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‘Deep’ Integration of 19th Century Grain Markets: Coordination and Standardisation in a Global Value Chain

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Abstract:
This paper explores the dynamics underlying integration of the international grain markets of the nineteenth century. It demonstrates that ‘deep’ integration implied changes to market structures, firm strategies *and* the commodity being marketed. Coordination within grain markets occurred at multiple levels (markets, firms, committees, etc.) and involved various firm strategies (integration, co-specialisation, voluntary consensus, etc.). There was a greater degree of standardisation as centralised grading systems were developed by commodity exchanges in the US and UK. Greater standardization *made* the commodity fungible and tradable through an institutional rather than a technical process. The global value chain that emerged during this period developed governance structures and institutions to coordinate the enormous expansion in scope as well as scale of trade. Many of these structures and institutions continue to coordinate the international markets in the twenty-first century. The paper uses the global commodity value chain (GCC) approach to develop these arguments and focuses on the international wheat trade of the nineteenth century - centred on UK as the major importer. This research stresses that governance and institutions that enable global *disintegration* (of the value chain) crucially drives and informs our understanding of market integration – they are two sides of the same historical coin.

The dominant historical view considers price convergence to be irrefutable evidence of globalisation and international market integration.[1]

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This view has informed most recent studies of market integration in the nineteenth century providing stylised facts about international markets during that episode of globalisation.[2] Most economic historians accept that price spreads between transatlantic markets declined as real commodity prices converged in accordance with the law of one price (LOOP). The reasons for this convergence are believed to be increases in market efficiency in addition to the decline in trade and transport costs.

North (1958), and later Harley (1988), had stressed the role of declining transportation and freight costs on the price convergence of commodities, particularly wheat, during the latter half of the nineteenth century. Recent literature has provided new estimates of price convergence and expanded the role for other transaction and trade cost reductions in reducing price spreads.[3] Economic historians believe that policy and institutional factors had a significant impact on market integration, as much as, if not more, than technological factors.[4] Such facts have reignited the debate regarding the proximate causes for market integration, more robust estimations of the extent and efficiency of

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[1] Kevin H. O'Rourke and Jeffrey G. Williamson, *Globalization and History: The Evolution of a Nineteenth-Century Atlantic Economy* (Cambridge, MA: MIT Press, 1999). Kevin H. O'Rourke and Jeffrey G. Williamson, "When Did Globalisation Begin?," *European Review of Economic History* 6, no. 01 (2002).

[2] David S. Jacks, "What Drove 19th Century Commodity Market Integration?," *Explorations in Economic History* 43, no. 3 (2006). David S. Jacks, Christopher M. Meissner, and Dennis Novy, "Trade Costs in the First Wave of Globalization," *Explorations in Economic History* 47, no. 2 (2010). Karl Gunnar Persson, "Mind the Gap! Transport Costs and Price Convergence in the Nineteenth Century Atlantic Economy," *European Review of Economic History* 8, no. 02 (2004). Mette Ejrnæs, Karl Gunnar Persson, and Søren Rich, "Feeding the British: Convergence and Market Efficiency in the Nineteenth-Century Grain Trade," *The Economic History Review* 61, no. s1 (2008). etc.

3 Persson, "Price Convergence."

4 Jacks, "Market Integration." Jan Tore Klovland, "Commodity Market Integration 1850-1913: Evidence from Britain and Germany," *European Review of Economic History* 9, no. 02 (2005).

integration, and the timing and speed of market adjustment.[5] These issues remain engaging to economic historians.

The price convergence – trade cost literature, however, remains silent on some important issues surrounding market integration. This literature assumes that markets (and firms) internalised the externalities that drove the expansion in trade volumes, i.e. increase in the *scale* of trade. Such externalities include technological changes (cost of transportation and distribution), economic (transaction costs and coordination), political (trade restrictions, stable monetary regime), etc. Why and how were markets (and firms) able to capture these externalities? Why and how were markets (and firms) able to capture these externalities? Did it depend upon organisational, structural or institutional changes to the market(s)? Did firms integrate, form new networks, centralise activities, etc.? How crucial was the role of institutions such as commodity exchanges and trade associations? These are important questions if we are to understand integration as a historical process.

Further, modelling techniques used in the price-convergence literature control for product quality in order to establish price convergence. In other words, an assumption of product homogeneity or fungibility is made in most price convergence studies.[6] The models assumes that fungibility is a technical attribute and that it is achieved costlessly. Importantly, the models mask the *increase* in product heterogeneity that was the consequence of expanding international trade. For a staple commodity such as wheat, the number of varieties (distinguished both by quality and biological variety) available in British

5 Ejrnæs, Persson, and Rich, "Convergence & Efficiency." Jacks, Meissner, and Novy, "Trade Costs."

6 This is a common assumption in neo-classical models. Alfred Marshall had argued that commodities such as wheat, cotton and iron could be traded over large distances because they could be easily and exactly described; Alfred Marshall, *Principles of Economics*, 2nd Edition ed. (London: Macmillan and Co., 1891). Book V Ch1 p. 285.

markets increased from 16 to 65 between c1850 and c1880. Market integration entailed an expansion of the *scope* of commodity trade as well as *scale* of international trade.

This paper provides new insights on such issues by taking a different approach and asking different questions. It explores the dynamics underlying market integration by studying the historical processes and the structural changes experienced by markets as they became increasingly more integrated. How did the grain markets alter - structurally and organisationally - to accommodate the increased scale as well as scope of trade? Did the structural and organisational change determine the speed with which markets integrated in the nineteenth century? How did the markets coordinate the increasingly complex trade in an increasingly complex commodity? Such questions are answered by understanding the 'deep' integration of international grain markets in the nineteenth century.

'Deep' integration in this paper refers to a greater, more explicit and deeper level of coordination and control. It is characterised by the elimination of product differences through the harmonisation of practices as well as by standardisation of products, emergence of governance structures and market institutions, evidence of multiple levels of coordination, and a global dependence on value-added activities. This approach moves away from the exclusively market-oriented or firm-oriented view of integration. It incorporates explanations for historical changes to the *commodity*, in addition to the market structure and firm strategies and offers a broader perspective on the historical processes.

Correspondingly, the paper explores the integration process through the study of global commodity chains and claims that global *value chains* – as opposed to global trading networks –emerged in the grain markets in the late nineteenth century. Global commodity chain (GCC) analysis presents powerful insights on three of the most important

issues driving market integration: institutional changes that lowered transaction and information costs that had acted as barriers along international markets; structural changes within the markets that enabled economic groups to internalise the externalities generated during the 'first wave of globalisation'; the speed of institutional and structural changes which in turn affected the speed of integration. In this paper, the commodity chain studied is the international wheat-flour chain of the nineteenth century centred around UK as the major consumption centre.

The GCC analysis is distinct from the *world systems* view proposed by Immanual Wallerstien and Andre Gunder Frank and the strong *a priori* assumptions regarding systematic long term trade between the 'core' and the 'periphery.' Rather, the analytical framework developed for this paper, discussed in detail in the following section, is based upon the approaches developed by Gereffi (1994), and Gibbon (2001).[7] The main advantage of the GCC approach is that it focuses on the changing structural and institutional relationships, traces the economic behaviour of heterogeneous groups linked by the chain (producers, intermediaries, and consumers), and analyses the diverse ways in which economic activity is coordinated along the chain.

This paper presents four arguments in relation to integrating grain markets of the nineteenth century. Coordination in international wheat markets occurred at multiple levels (markets, firms, committees, etc.) and in several different ways (integration, co-specialisation, voluntary consensus, regulation, etc.). Markets had to standardise various ways of measuring and grading an increasingly complex commodity. As a result, decentralised and *de facto* standards that had historically emerged in

[7] Other historians have used a similar approach to commodity chains, which is different from the World Systems view; see contributions in Steven Topik, Carlos Marichal, and Zephyr Frank, eds., *From Silver to Cocaine: Latin American Commodity Chains and the Building of the World Economy, 1500-2000* (Durham & London: Duke University Press, 2006).

domestic markets were replaced by centralised quality grades developed by commodity exchanges. These grades, which emerged independently in the US and UK formed the basis of the international trade by the last quarter of the nineteenth century. Fungibility of this commodity was dependent upon such standardisation and grading and was institutionally created, rather than technically derived. This institutional process was greatly influenced by the coordination forms and structures, and was the result of explicit negotiation and consensus. The international value chain that emerged during this time developed various governance structures and institutions, which helped to coordinate activity along the chain. They also helped to develop the standards and grades that underscored the international expansion, both in terms of scale and scope. Thus, for example, institutions transformed quality testing into quality assurance by standardisation that enabled the markets to manage the increasing heterogeneity of an internationally traded commodity. The paper claims that these historical changes, which occurred during the second half of the nineteenth century, enabled 'deep' integration to develop between international grain markets.

The major implications of the arguments made in the paper are twofold. First, economic historians need to be cautious that over the long term commodities change or alter, both in an institutional as well as a physical/technical sense. Fungibility, tradability and homogeneity of commodities are social constructs and not inherently physical qualities. Commodities were *made* easily describable so that they could become fungible and tradable; they were not universally or easily describable to begin with.[8] Historical surveys over the long periods need to be cognizant of dynamic markets, firms *and* commodities. Second, international integration in the nineteenth century was an enduring process, with implications beyond the historical period during which prices converged.

[8] Marshall, *Principles*. Book V Ch 1.

The seeds of the integrated international markets for many commodities, such as wheat and other grains, in the twentieth century lay in the forms, structures, and institutions that emerged during late nineteenth century. The effects of integration endured beyond the nineteenth century because productive and economic activity could be effectively disintegrated globally.[9]

The main arguments are developed in the rest of the paper in the following manner. Section I explains the overall methodological approach and develops the analytical framework for the global chain analysis. Section II describes the changing structure of the trade during the nineteenth century in terms of market structures and the business groups that formed the value chain. It sets the basis for understanding why coordination and standardisation were crucial issues along this commodity chain. Section III explores how the trade developed various different ways to grade this complex commodity, why this was a prolonged process, and how eventually these grades became acceptable standards internationally. Section IV describes how the non-trading firms within this chain adopted the grades, while developing their own methods of coordination and standardisation. Section V examines the evidence and develops the main arguments. The concluding section offers remarks on the broader implication of the 'deep' integration analysis.

