synchronised, price volatility will be transmitted in times of common crises, but in times of local crisis, price volatility should be lower than under conditions of autarky as supply from distant markets augments local shortage (Persson, 1999). Ultimately, this suggests that integrated markets result in welfare gains and historically should have reduced the severity of local subsistence crises as merchants shipped commodities to deficit regions in times of local shortage.

Market location was an important factor in determining price differentials. Peripheral markets served by poor transportation infrastructure were likely to be less integrated. Therefore, infrastructure development was an important part of the process of market integration (Chilosi et al., 2013). Road and canal systems allowed commodities to be transported more easily and at lower costs (Buyst et al., 2006; Persson, 1999). This resulted in greater price convergence across markets as price differentials between markets fell. The speed of communications and the flow of information across markets affected merchants' ability to respond to arbitrage opportunities. Both of these increased over the eighteenth century across much of Europe and Britain, with postal services becoming more regular and newspapers providing regular coverage on the economic and financial press, including commodity prices (McCusker, 2009).

Studies of market integration have typically assessed price convergence and market efficiency in grain markets. The geographical level at which market integration has been studied ranges from national/regional markets to continental and global market levels. Studies have used wheat prices to track the integration of European markets from the late middle ages, stretching back in some cases to the eleventh century (Bateman, 2011; Rogoff et al., 2001; Federico et al., 2018). The consensus is that European markets were integrated from the fifteenth century and that the level of integration increased over the early modern era. Large international wars, which disrupted trade networks, like the Thirty Years War of the seventeenth century, and the French/Napoleonic Wars from the 1790s to 1815, caused temporary setbacks in the process of market integration (Federico et al., 2018).

By the eighteenth century, European colonial powers had established empires across America and India. Empire led to increasing trade levels across the global economy, as new exotic goods like sugar, tea, and tobacco from the Americas, and spices and textiles from India, flowed into Europe (Findlay and O'Rourke, 2003). Expanding agricultural capacity in the New World and advancements in transportation led to increased European grain imports from North America. Studies of market integration across continents, the globalisation literature, broadly have two opposing views. The consensus view is that globalisation began in the nineteenth century (Findlay and O'Rourke, 2003; Jacks, 2005; Ejrnæs et al., 2008; Uebele, 2011), and was driven by the technological advancements in communications and transport. Others argue that globalisation began earlier and find evidence of price convergence between North American and European markets in the eighteenth century (Dobado-González et al., 2012; Sharp and Weisdorf, 2013).

Price convergence and market efficiency has also been measured within national market structures. Integrated national markets brought significant welfare gains, including the capacity to respond in a more effective and coordinated manner to local or regional subsistence crises, redistributing food from surplus to deficit regions in times of crisis. Studies of

national market integration have been conducted for several countries, including England, France, and the Low Countries (Brunt and Cannon, 2014; Ejrnaes and Persson, 2000; Buyst et al., 2006), and have assessed the impact of international conflicts, increased speeds of communication, and declining transport costs, on the integration of national markets.

Table 1: Historical commodity market integration survey

Authors	Markets	Period
Cointegration/Error Correction		
Ejrnaes and Persson (2000)	Intra-national (France)	18–19th century
Jacks (2004)	Baltic Sea region	16–19th century
Jacks (2005)	International/Intra-national	18–20th century
Buyst et al. (2006)	Intra-national (Low Countries)	18th century
Ejrnæs et al. (2008)	International	19th century
Bateman (2011)	Continental (European)	14–19th century
Sharp and Weisdorf (2013)	International	18–19th century
Brunt and Cannon (2014)	Intra-national (England)	18–19th century
Federico et al. (2018)	Continental (European)	14–20th century
Dynamic Factor Analysis		
Uebele (2011)	International	19th century
Chilosi et al. (2013)	Continental (European)	17–20th century
Andersson and Ljungberg (2015)	Baltic Sea region	19th century
Federico et al. (2018)	Continental (European)	14–20th century

Studies of market integration have used various econometric techniques to test for price convergence and market efficiency. The coefficient of variation is traditionally used to test for price convergence in a multivariate context across a sample of markets. Cointegration techniques have been commonly applied in bi-variate cases to test the law of one price. This method assesses whether or not the residual between the price levels of a commodity in two markets is stationary using standard unit root tests. If stationarity cannot be rejected, it

suggests that a long-run equilibrium relationship may exist between prices at both markets and that the law of one price holds. An error correction model can then be applied to assess the degree to which prices adjust in response to a departure from equilibrium to restore the law of one price. Increased adjustment speed may reflect improvements in communications and physical infrastructure.

Recent studies of market integration have used dynamic factor analysis to test the efficiency of markets (Andersson and Ljungberg, 2015; Chilosi et al., 2013; Federico et al., 2018; Uebele, 2011). These panel models test for a number of common trends between market price movements and can be used simultaneously to test for integration at different levels, i.e., national, regional, continental, and global. The loading factors (coefficients) estimated by these models are used to estimate a variance decomposition for commodity price movements at each market, indicating the percentage of variation in each markets' price changes explained by each factor (Kose et al., 2003). These models avoid the problems associated with the estimation of adjustment speeds using low-frequency data with error correction models and the estimation of many parameters, which is necessary when using bivariate cointegration models.

2 Why Scotland?

There is a significant motivation for using Scotland as a case study to test national market integration. The Scottish economy experienced rapid economic development from the mid-seventeenth century, evolving from a primarily rural economy to a pre-industrial economy, which along with England, had the highest rates of urbanisation in Europe (Devine, 2000). This transformation was supported by a change in the organisation of agricultural production and marketing. Until the seventeenth century, Scotland's agricultural system was based on communal joint tenancy agreements, where the majority of the population had access to the land and cultivated it for their own needs. From the latter half of the seventeenth-century land clearances saw large proportions of the rural population, particularly in the Lothians and the Borders, displaced from the land; this ultimately increased the pace of urbanisation and the proportion of the Scottish workforce engaged in urban-based industrial employment. Urbanisation increased the need to organise food distribution, encouraging formal marketing structures and specialisation in agricultural production (Devine, 1989; Saville and Auerbach, 2006).