I

The overall methodological approach in the paper is to analyse integration as a long-term historical process rather than as shifts in equilibria. Analytically, this permits the observation of changes *within* markets and the dynamics *along* the networks connecting the markets, in

[9] Robert C Feenstra, "Integration of Trade and Disintegration of Production in the Global Economy," *The Journal of Economic Perspectives* 12, no. 4 (1998).

addition to observing convergence *between* the markets. 'Deep' integration can be established by investigating product standardisation, and the development of institutions and governance structures. The criteria for deep integration is thus greater coordination and control.

This important link between coordination and integration was stressed by Lawrence (1996) when he used the term 'deep integration' to mean the elimination of differences in national production and product standards, credible and stable governance mechanisms, secure access to large foreign markets and removal of barriers to regional production systems and service investment.[10] Birdsall and Lawrence (1999) argue that deeper integration (among nations) brings 'integration not only in production of goods and services but also in standards and other domestic policies' (p. 128). International economists have stressed the problem of coordination in cross-border trade, particularly as exchanges in international markets have historically been subject to discontinuities in political and legal systems. Incomplete international contracts have had to rely upon international norms and customs for coordination.[11] The problem of coordination and control also becomes significant when we consider that trade integration has historically been accompanied by disintegration of production and consumption centres.[12] To understand trade integration, we also need to understand the disintegration of productive and consumption activities.

Global commodity chain (GCC) analysis offers a powerful way to analyse deep market integration, within this broader framework. Recent literature on commodity chains distinguishes between different types of

[10] Lawrence distinguishes 'deep' from 'shallow' integration, the latter of which, he argues, involves only the removal of border barriers to permit trade (p. 17).
[11] Dani Rodrik, "How Far Will International Economic Integration Go?," *The Journal of Economic Perspectives* 14, no. 1 (2000). Jean Tirole, *The Theory of Industrial Organization* (Cambridge, US: MIT Press, 1988). and Oliver Hart, *Firms, Contracts and Financial Structure* (New York: Clarendon Press, 1995). for problems of incomplete contracts.
[12] Feenstra, "Trade Integration."

coordination: producer-driven as distinct from buyer-driven, etc.[13] The analytical focus here is to unearth the mechanism of coordination – 'who does what' – with an objective of identifying the locus of control. The method does not assume that control depends upon the concentration of the ownership of productive resources. In this regard, the coordination approach distances this literature from its roots in the 'dependency theory' and *world systems view* where control of global trade was often equated with international control of productive facilities. The major insight from this literature is that industrial and commercial capital promoted global integration (as distinct from global trade) without direct ownership by establishing distinct forms of coordination.

Gibbon (2001) identified a form of coordination seen particularly within chains of 'traditional' primary commodities. This form of coordination, which he termed 'trader-driven', depended upon the 'shifting, highly filamented, upstream networks of trade and finance combined with more permanent downstream and horizontal networks (p. 351).' While such trader driven coordination has a special significance to the analysis of international grain markets, the broader issue is that this literature identifies a mechanism to analyse how global-scale production and distribution systems could operate without direct ownership of facilities.

This coordination focussed analysis of international chains enables us to examine whether price-convergence coincided with the emergence of specific coordination forms within international grain markets of the nineteenth century. We are also able to evaluate whether these coordination forms enabled firms to internalise the trade and transaction

[13] Gary Gereffi, "The Organization of Buyer-Driven Global Commodity Chains: How Us Retailers Shape Overseas Production Networks," in *Commodity Chains and Global Capitalism*, ed. Gary Gereffi and Miguel Korzeniewicz (Westport, Connecticut: Praeger, 1994). Gary Gereffi, "International Trade and Industrial Upgrading in the Apparel Commodity Chain," *Journal of International Economics* 48, no. 1 (1999).

externalities without the need for vertical integration or direct ownership. Finally, we are able to investigate whether this coordination mechanism rendered an inherently heterogeneous commodity fungible by eliminating differences and standardising the commodity.

GCC analysis is distinct from, but not necessarily at odds with, the diverse literature on business networks, and firm structures that promote trust and commitment in historic long distance trade.[14] Ties of kinship, religion, ethnicity or other forms of associations and the organisational structures of firms that reduced transaction and information costs (including costs of commercial information, determining business strategies, monitoring competition, and appraising investment decisions) are forms of coordination that enabled firms to become competitive and profitable. However, the framework of chain analysis developed here is able to analyse changes to the *commodity* in addition to the business groups and the economic ties between them. This is important, as this paper shows that increasing coordination within the chain involved 'making' the commodity fungible. The analysis in this paper will show that homogeneity and fungibility of primary commodities was not a technical attribute and historically was the product of negotiation and agreement.[15]

The main elements of the GCC analysis can be described as follows. The paper focuses on the emergence of a global commodity

[14] Avner Greif, "The Fundamental Problem of Exchange: A Research Agenda in Historical Institutional Analysis," *European Review of Economic History* 4, no. 03 (2000). Mark S. Granovetter, "The Strength of Weak Ties," *The American Journal of Sociology* 78, no. 6 (1973). James E. Rauch and Vitor Trindade, "Ethnic Chinese Networks in International Trade," *The Review of Economics and Statistics* 84, no. 1 (2002). Robin Pearson and David Richardson, "Business Networking in the Industrial Revolution," *The Economic History Review* 54, no. 4 (2001). Also Mark Casson and Howard Cox, "International Business Networks: Theory and History," *Business and Economic History* 22, no. 1 (1993). for a discussion of institutions and a transaction costs view of the firm.

[15] See James E. Rauch, "Networks Versus Markets in International Trade," *Journal of International Economics* 48, no. 1 (1999). who argues that homogenous commodities are distinguished by the fact that they have a reference price that helps to bring down search costs, unlike differentiated commodities that do not have a reference price and therefore depend upon network ties to match international buyers and sellers.

chain in the international wheat market of the nineteenth century, centering upon the UK as the main importing nation. The evidence for the formation of the GCC during the nineteenth century is evaluated on the basis of three criteria: a well-defined input-output structure that included various economic groups involved in the production, consumption and intermediation of the commodity, global dispersion of this structure and the various economic functions, and emergence of governance structures and institutions. This analysis is then used to evaluate the thesis of deep integration.

Standardisation is analysed on the basis of the standards of wheat quality and the complex norms that emerged to measure the quality of wheat along this chain. The theoretical discussion on the problem of quality standards and measurement was set out previously by institutional economists.[16] They argued that many (primary) commodities faced a fundamental exchange problem as delineating complete information about such products is inherently costly. Information, particularly about quality, is usually based upon multiple product attributes, creating the potential for information asymmetry – a classic principal-agent problem. Thus, the greater the number of measurable attributes, the costlier it is to measure the product *ceteris paribus*.

Transaction costs depend upon the *ease* with which quality attributes can be measured. Thus, *search* attributes (e.g. color, weight, etc.) are easier to measure at the time of transaction, whereas *experience* attributes (e.g. taste, functionality, etc.) can usually be measured on an *ex-post* basis. *Credence* attributes (e.g. method of production) cannot be measured even on an *ex-post* basis and are based upon trust, reputation or third-party certification.[17] Transaction costs also depend upon whether

[16] Yoram Barzel, "Measurement Cost and the Organization of Markets," *Journal of Law and Economics* 25, no. 1 (1982). Steven S Cheung, "The Contractual Nature of the Firm," *Journal of Law and Economics* 26, no. 1 (1983).
[17] Tirole, *Industrial Organization*.

measurable attributes capture information about a product's *condition* (freshness, moisture, color, size, etc.) or *composition* (chemistry, strength, purity, etc.) or *functionality* and performance ('does it do what it says on the tin?'). It is less costly, *prima facie,* to measure the product's condition rather than its composition or functionality.

The challenge facing economic groups within a commodity chain was likely how to manage or minimize the measurement problem. Standardisation is an effective tool in overcoming information asymmetry by ensuring that measurements are made on the basis of common or summary criteria.[18] Such common criteria could result from negotiation and compromise, and are not solely dependant upon economic or technical factors. Standardisation by third-party organizations, such as commodity exchanges also reduce potential costs by eliminating the need for repeated or duplicative measurements.[19]

Thus, standardization – meaning elimination of product differences – is intimately tied to the governance structures, institutions and forms of coordination along the chain. In fact, standardization requires considerable coordination efforts between individuals, groups, organizations and institutions at various levels.[20] This insight comes from 'convention theory' which distinguishes between several modes of coordination. This theory suggests that humans create 'equivalences' between themselves in a variety of ways. These include both cognitive as well as organizational forms. Consequently, coordination forms depend upon the level of complexity involved in making things more general – or

[18] Stefano Ponte and Peter Gibbon, "Quality Standards, Conventions and the Governance of Global Value Chains," *Economy and Society* 34, no. 1 (2005). Benoit Daviron, "Small Farm Production and the Standardization of Tropical Products," *Journal of Agrarian Change* 2, no. 2 (2002).
[19] Stephen Craig Pirrong, "The Efficient Scope of Private Transactions-Cost-Reducing Institutions: The Successes and Failures of Commodity Exchanges," *The Journal of Legal studies* 24, no. 1 (1995).
[20] Aashish Velkar, "Markets, Standards and Transactions: Measurements in Nineteenth Century British Economy " (London School of Economics, 2009). Unpublished PhD Thesis.

standardised - across contexts.[21] As complexity (of exchange) stretches from bi-lateral to multi-lateral, coordination stretches from being *ex ante* or *de facto* (between individuals) to *ex post* or explicit (by committees or associations). On this spectrum, market-coordination and firm-coordination lie somewhere between the two extremes. Importantly, there need not be a single rule or set of rules coordinating economic activity or behaviour.[22] This resonates with Gibbons' conception of coordination modes in primary commodity chains, discussed previously, where filamented networks combine with permanent structures.