The Borderlands specialised in the raising of sheep, producing wool and meat, demand for which was sustained by growing urban demand in the towns of central Scotland and northern England (Devine, 2000). The Highlands specialised in cattle production, a trade from which the drove roads emerged between the Highlands and the central Lowlands. Drovers negotiated prices with Highland farmers based on expectations of southern demand. After cattle had been transported to the Lowlands, they could either be used for domestic consumption or exported to foreign markets (Devine, 2000). Grain was produced in the fertile regions along the east coast, from Aberdeenshire to East Lothian. The favourable climate and the quality of its land supporting the cultivation of barley, oats, rye, and wheat. Specialisation increased the need for domestic trade as Highlanders purchased grain from

their east Lowland neighbours and the border region imported cattle and grain from the north and east of the country (Devine, 1989). Grain was shipped along the entire east coast from the Moray Firth to the Lothian region and was exported to foreign ports, particularly to the Baltic region in times of surplus (Rössner, 2008; Gibson and Smout, 1995b).

The western Lowlands and in particularly Glasgow, owed its development to the textile industry. Linen production increased the urban workforce in Glasgow. Glasgow linen found ready markets in the border region and the north of England after the Union of Crowns in 1603 brought a reduction of market restrictions on trade with England (Devine, 2000). The overall growth and development of Glasgow and the west of Scotland from the early eighteenth century also affected regional commercial development in the west. Markets in Argyll and the Inner Hebrides benefitted from the expansion of the cattle trade from the north. The plantation of Ulster under James VI and I created a neighbouring centre through which Glasgow could market its agricultural and textile produce (Cochran, 1985; Devine, 2000).

The expansion of domestic trade and commerce led to the formation of mercantile networks among Edinburgh's 'Merchant Princes' in the early seventeenth century (Lynch, 1989). Collaboration in the charting of and investment in shipping for trade and the formulation of a credit system based on bills of exchange dates back to the 1620s (Lynch, 1989). These developments were correlated with a resurgence in Scotlands overseas trade, which began in the late fifteenth-century (Lynch, 2011). Trade was mainly in raw materials, wool, hides, skins, salt and coal, and agricultural goods, depending on local conditions (Devine, 2000).

Both Whatley (2000) and Devine (1994) note the increasingly commercial or market orientation of landowners from the end of the seventeenth century. This is evidenced in several ways. There was an increase in the number of tenancies where rents were paid in money rather than in kind: in Leven, less than 10% of tenancies were cash rents in 1650, but this had increased to 46% by 1710 (Devine, 1994). "Improvement leases", which required tenants to adopt new technologies, became more widespread outwith the Highlands, whilst the number of single tenant (as opposed to multi-tenant) leases fell. Average lease length increased, and more renewals of leases were made available to tenants that could pay the highest rents (rather than to the existing tenant). One driver of the need for improvements in agricultural productivity is noted by Campbell and Skinner (1982) as the needs of more powerful landowners who joined London's political elite after 1707 for higher incomes from their land, in order to offset the higher costs of maintaining a London presence.

The patterns of rural clearances and urbanisation that had emerged in the seventeenth century intensified throughout the eighteenth century, encouraging further developments in agricultural production and marketing (Devine, 2000). The coastal trade network in grain that had emerged between the ports of the east coast in the seventeenth century extended its influence to the West under Edinburgh merchants (Gibson and Smout, 1995b). Scotland's international trade levels increased as the Union of Parliaments in 1707 granted Scotland duty-free entry to English markets and equal terms in England's colonial trades. Glasgow became the centre of the colonial entrepot trade, re-exporting consumer products like tobacco and sugar to European markets. These trades, along with the linen industry, helped establish Scotland's industrial manufacturing roots, and by the nineteenth century,

the country was ripe for industrial expansion in the coal, cotton, iron, and shipbuilding industries (Finlay, 2001).

The expansion of the Scottish economy in the eighteenth century was supported by developments in the country's financial and physical infrastructure. Scotland's banking system developed from the late seventeenth century with the establishment of the Bank of Scotland (1695) and the Royal Bank of Scotland (1727) (Munn, 1981). Along with the private banking system, these and many other banks provided credit to Scottish merchants and producers, enabling an expansion of trade and land improvement. Scottish Banks also provided credit through the use of inland bills of exchange on London, a trade which increased following the Union of Parliaments with more Scottish officials resident in London and therefore engaged in remittance between London and both Edinburgh and Glasgow (Cullen, 2012). The banking system also directly provided money for investment in Scottish shipping, warehouses, and inventory (Saville and Auerbach, 2006). Scotland's physical infrastructure also expanded in the eighteenth century. The developments in turnpikes by turnpike trusts (Devine, 1994), military roads, and drove roads (Haldane, 1952) to serve the Scottish cattle trade, and the development of inland waterway transport enabled easier transportation of commodities across Scotland to serve newly emerging markets.

3 Methodology

The coefficient of variation has been widely applied throughout the historical market integration literature to test for price convergence. The coefficient of variation is calculated by expressing the standard deviation of our panel of market prices as a percentage of the mean in each year.

$$\frac{\sqrt{\sum(\frac{(x_i-\bar{x})^2}{n})}}{\bar{x}} \tag{1}$$

Most recently Federico et al. (2018) used the coefficient of variation to test for price convergence in European wheat markets from the mid-fourteenth century until the early twentieth century. The coefficient of variation is easy to calculate, is comparable across time and space for the same product, and is robust to quality differentials for homogenous products such as wheat. It is also a direct measure of market integration that can be arranged as a time series and subjected to standard econometric tests (Federico, 2011).

We test the coefficient of variation for structural change using the Bai and Perron (1998, 2003) test for multiple unknown structural breakpoints. This test selects the number of breakpoints, m, which minimises the sum of squared residuals in the Bai Perron test equation. This results in $m+1$ segments over which the level of price convergence is structurally different. The results allow us to identify phases and historical turning points in the process of integration (or disintegration). We use these to segment all further time series analysis, as testing across the full sample in the presence of structural change would be misleading.

To test trends in the price convergence process over time, we apply a Hodrick Prescott filter to decompose long-run trends from short-run cyclical movements. To further establish the pattern of integration empirically, we follow the approach of Federico et al. (2018) to estimate linear trends in the coefficient of variation in each time segment identified by our

structural breakpoint analysis.

$$\Delta ln(CV_t) = c + \beta Time + \delta ln(CV_{t-1}) + \lambda ln\Delta ln(CV_{t-1}) + \mu_t \tag{2}$$

Where $Time$ tests for the presence of a deterministic trend, if β is negative it suggests that the coefficient of variation falls over time and therefore prices are converging, δ is the coefficient on the error correction term and measures the speed of adjustment back to the trend in the event of an economic shock which causes temporary disintegration, and the lagged shock term $ln\Delta ln(CV_{t-1})$ accounts for possible serial correlation.

To test market efficiency we use a dynamic factor model. This model is used when co-movement is tested for $N > 2$ series. All series in the sample are tested individually against a common benchmark. This benchmark is found be decomposing a panel of prices series from different markets, $P_{i,t}$ (i=1,...,N are markets, and t=1,...,T are time units) into common and idiosyncratic components.

$$P_{i,t} = \alpha_i + \lambda_i C_t + \mu_{i,t} \tag{3}$$

where α_i is a constant, C_t represents the common component, λ_i is a loading factor (coefficient) which links the i-th variable to the common component, and $\mu_{i,t}$ is the idiosyncratic component which accounts for specific local market conditions, i.e. local harvest failures, and fluctuations in supply and demand conditions (Uebele, 2011).

When the model outlined in equation 3 is used to test for market efficiency, regional and national trends in price movements are used to explain price changes at each market centre. The idiosyncratic components derived for each market indicate the strength of local factors in determining price movements. Regional factors may explain price changes among a subset of towns or regions within a nation, these are geographically regional (or subnational) factors. Multi-level models can be formulated by adding regional components to the model in equation 3,

$$P_{i,t} = \alpha_i + \lambda_{i,c} N_{t,c} + \sum_{k=2}^{k} \lambda_{i,k} R_{t,k} + \mu_{i,t} \tag{4}$$

Equation 4 is the standard model adapted for application to a national market, N represents a common 'national' factor; increases in the strength of this factor across time can be used to track the emergence of a unified national market. The R factors are included to account for the influence of regional or subnational factors on price changes. In our model, these capture regional effects in either the east or west of the country. The common regional components in equation 4 are orthogonal to the common national component; this ensures that they are linearly independent. The idiosyncratic component is likewise orthogonal to the sum of the national and regional common components.

The factors estimated in the above model are then used to decompose the variation of price changes at each market according to their co-movement with national and regional trends of price co-movement. This provides an exact breakdown in percentage terms of the amount of variation in each market's price movements explained by national, regional, and

local factors. To decompose the variance of price changes at each market the loading factor for each market is multiplied by the variance of each estimated factor, this proportion is then added to the variance proportion caused by idiosyncratic, local factors, to calculate a total price variance measure for each market,

$$\sigma^2(y_{i,t}) = (\lambda_i)^2\sigma^2 N_t + (\delta_i)^2\sigma^2 R_{r,t} + \sigma^2(\mu_{i,t}) \tag{5}$$

after which a simple ratio provides a breakdown of the fraction of total volatility explained by each factor (Kose et al., 2003).

4 Data

We use fiars grain prices to test for Scottish regional market integration.[1]. Scotland's fiars courts met each year to determine official prices for grain products. Prices were 'struck' by local sheriffs around Candlemas (2 February) at each county's fiars court. The price struck was representative of the previous winter's prevailing price for each grain and was typically based on price observations from November to early February. Fiars prices were used as an economic yardstick to settle payments in kind. Many different forms of contracts and dues, including the settlement of crown and feudal duties, relied on these prices for settlement. This was an important consideration in early modern Scotland, particularly in the early seventeenth century, when economic conditions were relatively underdeveloped.

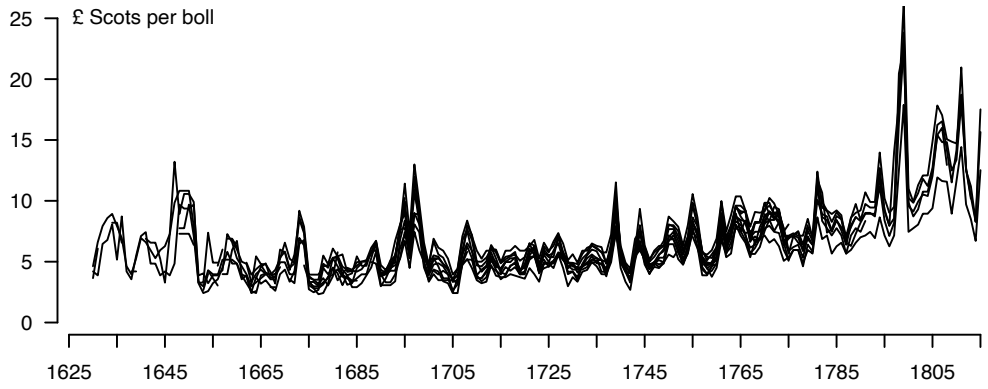

Figure 1: Scottish oatmeal prices, 1630–1815

[1]Fiars prices to 1780 were compiled and published in (Gibson and Smout, 1995a) for all Scottish counties with surviving records. For the period after 1780, fiars prices were published in (Flinn et al., 1977) and subsequently made available digitally on the International Institute of Social History's website http://www.iisg.nl/hpw/scotland/

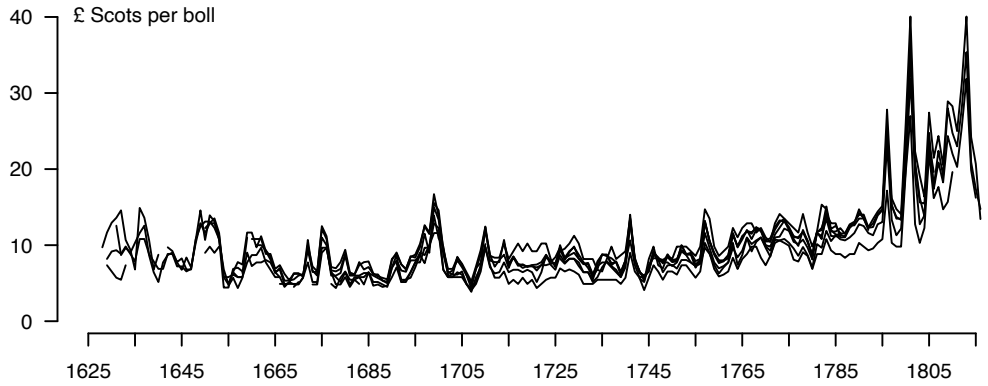

Figure 2: Scottish wheat prices, 1630–1815

The first of two quantitative studies on Scottish grain prices was published in 1965. Rosalind Mitchison analysed the movements of grain prices across Scottish regional markets in the seventeenth and eighteenth centuries (Mitchison, 1965). She concluded that significant co-movement only emerged in the eighteenth century, with a nationwide grain market emerging in the 1730s. In 1995, Alex Gibson and Chris Smout published a history of prices, food, and wages in Scotland (Gibson and Smout, 1995a). In the same year, they used this data to conduct a regional market integration study, focusing on the correlations of price movements across Scottish grain markets (Gibson and Smout, 1995b). They contested Mitchison's claim that Scottish markets only became integrated in the eighteenth century. The results of their analysis suggest that a Scottish national grain market had emerged in the second half of the seventeenth century.