The major archival sources consulted in preparing this paper include the records of the London Corn Trade Association (located at Guildhall Library, London, UK), reports of and evidence presented to various parliamentary select committee (pubished in the British Parliamentary Papers), and the UK Board of Trade Papers (located in London, UK). In addition, trade journals, such as *Miller*, provided facsimilies of letters by merchants and millers (which were treated as primary evidence) as well as technical and commercial reports (which were treated as secondary evidence). These journals, along with the Statistical Abstracts of the UK and other statistical information published in the Parliamentary Papers also provided valuable price and trade data. Published histories of the grain trade, merchants and business firms, as well as literature on millers and milling industry was invaluable in piecing together the structure of, and changes to, the international commodity chain. Evidence on the US commodity exchanges was primarily based upon published literature and histories, with the exception of select annual reports of the Chicago Board of Trade.

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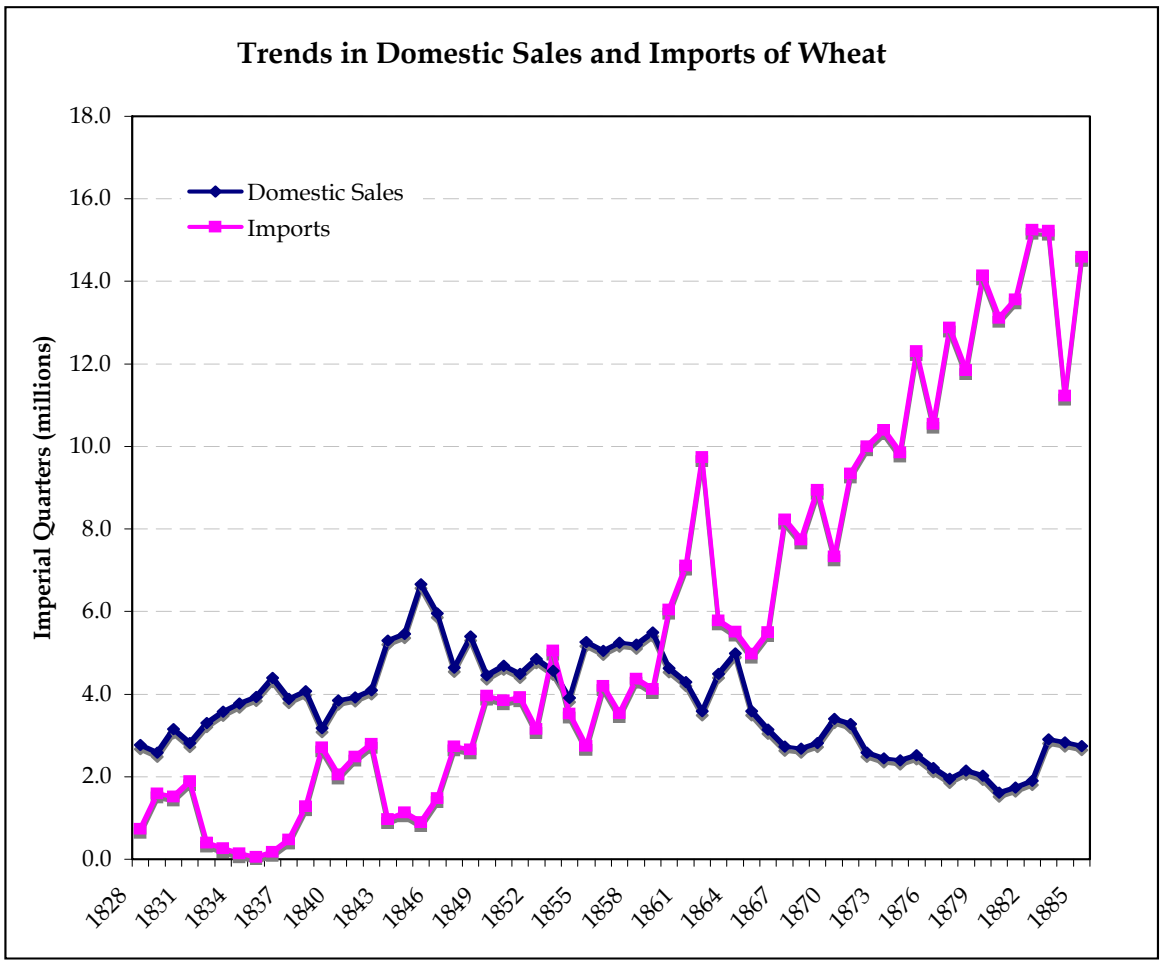
[21] Laurent Thévenot, "Organized Complexity: Conventions of Coordination and the Composition of Economic Arrangements," *European Journal of Social Theory* 4, no. 4 (2001): 406-407.
[22] John Wilkinson, "A New Paradigm for Economic Analysis?," *Economy and Society* 26, no. 3 (1997): 323.

II

The evidence for the emergence of a global value chain in the international wheat markets helps to unravel the profound changes to the input-output structure within the wheat markets. Market integration was accompanied by radical changes in the market composition and structure, the international sources of wheat and the major trade routes along which it flowed, the different economic groups involved in the market, and the degree of co-specialisation and integration of economic activity. Explaining these changes establishes the manner in which the externalities resulting from the economic, technological and institutional changes of the nineteenth century were internalised, i.e. whether through integration, co-specialisation, regulation or better governance structures. Finally, the changes to the commodity chains helps to shed light on an important historical question: why did Atlantic markets (e.g. UK-US) take almost a half century to mature from emerging international market following the repeal of the Corn Laws?[23]

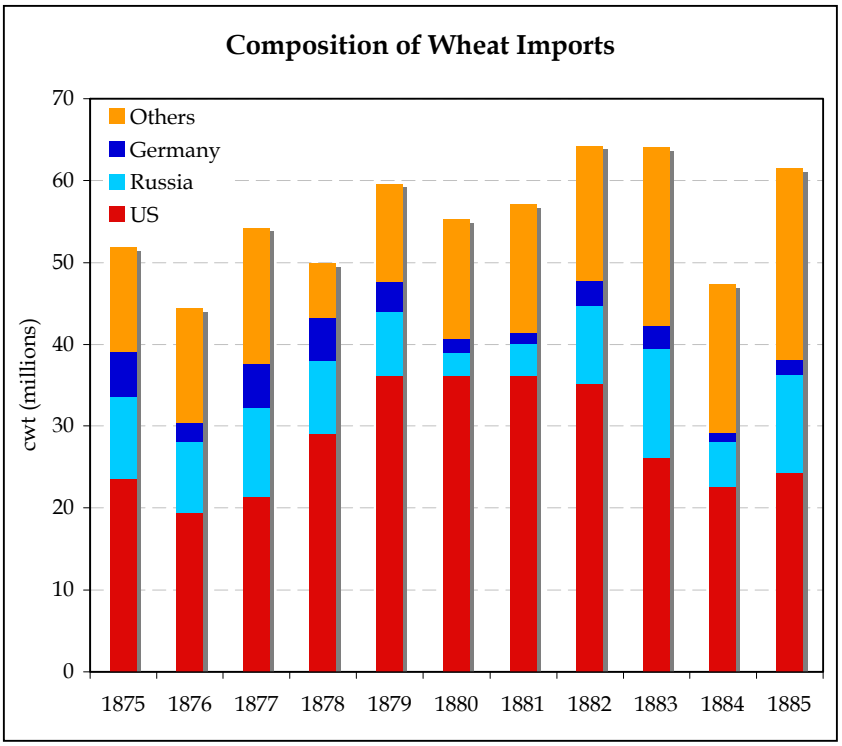
[23] Ejrnæs, Persson, and Rich, "Convergence & Efficiency," 3.

Figure 1:



Source: Data on domestic sales from PP 1889 Vol. LX p. 23; data on imports from PP 1886 Vol. LX p. 405.

Figure 2:



Source: Statistical Abstracts Nos. 37 & 38.

The wheat-flour commodity chain is analysed along four changing dimensions: the input-output structure of the commodity chain, its spatial dispersion along international trade routes, the internal governance structures, and the changing institutional framework. Throughout the nineteenth-century the volume of grain being sold and consumed grew exponentially. Domestic wheat sales increased roughly fives times in quantity between 1815 and 1850. With the repeal of the Corn Laws, which had restricted the import of foreign corn between 1815 and 1846, imports of wheat increased nearly tenfold between 1830 and 1885 (figure 1).[24] This slowed the growth in domestic wheat sales, and by the 1860s, more wheat was imported than was being sold in the domestic markets. The commodity was imported from several sources, the main sources

[24] See also Susan Fairlie, "The Corn Laws and British Wheat Production, 1829-76," *The Economic History Review* 22, no. 1 (1969).

being the US and Russia in the late nineteenth-century. However, wheat was also imported from Argentina, Australia, India and several other locations in Europe. In addition to wheat, these markets supplied the UK with other grain and cereals, such as barley, malt, rye, etc. The US imports became the single most important overseas source of grain for the UK in the last two decades of the nineteenth-century. On an average, imports of wheat from the US accounted for nearly half of the annual wheat import into the UK between 1875 and 1885 (figure 2). The impact on domestic wheat and flour prices of such imports concerned both the millers as well as the corn trade in general; both groups being equally concerned about profitability.[25]

The proportion of British population consuming wheat (and wheaten bread) increased throughout the nineteenth-century compared to consumption of other cereals. Whereas in 1800 about two thirds of the population of Great Britain were estimated to have been consuming wheat, by 1900 wheat consumption had become nearly universal, while the consumption of oats and barley declined. In per capita terms, consumption of wheat is estimated to have increased from 5.1 bushels to 5.5 bushels in the latter part of the nineteenth-century.[26] These shifts were a result of several factors, such as the decreasing price differentials of the various cereals, the high cross-price-income elasticity of wheat, degree of urbanization, the emergence of professional bakers and millers, technological improvements in milling, changing eating habits, etc.

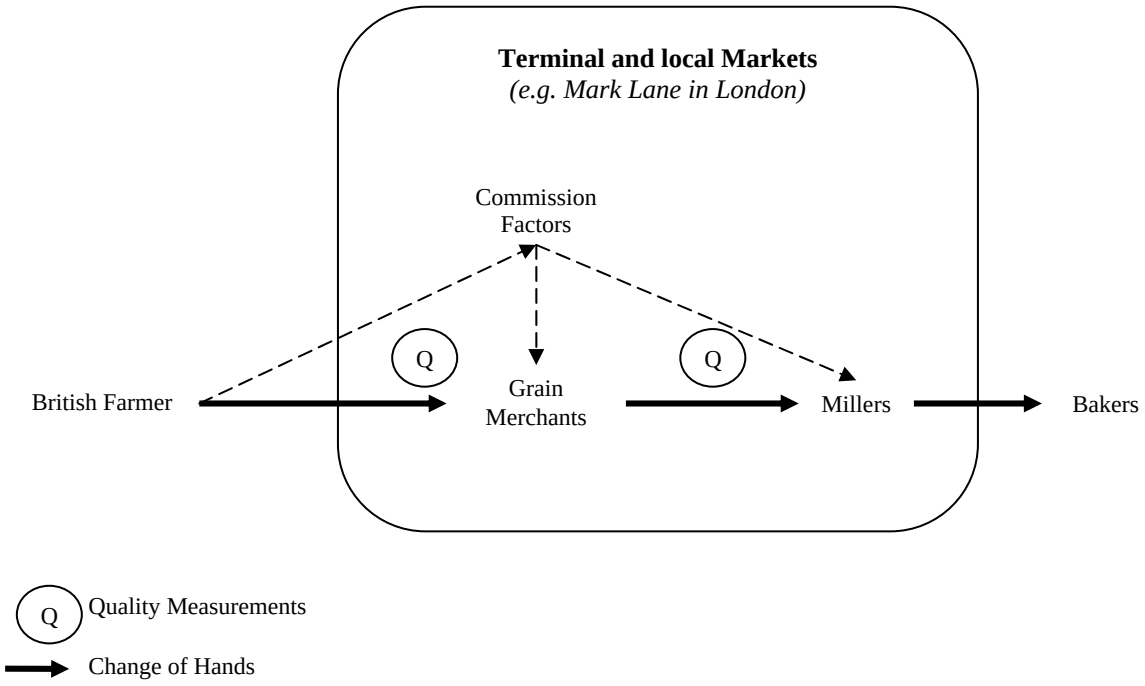
The input-output structure of the commodity chain changed radically during the nineteenth-century. By the end of that century, the

[25] PP 1886 Vol. XXI, First Report of Royal Commission on Depression of Trade and Industry, p 93, memo from Liverpool Corn Trade Association.
[26] E J T Collins, "Dietary Change and Cereal Consumption in Britain in the Nineteenth Century," *Agricultural History Review* 23 (1975): 114-115. Meanwhile, in the US, per capita wheat production doubled between 1850 and 1880 from 5 bushels to nearly 10 bushels, even as per capita consumption remained steady at 4.5 bushels; Morton Rothstein, "Centralizing Firms and Spreading Markets: The World of International Grain Traders, 1846-1914," *Business and Economic History* 17 (1988)., p. 106

commodity chain involved a complex organizational structure, characterized by layers of interrelated firms and organized commodity markets. Traditionally, a large domestic market, such as London, was supplied by the home counties of Kent, Essex and Suffolk. In the mid-eighteenth-century, a corn exchange was set up in Mark Lane in London, which signalled the beginnings of an organized or terminal market for wheat and other grains. Very few farmers sold directly at Mark Lane. Instead, the sale of wheat was controlled by a group of *factors*, known as 'hoymen'. They sold wheat and other grains on commission on behalf of the farmers. Wheat was mainly sold to the miller, while other corn was purchased by 'a galaxy of corn dealers [and other middlemen], many of whom were engaged in "dealings" or speculative activities alongside their basic trades.'[27] Private bargaining characterized the trades in such exchanges, with open or regulated market trades being insignificant or non-existent, at least in the early years. Wheat from the home counties that was not sent to London was sold to country millers, although it was not unusual for country millers to obtain wheat from London based factors.[28]

[27] Dennis Baker, "The Marketing of Corn in the First Half of the Eighteenth Century: North-East Kent," *Agricultural History Review* 18, no. 2 (1970): 136.
[28] C R Fay, "The London Corn Market at the Beginning of the Nineteenth Century," *The American Economic Review* 15, no. 1 (1925): 72-73. Baker, "Corn Marketing," 138.

Figure 3a
Domestic (UK) Wheat-Grain Commodity Chain

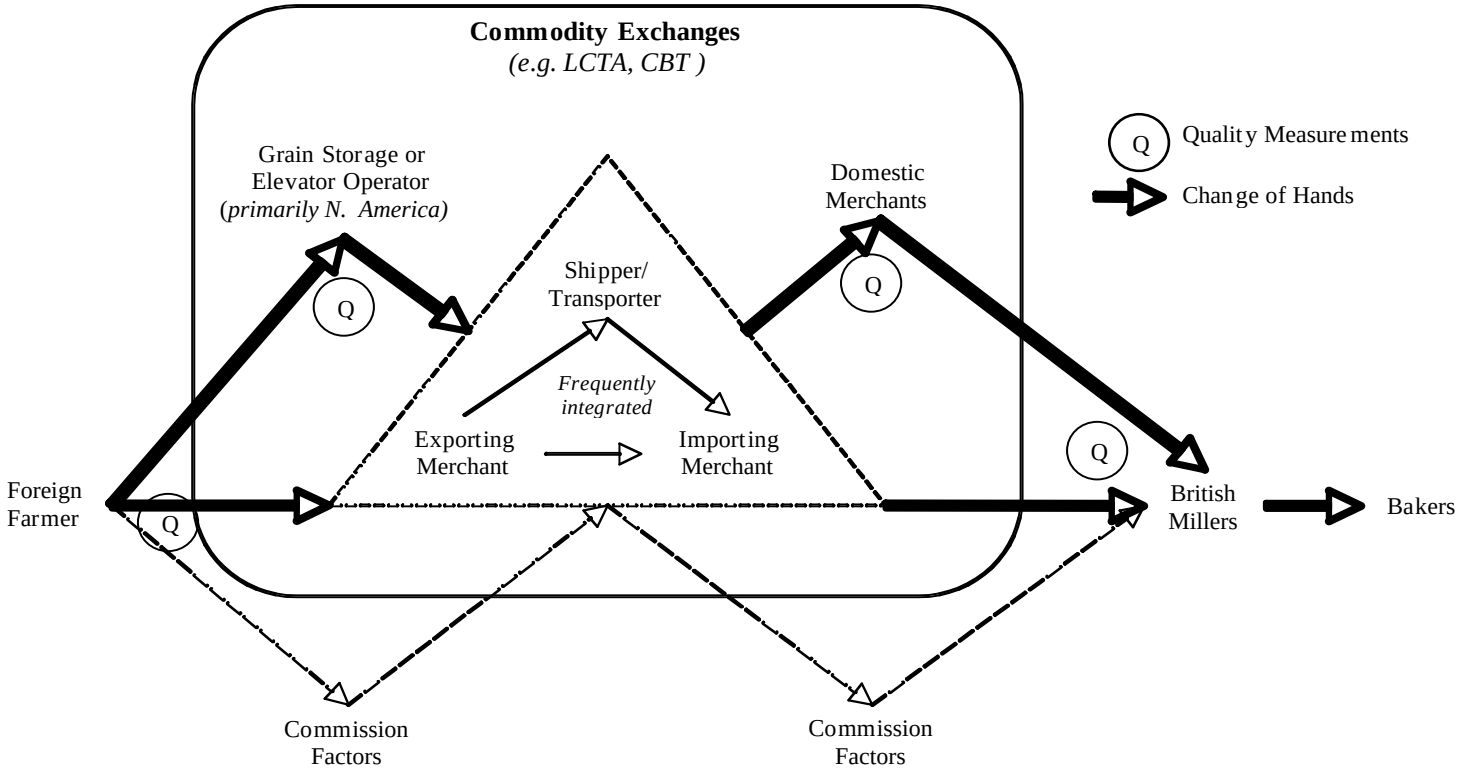


The mealman purchased and milled the grain - or got it milled from *millers* - and subsequently sold the flour directly to the bakers or on the open market.[29] Sometime during the eighteenth-century, the millers integrated several related activities: corn buying, grinding, dealing in meal and flour, etc. They effectively subsumed the functions of the mealman, whereby they began 'mealing', or mixing flour. Some bakers had begun to integrate backwards combining the functions of the baker, miller and mealman. Nevertheless, we find the millers and bakers as distinct groups in the nineteenth-century, suggesting that not all bakers had integrated backwards.[30]

[29] F. J. Fisher, "The Development of the London Food Market, 1540-1640," *The Economic History Review* 5, no. 2 (1935): 61.
[30] Baker, "Corn Marketing," 142-143.

By the end of the eighteenth-century, imported wheat began reaching British markets in large quantities, such as supplies of Irish corn sold in Liverpool. The *importing merchant* became an important member in this chain, although it was the factor that remained the main conduit for the buyers of wheat. As imports of wheat grew considerably after c1860 (figure 1), dynamics within the exporting country became significant.