Both Mitchison (1965) and Gibson and Smout (1995b) used fiars prices in their studies. Both highlighted some of the advantages and shortcomings of this data. Despite being struck using price evidence from the winter months only, both Mitchison (1965), and Gibson and Smout (1995b) have suggested that fiars price provide an adequate overall guide to price trends and movements in early modern Scotland. Annual grain price series derived using fiars data are generally only about four percent lower than national averages derived using prices from monthly market reports (Gibson and Smout, 1995a). They are also one of the longest and most complete sets of price records for the early modern era and even surpass the data available for England at this time (Mitchison, 1965).

In figures 1 and 2, we present fiars prices for oatmeal and wheat in pound Scots per boll. The Scottish currency was replaced by sterling after 1707 at a ratio of twelve to one; however, the pound Scots continued to be used as a unit of account for most of the eighteenth century. A boll was a Scottish measurement of dry capacity, which was just over four times the size of a Winchester bushel. The size of a boll varied by region throughout Scotland.

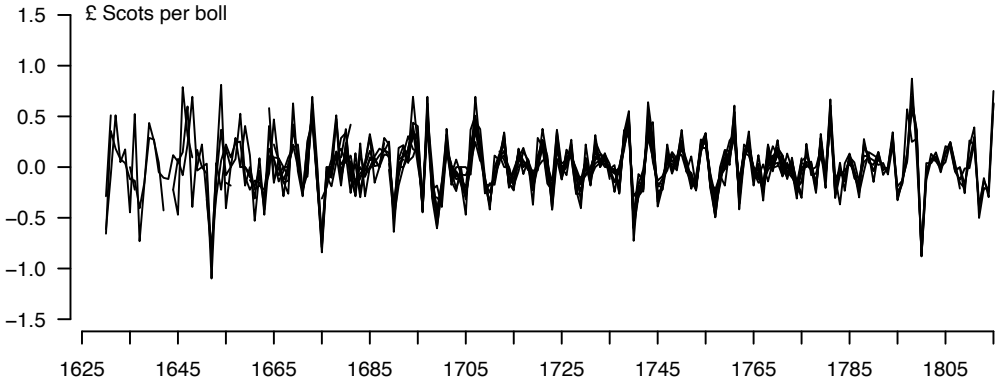

Figure 3: First differenced Scottish oatmeal prices, 1630–1815

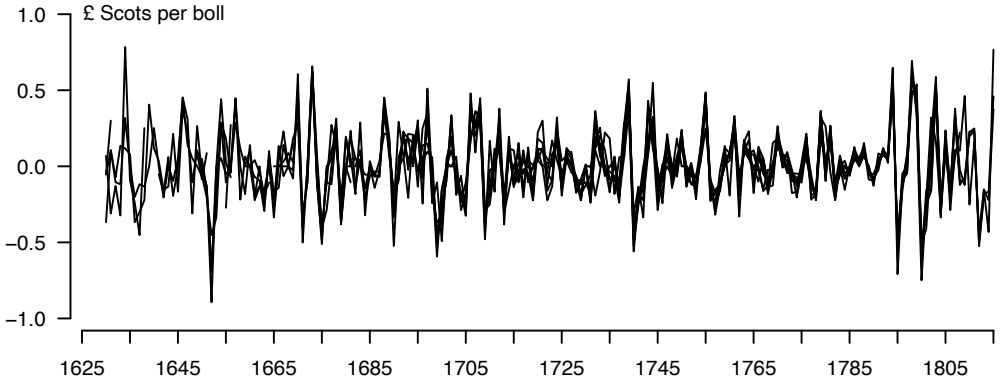

Figure 4: First differenced Scottish wheat prices, 1630–1815

Gibson and Smout (1995a) provide the capacity measures for each regional boll relative to the Linlithgow boll, the Scottish standard. The data in figures 1 and 2 have been converted from local boll measures to the Linlithgow boll, therefore all prices are in pounds Scots per Linlithgow boll. Figure 1 plots regional oatmeal prices from 1630 to 1815 for the Aberdeen, Ayr, Berwick, Edinburgh, Fife, Forfar, Glasgow, Lanark, Linlithgow, Perth, and Stirling markets. In figure 2, we present fiars wheat prices for Aberdeen, Ayr, Berwick, Edinburgh, Fife, Haddington, Linlithgow, Perth, and Stirling. Unfortunately, there is missing data for

some markets for the periods before the mid-seventeenth century, and after 1780, however, both of these periods still include prices for a significant number of markets.

Figures 1 and 2 suggest that the timing of price convergence in Scottish oatmeal and wheat markets was different. For oatmeal prices, significant price convergence appears to have occurred by the end of the seventeenth century. Wheat prices do not show any clear trend towards price convergence until the 1730s, when it looks as if prices began to converge across regional markets. In figures 3 and 4, we present price movements in oatmeal and wheat markets. Price changes in oatmeal markets appear to have become more synchronised from the late 1690s. In wheat markets, price co-movements appear highly synchronised from around the 1730s.