Figure 3b
International Wheat -Grain Commodity Chain



The claim in O'Rourke (1997) that the 'invasion' of cheap grain from the New World increased real wages in the UK, and also elsewhere in Europe in more or less an accepted fact about the international grain trade of the nineteenth century. This 'invasion' required grain (wheat) exporting nations – the US, Australia, Russia, Argentina, etc. – to substantially expand land under wheat cultivation. From the UK perspective, this expansion of productive capacity was accompanied by three vital shifts. First, the imported wheat was of 'harder' variety compared to the 'softer' varieties that were increasingly grown in the UK.[31] Second, multinational merchants – who gradually transformed into multinational firms – dominated the intercontinential grain trade (e.g. Ralli Brothers). Several Anglo-Greek shipping firms that has depended upon historic, kinship ties were challanged by the newer multinationals who were integrating the various intermediary functions in the Atlantic trade.[32] In the US, 'grain barons' emerged who dominated various parts of the trade including milling, warehousing, and storage and transportation (e.g. Issac Friedlander, Washburns, Pillsburys, William Cargill, Frank Peavey, etc.).[33] Third, exporting countries, particularly the US, developed dedicated institutions and organistions that coordinated the marketing, distribution, storage, and quality control along the commodity chain (e.g. Chicago Board of Trade, Board of Railroad and Warehouse Commissions, etc.).

Broadly speaking, wheat sold by the farmer to the *exporting merchant* for reshipment to Britain would normally arrive in sacks at the importing port, which could be identified with the original seller. If grain

[31] John R Walton, "Varietal Innovation and the Competitiveness of the British Cereals Sector, 1760-1930," *Agricultural History Review* 47, no. 1 (1999).
[32] Geoffrey Jones, *Merchants to Multinationals: British Trading Companies in the Nineteenth and Twentieth Centuries* (New York: Oxford University Press, 2000). Stanley Chapman, *Merchant Enterprise in Britain: From the Industrial Revolution to World War I* (Cambridge: Cambridge University Press, 1992). Rothstein, "Centralizing Firms ".
[33] Dan Morgan, *Merchants of Grain* (New York: The Viking Press, 1979).

was mixed it was done by the importing merchant at the port of import. The most important exception to this was North American corn, which was sold to the operators of the grain elevators. Here the grain would be mixed with other grain of similar quality, the farmer receiving the price according to the quality. The operators would sell this mixed grain, of 'standard' quality either at the trade exchanges or to the exporting or commission merchants at the large primary markets, such as Milwaukee or Chicago.[34]

The important fact here is that the commodity changed hands a number of times along the chain as it travelled from the producer to the consumer. Also, value addition to the commodity occurred in various forms and along the various stages in this chain: sorting and grading, mixing and storage, transport and distribution, milling and baking, etc. These activities gradually dispersed internationally as the chains lengthened along international routes. Thus, grain milled into flour in Britain was most likely to have been grown, sorted, graded, and mixed in transcontinental locations, such as the Americas, by the end of the nineteenth century (figures 3a & 3b).

These facts highlight two important and related developments within the commodity chain. For the commodity to efficiently change hands a number of times and to go through the various stages of value addition along the chain, the commodity had to become fungible. Simultaneously, the exchanges between the buyer and the seller had to be well coordinated. Fungibility depended both upon the degree to which the product was standardised throughout the chain as well as the extent to which the producer's identity was alienated from the produce.[35] Coordination implied, among other things, the reduction in search costs as well as the emergence of effective dispute resolution mechanisms.

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[34] *Miller* (London) April 5, 1880, p 99.
[35] Daviron, "Standardization," 163.

The confluence of both these developments determined the speed and extent to which the chains lengthened and dispersed internationally. Both fungibility and coordination required standardisation and the elimination of product differences across international routes.

One of the key institutional innovations of the nineteenth century that aided these two developments was the emergence of the commodity exchanges in the US and UK. The exchanges began to standardise quality grades and commercial contract terms. Thus, they instituted new, or improved existing, governance structures along the chain. Few agricultural products could be standardized by simple and controllable processes by the end of the nineteenth-century. They were affected by several natural factors, and quality variations within the same variety or breed could occur in an unpredictable fashion.[36] This problem of standardisation implied that most disputes involving the sale of commodities such as wheat involved the inability of trading parties to agree on the quality of the goods. Indeed, in the nineteenth century, it was 'mostly the disputes over the condition and quality of goods sold that occupied the time of arbitrators.'[37] Disputes only multiplied as the volume of transactions increased throughout the nineteenth century and 'buyers [became] less disposed to leave themselves at the mercy of the shippers.'[38] Consequently, radical changes were made in the way quality was assessed along internationalising commodity chains.

Traditionally, it was in the interest of the mealman, who mixed different grades of wheat, to assess the quality of grain he bought, as there was often a substantial price differential between the best and

[36] Wells A Sherman, "Standardizing Production - What Has Been Done and What Can Be Done," *Annals of the American Academy of Political and Social Science* 142 (1929): 419.
[37] Robert B Ferguson, "The Adjudication of Commercial Disputes and the Legal System in Modern England," *British Journal of Law and Society* 7, no. 2 (1980): 145.
[38] C Chattaway, "Arbitration in the Foreign Corn Trade in London," *The Economic Journal* 17, no. 67 (1907): 428.

inferior quality wheats.[39] When the millers integrated the functions of the mealman by the eighteenth-century, the mixing of different grain quality, and therefore the assessment of quality, was done by them. With the establishment of the organized markets, such as Mark Lane or other regional markets, the assessment of quality was done at these nodes. This coincided with the rise in the practice of selling by sample. The buyer and the seller would agree on a price upon inspection of the sample and the delivery by the seller would have to conform to the quality of the assessed sample.[40]

From the mid-nineteenth-century onwards, commodity exchanges, such as the London Corn Trade Association (LCTA) or the Chicago Board of Trade (CBT), began to develop detailed mechanisms to measure and grade these complex goods. The exchanges were mainly concerned with grading imported wheats, not domestic ones: there is no evidence that either of these exchanges developed formal grades for the domestic trade. This is perhaps not surprising, as by the time these exchanges began developing formal grades c1880, the quantum of foreign imports was roughly eight times that of domestic sales (figure 1).[41] After c1860, grain imported from North America, especially from the Midwest area of the US, was shipped according to distinct quality grades. The grain elevator operators in the US did the grading, particularly since grain from different producers was being mixed during storage and prior to transportation.

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[39] Christian Petersen, *Bread and the British Economy, C1770-1870*, ed. Andrew Jenkins (Aldershot, England: Solar Press, 1995), 158-159. *PP 1805 Vol. III, Report of Select Committee on Import and Export of Corn,* p. 195, evidence of Peter Giles to the select committee stating that the price of good quality wheat could be double that of inferior quality.

[40] Baker, "Corn Marketing," 138. *PP 1834 Vol. XLIX, Returns from corn inspectors* p. 259.

[41] In 1880, foreign wheat imports amounted to 55 million tons as opposed to 6.7 million tons reported in domestic returns; *PP 1889 Vol. LX, Statistical Tables of Corn Averages*, p. 423. *PP 1886 Vol. LX, Report of Grain Imported into the UK,* p. 405.

By the end of the nineteenth-century, guaranteeing quality of imported wheat traded in the British markets was based primarily upon the grades that the exchanges developed. Commodity exchanges initially found it difficult to fix numerical grading standards. Standardised contract terms enforced by these exchanges provided an alternative mechanism for dispute resolution or arbitration even when product attributes could not be graded absolutely or quantitatively. The commodity exchanges therefore emerged as quality *assurance* or *guaranteeing* institutions.

Such standardisation by commodity exchanges can be understood on the basis of at least four arguments. First there is the reduction in the measurement cost argument. This view suggests that because primary commodities are effectively heterogeneous, absence of product standards or quality grades would have resulted in costly, repeated and duplicative examination by buyers and sellers.[42] Another view is the transaction cost argument, which suggests that standardized contract terms helped to institutionalize arbitration mechanisms and helped the 'clearing house system' within commodity exchanges.[43] The third view is the internationalization of farms argument, which suggests that commodity exchanges were instrumental in developing quality grades on the basis of which futures trading could develop. A futures market could transfer the price risk to a specialized group of speculators (the broker-merchants) linking local farms to the international markets.[44] Finally, there is the creation of trust argument, which supports the view that third party or 'official' grades are better able to guarantee quality than individual

[42] Pirrong, "Commodity Exchanges," 232-233.
[43] Ferguson, "Commercial Disputes," 144-145. Chattaway, "Arbitration," 428. R B Forrester, "Commodity Exchanges in England," *Annals of the American Academy of Political and Social Science* 155, no. 1 (1931): 201-203.. The 'clearing house system' that Forrester describes refers to the activities of passing shipping and other commercial documents between traders, settlement of contracts, clearing of differences, etc. all in relation to 'string transactions', p. 203.
[44] Daviron, "Standardization," 163.

inspection or certification.[45] It is likely that a combination of factors influenced the emergence of commodity exchanges and the resultant standardisation. Nevertheless, studying the development of standards, such as quality grades, by commodity exchanges provides important clues regarding the manner and extent to which internal governance structures developed or altered along the commodity chain.

There was a fundamental transition during the nineteenth century as far as quality standards were concerned. Measurement of quality transformed from a decentralised activity situated in regional or local markets into a centralised activity coordinated by the commodity exchanges. Further, the standards used to measure the quality of wheat were transformed from the *de facto* standards used within local or regional markets to voluntary consensus standards that were acceptable on an international basis. Finally, the role of quality standards itself transformed from measurement of quality to that of guaranteeing or assuring quality to the buyer.

The following sections analyse why and how this transition occurred during the nineteenth century in the international wheat grain commodity chain, primarily from the perspective of the UK markets. Along the way, it will shed light on two important questions. What institutional changes were required before product differences were eliminated along this commodity chain? How did the standardisation and institutional change help in reducing transaction costs?

III

Wheat markets dealt with numerous varieties of the commodity, based not only upon botanical distinction but also the distinct

[45] J C F Merrill, "Classification of Grain into Grades," *Annals of the American Academy of Political and Social Science* 38, no. 2 (1911): 61.

characteristics of each botanical variety. Before 1840, few varieties apart from several descriptions of the Red Lammas type were available in domestic British markets. In the 1850s and 1860s, many more varieties began appearing in the farm sales notices, including Hertfordshire White, Golden Drop, Trump, Spalding, Suffolk, April, Taunton, Mexican, Dantzic, Malaga, White Scotch, etc. At least 16 different domestic wheat types were available for sale in English grain markets in the 1850s, each differing not only in gluten content – the chemical substance which determines the bread-making ability of wheat - but also in terms of yield (i.e. quantity of grain per acre).[46] In addition to the domestic varieties, wheat imports greatly increased the total number of varieties available for sale in British markets. One source listed more than 25 domestic varieties (including distinct grain types as well as grains of different quality) and about 40 foreign ones available in 1884.[47] Prices of over a dozen American and European varieties in London and Liverpool were regularly reported in addition to prices of wheat from Bombay, New Zealand, Australia, Chile, and French varieties such as Nantes, Bayonne and Lille.[48] The internationalisation of the wheat markets, thus, not only increased the sources of the commodity and the trade routes along which it travelled, but dramatically increased the heterogeneity of the wheat available for purchase in British markets.

Millers and bakers in Britain naturally responded to the internationalising wheat markets by using a ‘grist’ made of numerous wheat varieties. Mixing of different wheat varieties allowed the widest possible use of inferior grade of wheats, which by themselves would have been unsuitable for making baking flour, particularly in London and other larger towns. Mixing also eked out the supply of expensive best quality

[46] Walton, "British Cereals," 45-48.
[47] William Jago and William C Jago, *The Technology of Bread-Making* (London: Kent & Co., 1911), 272-279.
[48] see *Miller*, various issues.

wheat, and enabled the miller to enhance his margin by mixing expensive and inexpensive wheats and still sell the mixed flour at a price higher than that of inferior quality flour.[49]

A typical mixture recommended in the eighteenth-century included one part best quality wheat to one part second-best quality wheat to two parts inferior quality wheat.[50] As the availability of foreign wheat increased, best quality imported wheat was mixed with lower quality domestic varieties.[51] In conjunction with the abolition of the assize in 1836, this greatly increased the choice of wheat available for the miller to mix in various proportions, vastly compounding the complexity of the mealing process.[52] By the latter half of the nineteenth-century, millers required knowledge about the varieties available, its sources, and quality; the millers craft now required a great deal of experimentation and risk.

At some stage during the nineteenth century, it became important to establish the quality of the grain, independent of its origin and its botanical characteristic; this was, however, easier said than done. Historically, buyers in domestic markets had developed their own individual criteria for evaluating the quality of produce and the degree to which it matched their requirements. Varieties were identified according to their geographical origin, as was common practice in several other commodity markets (e.g. cotton). However, quality according to this criterion varied considerably and was not always consistent. Samples of wheat sold in important markets such as London or Liverpool were submitted for inspection and the ‘natural weight’ of the grain (i.e. its

[49] PP 1814-15 Vol. V, Report of Select Committee on Manufacture and Sale of Bread, p1353, evidence by E G Smith.
[50] Petersen, *Bread*, 159. Historically, wheat had been divided into ‘best’, ‘second’ and ‘third’ quality categories according to some quality attributes for the purpose of setting the Assize of Bread, 12 Henry VII cited in *PP 1814-15 Vol. V*, p. 1344.
[51] PP 1834 Vol. VII; PP 1814-15 Vol. V, various testimonies.
[52] Sidney Webb and Beatrice Webb, "The Assize of Bread," *The Economic Journal* 14, no. 54 (1904). James Davis, "Baking for the Common Good: A Reassessment of the Assize of Bread in Medieval England," *Economic History Review* 57, no. 3 (2004).

weight per cubic capacity or density), its colour, dryness, presence of impurities and other physical characteristics were important attributes on which quality was assessed. The extent to which tacit knowledge was used to assess quality was high as 'the eye, nose and hand were necessary [in] judging the value of grain, and dealers could determine its [density] by "merely taking up and poising a small quantity of it in their hands"'.[53] Grain quality was assessed on the basis of such attributes before the advent of centralised grading by commodity exchanges after c1860. Prime, medium, and inferior reds and whites existed alongside English, French, Chicago, Milwaukee and New Orleans varieties of grain and most millers had to make their selection of grain with 'care and deliberation'.[54]

The proliferation of the different types and qualities of wheat grain during the latter half of the nineteenth century further exacerbated the problem of quality measurements. The following extract from *The Miller*, c1875 is illustrative:

> 'In purchasing wheat and choosing the description necessary to secure a uniform brand of flour, millers must often feel the want of a reliable test to guide them. It requires a very long and constant experience to judge the quality of even those wheat appearing daily in our markets; but we are left with the most unpleasant uncertainty when new descriptions are introduced to our notice.'[55]

[53] Stanley Dumbell, "The Sale of Corn in the Nineteenth Century," *The Economic Journal* 35, no. 137 (1925): 144. It is important to consider the difference between *specific gravity* and *natural weight* in this context. Specific gravity measurements usually refer to the density of individual wheat grains. However, as will become clear later in the chapter, due to the manner in which natural weight measurements were made, they included the 'density' of empty spaces (or air) in addition to the density of the individual grain.
[54] Ibid.
[55] *Miller*, Oct 4 1875, 'The study of a method to meet the requirements of millers in the analysis of wheat and wheaten flour', p 196-7.

The buyers naturally preferred to sort the commodity as finely as possible. The primary logic here is that there was little incentive for the seller (e.g. farmers, traders) to sort the commodity, into any more categories than was necessary, such as by variety, port of origin or the season (winter, spring, etc.). The buyers (millers), on the other hand, sought to sort the commodity into a greater number of categories on attributes that indicated the grain's bread-making ability. Practically, grain with certain 'undesirable' attributes, e.g. high moisture content, high impurities, etc., could be corrected and re-sorted into higher grades. But, grain with undesirable compositional attributes (density, colour, texture) could not be corrected for.[56]

These incentives shaped the commercial terms, buying practices, and quality measurements in wheat contracts, even before the nineteenth century. In domestic markets, selling wheat on the basis of its density had emerged as a common method of assessing the quality of produce. This method guaranteed that the contracted volume of grain, say one-*bushel* measure, would weigh a specified amount, say 60 *lbs*. If the actual weight was more or less than the guaranteed weight per volume, the contract price was adjusted proportionately.[57] For example, a contract for wheat from c1830, guaranteeing delivery weight to be 18 *stone* per *quarter*, specified price and terms as 54s 6d 'pay or be paid' i.e. the farmer was to make a 'proportionate allowance' to the merchant in case the net weight on delivery was under 18 *stone* 4 *lbs*, and conversely the farmer was to receive an allowance from the merchant in case the net weight on delivery was found to exceed 18 *stone* 4 *lbs*.[58] In another example from Sheffield, weight per *load* was mentioned by the seller as confirmation of quality and could vary from 12 *stone* 19 *lbs* to 13 *stone* 10 *lbs* according

[56] For the theoretical arguments, see Barzel, "Measurement Cost," 29-32.
[57] The other methods of selling grain in domestic markets were on the basis of volume–only or weight-only measures. *PP 1834 Vol. VII*.
[58] *PP* 1834 *Vol. XLIX*. p.259; 1 *stone* equals 14 *lbs* and 6.35 *kgs.*

to the quality of wheat. Also, wheat brought into this market from Gainsborough and Lynn was sold by the *quarter* weighing 504 *lbs*, whereas wheat from Hull was to be delivered at 480 *lbs* per *quarter*.[59] In the market town of Lewes, if the wheat purchased did not weigh the quantity stated by the seller per cubic capacity, 'a diminution in price agreed upon [was] made' and when the grain exceeded the weight stated, 'the price [was] advanced'.[60] There are similar examples from other market towns such as Lincoln, Stamford, York, Leeds, Wakefield, Hull, Whitby, Malton, Durham, Stockton, Darlington, Newcastle-upon-Tyne, Whitehaven, etc.

Returns from corn inspectors from 136 market towns suggest that two-fifths of these towns were selling wheat on the basis of their density in 1834.[61] Comparing the same 136 towns in 1878 suggests that the number of market towns selling grain on this basis had increased to more than half during the nineteenth-century.[62] Of the top twenty towns accounting for about 60% of the corn sold in domestic markets in 1880, eleven markets were reported to be using natural weight measurements as a basis for wheat sales. These included towns such as Norwich (10%), London (4%), Boston (3.5%) and Northampton (3%).[63]

The use of density measures to assess the quality of wheat was not unique to Britain. French bakers regularly used this method to distinguish between a *setier* of good wheat and average quality wheat. Although the 'artful and meticulous bakers' could assess quality of grain through sensory examination, by itself this was not considered to be a

[59] PP 1834 Vol. XLIX. p. 262
[60] *PP 1834 Vol. XLIX*. Letter by John Bartlett, Aug 27, 1833.
[61] *PP 1834 Vol. XLIX,* p. 256; in addition more than half the towns reported that the basis for selling corn was by volume-only measurements, and the rest of the towns using weight-only measurements.
[62] PP 1878-79 Vol. LXV, Memorandum by comptroller of corn returns. PP 1878-79 Vol. LXV, Summary of returns by corn inspectors.
[63] *PP* 1881 *Vol. LXXXIII.* Returns showing total quantity for wheat sold in 1880.. The figures in parentheses represents the proportion of grain sold in that market town compared to the total grain reported as sold for that year.

sufficient guarantee of quality; the most reliable test of goodness was weight.[64] As weight of wheat brought into Paris would vary sharply from year to year, a 'three-quality-range' had emerged in the mid eighteenth-century. The *setier*, the Parisian measure of volume, was equated to either 240, 230 or 220 *pounds* for a normal year, the highest weight representing the best quality wheat. In an exceptionally good year, the weight of the *setier* could be set as high as 250 *pounds*. The three-quality-range could vary: in 1769, the range was set at 241, 236 and 233 pounds in Etampes, whereas in Pontoise it was set at 229, 223 and 220 pounds respectively.