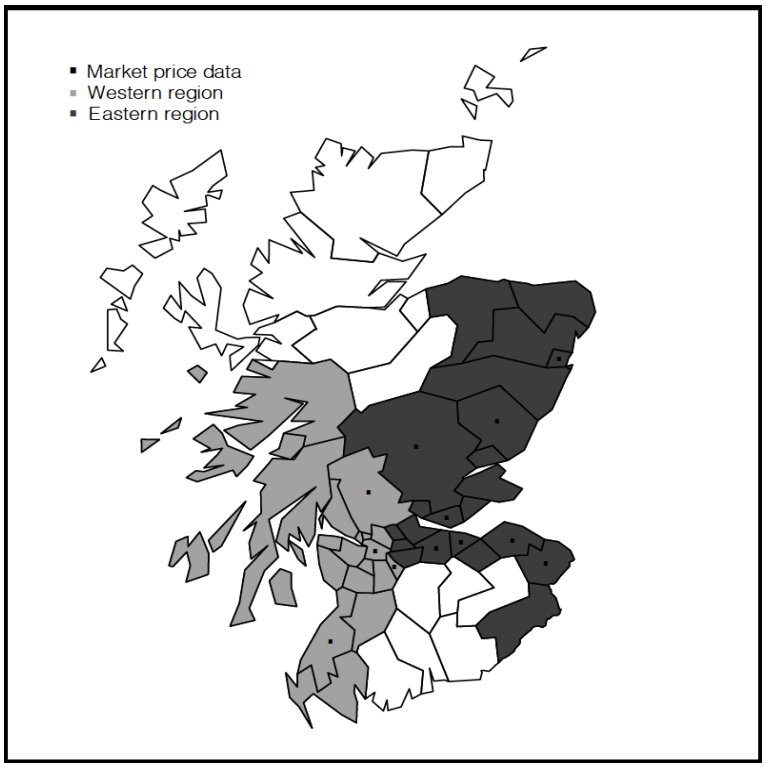

Figure 5: Scottish sub-national markets, seventeenth century

As discussed above, Gibson and Smout (1995b) argue that regional influences in Scottish markets were strong in the seventeenth century. In the map in figure 5, we show the markets for which we allow eastern and western regional factors to load on in our dynamic factor model. We test for western regional price trends among all markets shaded in light grey (Ayr, Glasgow, Lanark, Linlithgow, and Stirling) and for eastern regional price trends among all the markets shaded in dark grey (Aberdeen, Berwick, Edinburgh, Fife, Forfar, Haddington, and Perth). All the other regions, in white, represent regions for which price data is not available for the full sample period, and therefore we make no assumptions about regional influences in these areas. The areas shaded in our map are loosely based on the old Scottish

shires and not modern county boundaries.

5 Results and discussion

Figures 6 and 7 present the coefficients of variation for regional Scottish oatmeal and wheat markets. The level of price convergence was relatively higher among regional wheat markets in the seventeenth century and, despite significant volatility, remained fairly constant until the 1730s. In oatmeal markets, the level of price convergence was relatively lower, but the trend in figure 6 suggests that convergence increased substantially between the 1650s and the 1680s. Wheat was not widely consumed domestically; therefore oatmeal markets are probably more reflective of domestic market integration in Scotland.

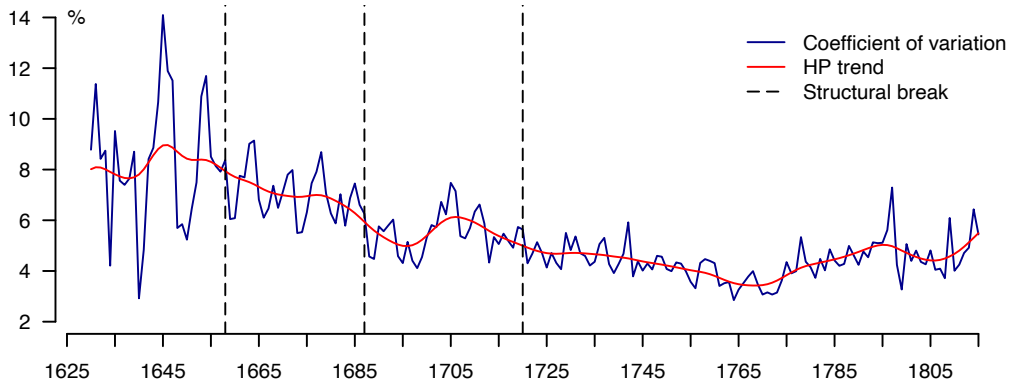

Figure 6: Coefficient of variation: oatmeal prices

Overall, price convergence increased over the course of the seventeenth and eighteenth centuries, but the process experienced temporary setbacks. The first setback occurred in the 1640s and 1650s when the level of price convergence in both oatmeal and wheat markets declined sharply. The timing of this decline suggests that the civil war and the Cromwellian occupation of Lowland Scotland had a significant impact on the functioning of inter-regional trade. As normal conditions returned in the late 1650s, the process of integration resumed, and in the following thirty years, price convergence increased substantially among regional oatmeal markets.

During the famine of the 1690s, the 'seven ill years of King William', the level of price convergence declined, a trend which lasted until 1705 in oatmeal markets and 1715 in wheat markets. The domestic harvest failures of the 1690s likely accounted for most of the decline in oatmeal markets; the famine caused by these failures resulted in widespread distress across Scotland and the death of somewhere between 5% and 15% of the Scottish population

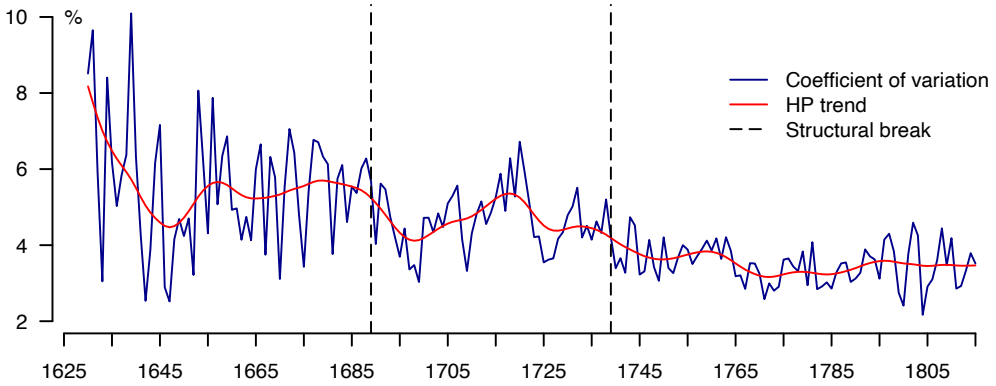

Figure 7: Coefficient of variation: wheat prices

(Cullen, 2010). However, in wheat markets where the decline lasted longer, trade disruptions related to the War of Spanish Succession likely affected the level of price convergence among Scottish regional markets. Wheat was more commonly exported than oatmeal and was likely more susceptive to volatility trends in international markets.