Density measurements – effectively, a *de facto* grading system - did not capture information about the condition of the grain, such as the presence of impurities, dryness or moisture content, texture, etc.. These attributes were equally important to the miller and the baker in addition to the density of the grain. Historically, information about the condition of the grain could be verified through sampling and visual inspection. However, even inspecting samples could prove to be problematic. Samples could hide the extent of variation in the quality of a given stock. They were also liable to damage due to exposure or handling and therefore could not represent the actual quality of the entire stock. For example, after selling on the basis of samples became common practice in the mid-eighteenth-century, there were complaints against corn factors that they exposed only a selection of their samples so that the buyers did not get a complete picture of the actual quality of stock they represented. Similarly, American grain inspectors sampling wheat from railway wagons faced similar problems in the early twentieth century. Sampling from fully loaded wagons, particularly those loaded to the roof, was fraught with difficulties

[64] Steven Laurence Kaplan, *Provisioning Paris: Merchants and Millers in the Grain and Flour Trade During the Eighteenth Century* (Ithaca and London: Cornell University Press, 1984), 52-53.

in terms of the reliability of the samples extracted. Sampling was also problematic in other commodity trades. Cotton sellers in Liverpool often accused brokers of carelessly handling samples, which 'prejudiced the sale of the whole lot and often put the seller to the expense of re-sampling'.[65]

The plethora of wheat varieties available in the latter half of the nineteenth century could be potentially classified in an incredibly large number of ways. Consequently, for the commodity exchanges to develop detailed mechanisms for measuring and grading these complex goods involved selecting a finite set of attributes, or 'summary criteria', such that the commodity could be graded into a manageable number of classes. Criteria used to determine the commercial grade of grain from the samples submitted for inspection included moisture content, density, freedom from foreign material (cleanliness), condition and texture of the kernels, etc.[66] Grain traders had previously adopted a distinct vocabulary to describe quality characteristics. This included several terms such as sound, bright, common, extra, choice, merchantable, clean, fair, hot, unsound, sweet, musty, etc.[67] Many of these terms were used to describe the grades that the commodity exchanges developed.

The commodity exchanges usually depended upon two methods to grade quality: certificate final, and fair average quality (FAQ).[68] Certificate final referred to grades that were certified by an authority in the originating country, such as the CBT in the US. These grades functioned as classes or standards, ranking the quality of the produce based on

[65] Daviron, "Standardization," 169. Lowell D Hill, *Grain, Grades and Standards: Historical Issues Shaping the Future* (Urbana & Chicago: University of Illinois Press, 1990), 6. Fay, "Corn Market," 73. Merrill, "Grain Grades," 63. Thomas Ellison, *The Cotton Trade of Great Britain : Including a History of the Liverpool Cotton Market and of the Liverpool Cotton Brokers' Association* (London: E Wilson, 1886), 177.
[66] Lloyd S Tenny, "Standardization of Farm Products," *Annals of the American Academy of Political and Social Science* 137 (1928): 209.
[67] Hill, *Grain, Grades and Standards*, 13-14.
[68] There were two other methods – the 'sealed sample' and the 'fair average' – but these were not often used in the UK.

descriptions of certain attributes, and which British merchants could accept as guarantee of quality. In contrast, the FAQ method, most commonly adopted in London, involved inspection of samples once the produce had reached the UK ports. Under this method, samples of all grain imported into UK were periodically collected by LCTA who would then arrive at the grades for a given year. The grades were thus developed on a responsive basis although the detailed mechanism or rules could not be determined from the archival records inspected. The FAQ grades were ranked categories into which the different samples could be sorted, rather than standards – as in a fixed reference point that established conformity or deviation.

When the LCTA began grading grain on the FAQ basis, the description of quality depended upon the source of the produce. For instance, when Indian grain was graded on FAQ terms, allowance was made for dirt and other impurities (such as non-farinaceous seeds). While drawing up the standards for Indian wheat for the 1889 season the East India Grain Committee of the LCTA defined the standard for No. 1 Club Bombay Wheat as containing

> '[Not over] 3% of impurities of which 1(1/2)% may be dirt for shipments to the 30th June, and 3(1/2)% [impurities], of which 2% may be dirt, for the remainder of the seasons shipments'[69]

Similarly, standards for New Zealand wheat were made separately for round berried and long berried wheat.[70]

While making the FAQ grades, the LCTA would take into account the differences in the density of the grain from Argentina, Australia, California or other locations. For example, while fixing the standard for

[69] East India grain committee, *London Corn Trade Association (LCTA).* Entry for 8th Aug 1889.
[70] American and Australian grain committee, *LCTA.* Entry for 9th April 1891. John George Smith, *Organised Produce Markets* (New York: Longmans, Green and Co, 1922), 24-25.

Australian wheat in 1894, the LCTA fixed an average weight of 63 *lbs* per bushel for the seasons wheat. On the other hand, the average weight of Californian White was assumed to be 60.5 *lbs* per bushel, while fixing the standards for 1895. Similarly, for grain imported from the Black Sea ports, the committee had developed rules to account for its density, especially for rye and barley.[71] In Liverpool, density was used to grade American milling wheat specified as spring wheat (weighing 60*lbs* per bushel), soft winter (of 61*lbs* per bushel) and hard winter (of 60½*lbs* per bushel). The North and South Argentine wheats too were graded according to their density at 59½ and 60½*lbs* per bushel respectively and the Australian wheat was specified at 60½*lbs* per bushel. No wheat weighing more than one pound per bushel 'under basis' was accepted within these grades.[72] LCTA annually reviewed the FAQ grades and did not use a fixed, invariable numerical standard.

In contrast, the Board of Trade of the City of Chicago (CBT) in 1858 began classifying grades of grain according to fixed descriptions of colour, quality and general condition and at the same time certifying to those grades.[73] Four basic grades for spring wheat, for instance, were established: Club wheat, No. 1 Spring, No. 2 Spring, and Rejected. When this system of grading attracted opposition, because it lacked uniformity and its inspectors had too much discretion, the CBT had to refine these grades. In 1859, it added 'test weight' i.e. grain density, as a grading factor for wheat. The following minimum densities (pounds per bushel) were introduced: Club, 60 *lbs*; No. 1, 56 *lbs*; Standard, 50 *lbs*; Rejected, 40 *lbs*. These did not always work, as in 1859 when grain less than 45 *lbs* per bushel but of Standard grade or better was delivered. As a result,

[71] American and Australian grain committee, LCTA; Sep 24, 1895; Feb 20, 1894, etc. Also, Black Sea Grain Committee, *LCTA*; especially the comparative table for the regulation of the 'natural weight' of rye. See also, Forrester, "Commodity Exchanges," 202.
[72] Forrester, "Commodity Exchanges," 204.
[73] Merrill, "Grain Grades," 58.

CBT revised the grades and the minimum densities as follows: No. 1, 56 *lbs*; Standard, 50 *lbs*; No. 2, 45 *lbs* and Rejected, 40 *lbs*. Even these 'standardized' densities failed to gain the trade's approval. The CBT consequently left the specification of the test weight to the discretion of the grain inspectors when ascertaining grade.[74]

By the turn of the century, a numerical system of grading the various varieties of red, white, winter and spring wheat had emerged. For instance, No. 1 white winter wheat was defined as that which was pure white, sound, plump and well cleaned. No. 3 was defined as not clean and plump enough for No. 2 but which weighed not less than fifty-four *pounds* to the measured bushel. The Board of Railroad and Warehouse Commissioners had developed this system of rules for inspection in order to 'establish a proper number and standard of grades for inspection of grain'.[75] These rules took into account the natural weight of grains such as wheat, barley and oats to define certain grades in addition to other attributes.

Nevertheless, the numerical grades in the US were not entirely based upon *quantitative* measurements of quality. Quantification of quality attributes continued to remain problematic and elusive. When the US Grain Dealers National Association adopted inspection rules in 1908, their Grade 1 specified moisture content to be 15%, impurities (dirt, broken grains, etc.) to be 1%. Yet in c1914, numerical grades used descriptions such as sound, dry, reasonably clean, sweet, mature, plump, etc. Studies were conducted by USDA after 1909 to identify 'tangible factors' influencing the 'intrinsic value' of corn. When the US Department of Agriculture (USDA) promulgated official grades for commercial corn in 1914, six distinct numerical grades were defined on the basis of moisture,

[74] Hill, *Grain, Grades and Standards*, 13-16.
[75] The forty-seventh annual report of the trade and commerce of Chicago. 1905, *Chicago Board of Trade.* Chicago, pp. 30-33.

damage to the kernels (due to heat or presence of broken corn, etc.) and presence of foreign material.[76]

The LCTA and US (primarily the CBT) grades were fundamentally different. The FAQ method that the LCTA used effectively produced ranked categories, the description of which depended upon the season's produce. The description of the wheat grain's quality thus tended to change according to the season, the year and the actual cargoes of grain. This was very different from the grading systems that emerged in the US, pioneered by the CBT in Illinois and gradually emulated by other wheat growing states. The US grades were intended to be fixed standards, with descriptions of grain attributes that were unvarying. On the basis of such standards, the grain inspectors could issue 'official certificate of inspection', which guaranteed the quality of a particular cargo.

For a long time, London (UK) buyers resisted and challenged the practice of US exporters to dispatch American wheat on the basis that inspection certificates were 'final as to quality.' A major objection was that inspection prior to shipment did not account for dissipation of quality due to moisture and poor storage conditions during shipment. Indeed, this was a major problem with transatlantic imports into the UK in particular, and European ports in general.[77] Consequently, the LCTA would inspect and confirm US wheat grade quality, along with imports of wheat from other foreign sources. Californian wheat, which was not imported along with inspection certificates, was naturally graded by the LCTA. This practice was still common by the 1890s. Eventually, in 1898 the London and Liverpool associations decided to accept the inspection certificates to be 'final as to quality and inserted clauses to that effect in the standard

[76] Hill, *Grain, Grades and Standards*, 18-19 & 71-76. Refer table 3 comparing grades specified by USDA and those used in three major grain markets of New York, Chicago and Minneapolis

[77] Merrill, "Grain Grades," 65-66. Merrill was the President of the CBT at the time he wrote this article. Hill pp. 25-7 Rothstein 1988, p. 107

American Cargo and Parcel Forms used by the LCTA members.[78] This acceptance was the result of continuing negotiations between the LCTA and the US commodity exchanges, culminating with the proposed involvement of the USDA. The 'moisture content certificates' that were issued also helped to make the inspection certificates acceptable to the UK and European buyers.