From 1705 until the 1770s, the level of price convergence consistently increased in oatmeal markets. Substantial progress was made too in wheat markets; the coefficient of variation in figure 7 shows an integration trend re-emerging from around 1715. Increasing integration in Scottish markets in this period reflects the developments of this time. Specialisation in production and inter-regional trade had increased substantially in the decades before this and were further strengthened by the Union of Parliaments, which resulted in the duty-free entry of Scottish exports to England and equal access to England's colonial re-export trade increasing external as well as domestic trade. Developments in banking, communications, and physical infrastructure like roads and canals all occurred in this period supplying credit to merchants and providing the physical infrastructure required to support growth in production and trade.

The American War of Independence brought a general downturn to the Scottish economy in the 1770s. Scotland was particularly affected by the war as it disrupted the hugely profitable re-export trade in tobacco and other colonial products. With this downturn came a decline in the level of price convergence among regional markets. However, this decline was largely confined to oatmeal markets, with movements in the wheat markets much lower. This demonstrates the importance of the colonial re-export to the Scottish economy in the eighteenth century and shows the potential for spill-over effects from international trade to domestic trade and regional integration. The level of convergence did not recover but managed to stay relatively stable in level terms throughout the French/Napoleonic Wars, but the volatility increased, likely reflecting the influence of wartime disruptions to international

trade networks.

Table 2: Error correction model: coefficient of variation

Period	Time coefficient	Error correction coefficient
Oatmeal		
1630–58	0.02	-0.58
1658–87	-0.001	-0.99**
1687–1720	-0.0002	0.33
1720–1815	0.00	-0.38**
Wheat		
1630–89	0.001	-0.80***
1689–1739	0.0005	-0.31*
1739–1815	-0.0001	-0.66***

Our dynamic factor analysis results suggest that market efficiency consistently improved across regional markets in the seventeenth and eighteenth centuries. We segmented our analysis according to our structural breakpoint test results and tested for efficiency separately in oatmeal markets between 1630–58, 1658–87, 1687–1720, and 1720–1815, and in wheat markets between 1630–89, 1689–1739, and 1739–1815.

The results for oatmeal prices, presented in figure 8, suggest that local conditions determined price changes in the first half of the seventeenth century. However, by the second half of the seventeenth century, regional conditions accounted for a significant proportion of the West's total variation in price trends. Up to half of the variation in price changes at Ayr, Glasgow, and Linlithgow is explained by a combination of regional and local factors. Local factors explained less than ten percent of the variation at Glasgow and Linlithgow, but nearly twenty percent at Ayr, a geographically peripheral market, with the rest explained by variation in national trends.

In the eastern part of the country, national and local market conditions affected price changes across markets at Edinburgh, Fife, and Perth. Gibson and Smout (1995b) suggest that the east coast market eventually developed into a national market; this likely accounts for the fact that regional factors are not detected in eastern prices. By the early eighteenth century, national conditions had begun to dominant price changes in the west also, suggesting

that a unified national market had emerged by this stage.

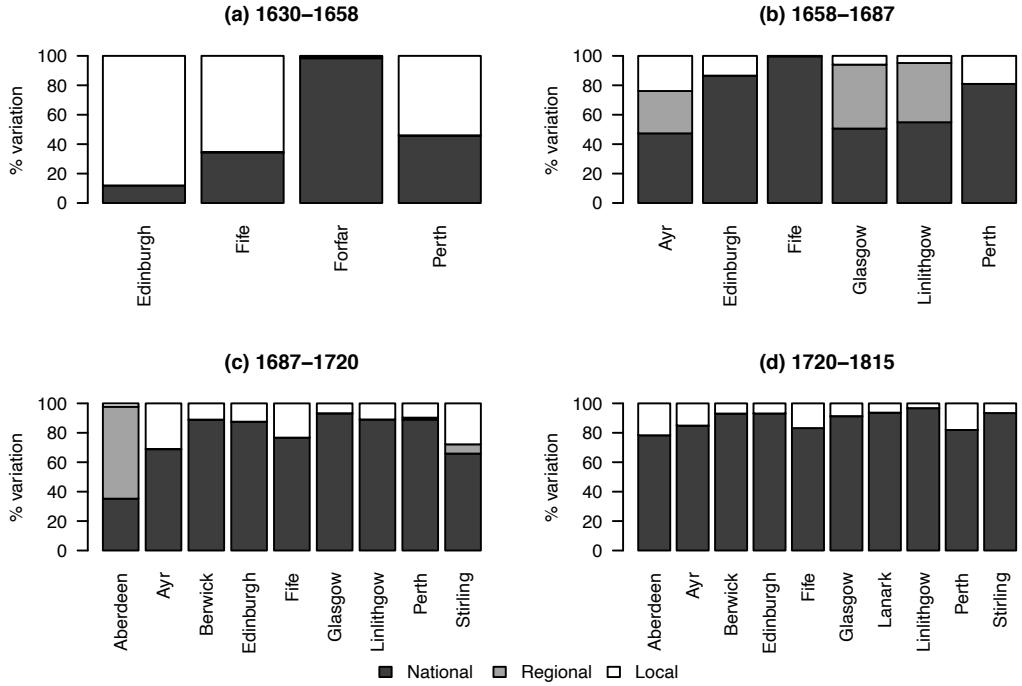

Figure 8: Dynamic factor models variance decompositions: oatmeal price changes

Local conditions still exerted some influence on price changes in the eighteenth century, particularly in peripheral markets like Ayr. As the eighteenth century progressed, however, the size of local influences in peripheral regions came into line with the levels of other markets, as shown in panel (d) of figure 8. Integrated market conditions increased the synchronisation of real conditions across markets, and in the eighteenth century, very few periods of local food shortage took place (Mitchison, 1965). Integrated markets likely influenced this, with increased capacity for arbitrage ensuring redistribution of food supplies from surplus to deficit regions in times of shortage.

Conditions in wheat markets remained relatively constant throughout the seventeenth and eighteenth centuries. The influence of local conditions in determining price changes in geographically peripheral markets declined after 1739, as indicated in figure 9. These developments reflect the expansion of infrastructure and communications throughout the eighteenth century as information and commodities could now reach all areas much faster. Unlike in oatmeal markets, regional influences did not affect wheat prices at any time in the seventeenth or eighteenth centuries. This likely reflects the fact that wheat was traded internationally and was not used for domestic consumption to the same extent as oatmeal.

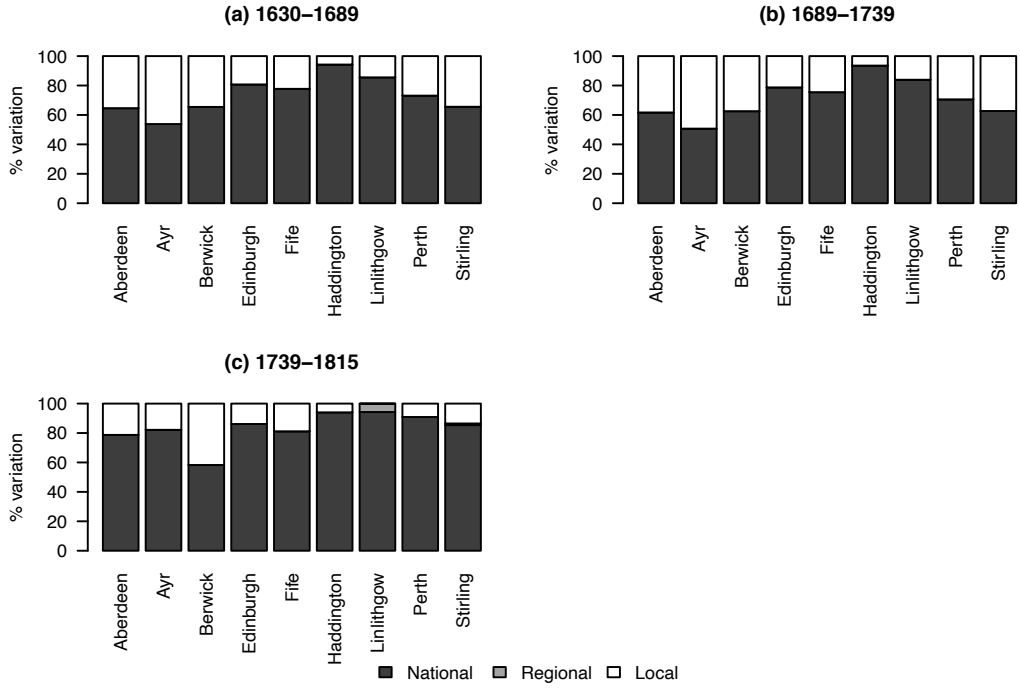

Figure 9: Dynamic factor models variance decompositions: wheat price changes

6 Conclusion

This article examines regional market integration in Scottish grain markets from the early seventeenth century until the end of the long eighteenth century in 1815. In this period, Scotland experienced rapid economic development driven by specialisation in production, the emergence of formal market structures, and the expansion of Scotland's financial and physical infrastructure. We test for price convergence across regional oatmeal and wheat markets using a range of econometrics techniques, including the coefficient of variation, error correction models, and dynamic factor models. The use of a dynamic factor analysis allows us to identify the emergence of a national market by estimating the influence of local, regional, and national conditions on price movements.

Our results suggest that the level of price convergence among Scottish regional markets increased over the course of the seventeenth and eighteenth centuries but that the process suffered a series of setbacks. These setbacks were caused by the impact of wars and famines on the functioning of markets. The civil war and the Cromwellian occupation of the 1640s and 1650s, the famine of the 1690s, and three international wars, the War of Spanish Succession, the American War of Independence, and the French/Napoleonic Wars, all caused the level of price convergence among regional markets to decline. Of these three wars, the American War of Independence, which led to structural changes in the composition of Scottish

trade, had the longest-lasting effect on the level of price convergence.

Our dynamic factor analysis results suggest that market efficiency in regional Scottish markets increased from the second half of the seventeenth century. In oatmeal markets, local conditions determined price changes in the early decades of the seventeenth century. By the second half of the century, sub-national (regional) markets had emerged in the east and the west. In the eighteenth century, these regional influences declined and gave way to a national market through which price changes were synchronised across the country. By contrast, price changes in wheat markets, a commodity that was not as widely consumed domestically, were not influenced by regional factors and were synchronised at a national level from the seventeenth century. However, infrastructure and communication developments reduced the influence of local market conditions on wheat price changes in the eighteenth century.

These results suggest that regional market integration is strongly affected by developments in production, market structures, communications, infrastructure, and trade networks. Political factors, like the Act of Union (1707), were important, but the timing of integration indicates that regional integration in Scotland was well underway before English markets were opened to Scotland duty-free. This suggests that the development of formal market structures and the conversion to a cash economy, which were encouraged by land clearances from the mid-seventeenth century, was an important driver of integration. International trade likely further incentivised the formation of efficient mercantile networks with the expansion of Scotland's trade with England after 1707 and participation in England's colonial re-export trade in the eighteenth century. The heights of the colonial re-export trade were correlated with a period of deep integration in Scottish grain markets, which only declined when the re-export trade was disrupted with the end of the revolutionary war in the American colonies and the establishment of the United States.

References

Andersson, F. N. and Ljungberg, J. (2015). Grain market integration in the baltic sea region in the nineteenth century. *The Journal of Economic History*, 75(3):749–790.

Bai, J. and Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, pages 47–78.

Bai, J. and Perron, P. (2003). Computation and analysis of multiple structural change models. *Journal of applied econometrics*, 18(1):1–22.

Bateman, V. N. (2011). The evolution of markets in early modern Europe, 1350–1800: a study of wheat prices. *The Economic History Review*, 64(2):447–471.

Brunt, L. and Cannon, E. (2014). Measuring integration in the English wheat market, 1770–1820: New methods, new answers. *Explorations in economic history*, 52:111–130.

Buyst, E., Dercon, S., and Van Campenhout, B. (2006). Road expansion and market integration in the Austrian Low Countries during the second half of the 18th century. *Histoire & mesure*, 21(XXI-1):185–219.

Campbell, R. R. H. and Skinner, A. S. (1982). *The Origins and nature of the Scottish Enlightenment: essays*. J. Donald.

Chilosi, D., Murphy, T. E., Studer, R., and Tunçer (2013). Europe's many integrations: Geography and grain markets, 1620–1913. *Explorations in Economic History*, 50(1):46–68.

Cochran, L. E. (1985). *Scottish trade with Ireland in the eighteenth century*. John Donald.

Cullen, K. (2010). *Famine in Scotland-the'Ill Years' of the 1690s*. Edinburgh University Press.

Cullen, L. M. (2012). *Economy, Trade and Irish Merchants at Home and Abroad, 1600-1988*. Four Courts Press.

Devine, T. (1989). *Social responses to agrarian 'improvement': the Highland and Lowland clearances in Scotland*, pages 148–168. Cambridge University Press.

Devine, T. M. (1994). *The transformation of rural Scotland: social change and the agrarian economy, 1660-1815*. Edinburgh Univ Pr.

Devine, T. M. (2000). *Scotland*, volume 2 of *The Cambridge Urban History of Britain*, pages 151–164. Cambridge University Press.

Dobado-González, R., Garcia-Hiernaux, A., and Guerrero, D. E. (2012). The integration of grain markets in the eighteenth century: early rise of globalization in the west. *The Journal of Economic History*, 72(3):671–707.

Ejrnaes, M. and Persson, K. G. (2000). Market integration and transport costs in France 1825–1903: a threshold error correction approach to the law of one price. *Explorations in economic history*, 37(2):149–173.

Ejrnæs, M., Persson, K. G., and Rich, S. (2008). Feeding the British: convergence and market efficiency in the nineteenth-century grain trade. *The Economic History Review*, 61:140–171.

Federico, G. (2011). When did European markets integrate? *European Review of Economic History*, 15(1):93–126.

Federico, G., Schulze, M.-S., and Volckart, O. (2018). European Goods Market Integration in the Very Long Run: From the Black Death to the First World War. London School of Economics and Political Science, Department of Economic History, Working Papers, No. 277.

Findlay, R. and O'Rourke, K. H. (2003). Commodity market integration, 1500-2000. In *Globalization in historical perspective*, pages 13–64. University of Chicago Press.

Finlay, R. (2001). *The Oxford companion to Scottish history*, chapter 1770–1850: the age of industrialization. Oxford University Press, Oxford].

Flinn, M. W., Gillespie, J., and Hill, N. (1977). *Scottish Population History from the 17th Century to the 1930s*. Cambridge University Press.

Gibson, A. J. and Smout, T. C. (1995a). *Prices, food and wages in Scotland, 1550-1780*. Cambridge University Press.

Gibson, A. J. and Smout, T. C. (1995b). Regional prices and market regions: the evolution of the early modern scottish grain market 1. *The Economic History Review*, 48(2):258–282.

Haldane, A. R. B. (1952). *The drove roads of Scotland*. Birlinn.

Isard, P. (1995). *Exchange Rate Economics*. Cambridge University Press.

Jacks, D. S. (2004). Market integration in the North and Baltic Seas, 1500-1800. *Journal of European Economic History*, 33(3):285–329.

Jacks, D. S. (2005). Intra- and international commodity market integration in the Atlantic economy, 1800–1913. *Explorations in Economic History*, 42(3):381–413.

Kelly, M. (1997). The dynamics of Smithian growth. *The Quarterly Journal of Economics*, 112(3):939–964.

Kose, M. A., Otrok, C., and Whiteman, C. H. (2003). International business cycles: World, region, and country-specific factors. *american economic review*, 93(4):1216–1239.

Lynch, M. (1989). *Continuity and change in urban society, 1500–1700*, pages 85–117. Cambridge University Press.

Lynch, M. (2011). *Scotland: a new history*. Random House.

McCusker, J. (2009). British commerical and financial journalism before 1800. In Suarez, M. F. and Turner, M. L., editors, *The Cambridge History of the Book in Britain*, volume V, pages 448–65. Cambridge University Press.

Mitchison, R. (1965). The movements of Scottish corn prices in the seventeenth and eighteenth centuries. *The Economic History Review*, 18(2):278–291.

Munn, C. (1981). *The Scottish Provincial Banking Companies 1747-1864*. Donald.

Persson, K. G. (1999). *Grain Markets in Europe 1500–1900 Integration and Deregulation*. Cambridge University Press.

Persson, K. G. and Sharp, P. (2015). *An economic history of Europe*. Cambridge University Press.

Pollard, M. and Ang, T. (1984). *Walking the Scottish Highlands: General Wade's Military Roads*. Deutsch.

Rogoff, K., Froot, K. A., and Kim, M. (2001). The Law of One Price Over 700 Years. IMF working paper, WP/01/174.

Rössner, P. R. (2008). *Scottish trade in the wake of union (1700-1760): the rise of a warehouse economy*. Number 198. Franz Steiner Verlag Wiesbaden gmbh.

Saville, R. and Auerbach, P. (2006). Education and social capital in the development of scotland to 1750. In *Prepared for the Economic History Society Annual Conference, University of Reading*, volume 31.

Sharp, P. and Weisdorf, J. (2013). Globalization revisited: Market integration and the wheat trade between North America and Britain from the eighteenth century. *Explorations in Economic History*, 50(1):88–98.

Uebele, M. (2011). National and international market integration in the 19th century: Evidence from comovement. *Explorations in economic history*, 48(2):226–242.

Whatley, C. A. (2000). *Scottish Society, 1707-1830: beyond Jacobitism, towards industrialisation*. Manchester University Press.

European Historical Economics Society

EHES Working Paper Series

Recent EHES Working Papers

2020

EHES 199 The Pre-kautilyan Period: a sustainable model through ancient economic ideas and practices,
Satish Deodhar, Sriram Balasubramanian

EHES 198 Accounting for Growth in Spain, 1850-2019,
Leandro Prados de la Escosura, Joan R. Rosés

EHES 197 Capital in Spain, 1850-2019,
Leandro Prados de la Escosura

EHES 196 Lordships, state capacity and beyond: literacy rates in mid-nineteenth-century Valencia,
Francisco J. Beltrán Tapia, Alicia Gómez-Tello, Julio Martinez-Galarraga, Daniel A. Tirado-Fabregat

EHES 195 Builders' Working Time in Eighteenth Century Madrid,
Mario García-Zúñiga

EHES 194 Is there a Refugee Gap? Evidence from Over a Century of Danish Naturalizations,
Nina Boberg-Fazlic, Paul Sharp

EHES 193 Epidemics, inequality and poverty in preindustrial and early industrial times,
Guido Alfani

EHES 192 The two Revolutions in Economic History,
Martina Cioni, Giovanni Federico, Michelangelo Vasta

EHES 191 Populism and the First Wave of Globalization: Evidence from the 1892 US Presidential Election,
Alexander Klein, Karl Gunnar Persson, Paul Sharp

EHES 190 The Feudal Origins of Manorial Prosperity in 11th-century England,
Vincent Delabastita, Sebastiaan Maes

All papers may be downloaded free of charge from: www.ehes.org

The European Historical Economics Society is concerned with advancing education in European economic history through study of European economies and economic history. The society is registered with the Charity Commissioners of England and Wales number: 1052680