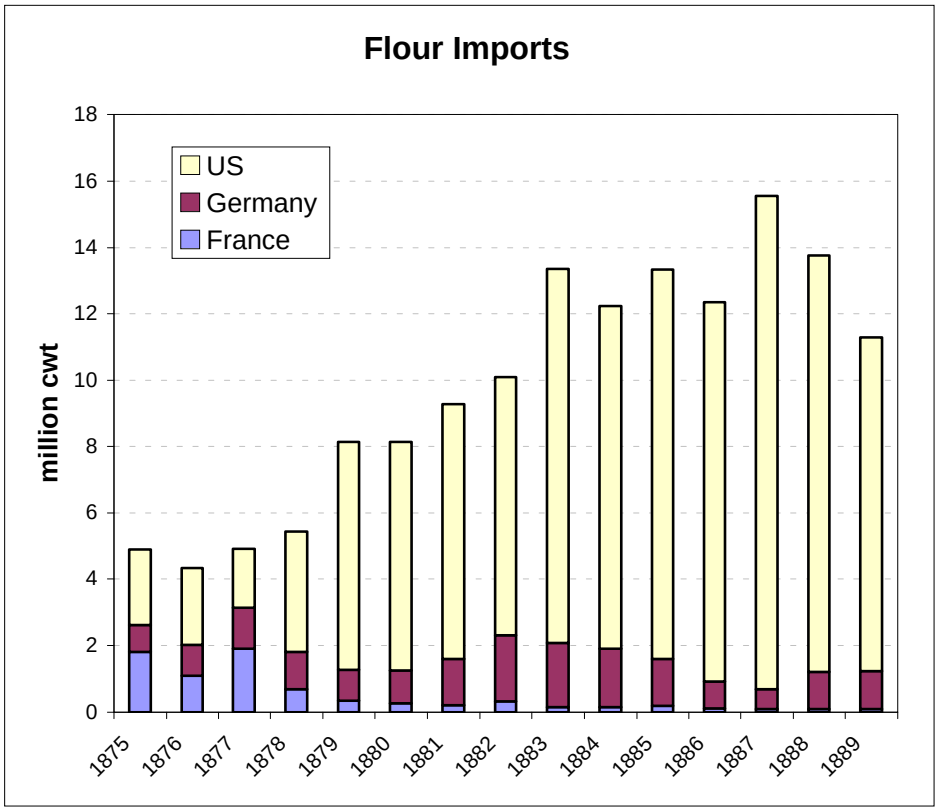
The elimination of differences in the product standards within the commodity chain thus involved the acceptance of US quality grades in the UK. Further, the acceptance of LCTA grades for wheat imported from other sources (forming nearly half of total UK imports) was also crucial in the standardisation process. No single criteria or uniform set of attributes was used to grade all imported wheat. The 'summary criteria' differed according to the trade route and sources of wheat. The centralising authority of the LCTA and the governance structures it developed were crucial in coordinating the vastly increased trade volumes and the greater heterogeneity of wheat varieties reaching UK markets by the end of the nineteenth century.

IV

While important changes were occurring on the supply side there were corresponding and equally significant changes in the milling industry. Being the largest buyers of wheat, these changes cannot be merely coincidental and were intimately connected.

[78] American and Australian grain committee, LCTA. Entry for 1st Jan 1891. Also, see Arbitration Subcommittee, *LCTA*, for suggested alteration of Contract Forms 1898 proposed by the Liverpool Corn Trade Association on 8th Nov 1897 and accepted by committee.

Figure 4:



Source: Statistical Abstracts Nos. 37 & 38

The milling technology in use around c1870 had remained unchanged for over a hundred years when steam milling had reduced the industry's dependence on wind and water. Millstones continued to be used for grinding wheat, the replacement of wooden gear wheels with iron ones being the only improvement of note in the intervening period. This 'sudden-death' grinding method ensured that the wheat grains were ground thoroughly and as quickly as possible. The consequence of this method was that the flour obtained contained a significant proportion of bran, although the extraction rate of flour from the wheat grain was about 80%. New developments in milling technology, particularly in Hungary and the US, involved improvement and perfection of roller milling techniques. Rolling produced whiter flour although the extraction rate reduced to about 72% of the wheat grain. The main advantage of this

new technology was that it improved the quality and the whiteness of flour obtained for the same proportion of grains used to produce the coarse 'household' grade flour using the older grinding technology.[79]

The speed and extent of adoption of roller milling was shaped by at least three important factors: increasing domestic demand for white flour, unsuitability of softer domestic wheat varieties to the technology, and increase in the imports of foreign flour and hard wheat varieties. The causal links between all these factors is not entirely clear. However, it is likely that the increasing demand for white flour had to be satisfied either by importing better quality foreign flour or by increasing the domestic production of white flour using the new technology. The roller milling technology was more effective with the harder wheats, which had been edged out of domestic markets when domestic wheat varieties gradually shifted towards the softer 'farmer's wheat' of the high yielding varieties.[80]

The import of foreign hard wheats after c1860 certainly aided the diffusion of the new technology. Imports of milled flour too increased during this period. Within a decade from 1875, the quantum of flour imports had nearly trebled, and most of it was sourced from the US (figure 4). The imported flour constituted nearly a fifth of the national consumption by the end of the 1880s, almost double compared to the previous decade. The take-up of roller milling technology was slow and uneven. Also, there was a polarization of the industry into a few large firms, serving regional and national markets, and hundreds of small country mills serving mainly local demand. The small firms formed about 95 percent of the mills in the UK in the late 1880s, but produced about 35

[79] Richard Perren, "Structural Change and Market Growth in the Food Industry: Flour Milling in Britain, Europe and America, 1850-1914," *The Economic History Review* 43, no. 3 (1990): 423-424. Jennifer Tann and Glyn Jones, "Technology and Transformation: The Diffusion of the Roller Mill in the British Flour Milling Industry, 1870-1907," *Technology and Culture* 37, no. 1 (1996): 41-43. Glyn Jones, *The Millers: A Story of Technological Endeavour and Industrial Success, 1870-2001* (Lancaster: Carnegie Publishing Limited, 2001), 22-25.

[80] Tann and Jones, "Flour Milling." Perren, "Flour Milling." Walton, "British Cereals."

percent of the domestic flour. By 1910, five of the largest roller milling firms (from a total of more than 800 firms) accounted for about one-fifth of the total output; this concentration would later increase to nearly two-thirds by 1930. The large firms were concentrated around the major port areas, which were both a source of raw materials as well as demand, and were characterized by significantly higher throughput rates due to the adoption of roller milling. By the end of the century, the milling industry was characterised by increasing competition, concentration and specialization, and the small country miller was being gradually marginalised.[81]

Accordingly, the manner in which grain quality was assessed, the attributes of grain that were important for making flour of a given quality, and the manner in which they were measured were re-examined and refined. ‘The value to the miller of a certain variety of wheat depends upon the quantity of fine flour it will yield’, wrote one correspondent in 1879.[82] Millers had traditionally believed that corn of higher density had greater bread making qualities. Wheat of lower densities were known to yield a lower quality of flour and vice versa. The proportion of albuminoids or flesh formers was thought to determine the quality or fineness of flour. It was found to increase as the density of grain increased, and was one of the principal reasons why denser grains were considered to have better bread making ability. ‘More flour is produced from corn of higher specific gravity, and more bread from such flour, than from inferior corn or inferior flour’, a report from 1834 had claimed.[83] Although lighter, coarser grains could yield a larger proportion of flour, this was achieved by including coarse bran and thereby reducing the quality of flour obtained.[84]

[81] Perren, "Flour Milling." Tann and Jones, "Flour Milling," 62-66.
[82] *Miller*, May 5, 1879, Technical Issue, p. 193.
[83] *PP* 1834 *Vol. VII.* London.
[84] *Miller*, May 5, 1879, Technical Issue, p. 193; Nov. 3, 1879, p. 682.

Generally, the millers, and bakers, preferred the ‘harder’ wheat varieties with high densities to the ‘softer’ wheat varieties with lower densities.[85]

But it was not only the density of the grain that was important to the miller: the ‘strength’ of the grain or flour was crucial to the miller (and the baker) as well. The strength was initially defined as the ability to absorb and retain moisture, which later was modified to indicate the quantity and quality of gluten the grain contained. Stronger flour was preferred because the number of loaves obtained from a given weight of flour were more than those obtained from weaker flour. Hard wheat of the low yielding (and conversely high density variety) were considered to be stronger wheats, whereas softer wheats were considered to be of the weaker kind. British wheats, on the whole, were considered to be of the weaker kind. The miller basically had to balance both the density as well as moisture characteristics of the grain, as those varieties with the highest-bushel weight with low moisture content usually gave the greatest amount of flour.[86]

Before the introduction of the rolling mills, when wheat was ground between millstones, the colour of the grain was also important to the miller, as invariably some of the bran or coat of the grain was also ground along with the fleshy part. Flour from red-grained wheats was never as white as that obtained from white-skinned wheats; white flour commanded a higher price in the market. In any case, white wheat was known to yield a slightly higher proportion of flour than red wheats. This difference in the colour of wheat became less important once the roller system of milling was adopted after c1880, as with this new technology very little of the bran was mixed with the rest of the flour and flour from red-grained wheat could be as white as that from white-skinned wheat.[87]

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[85] Walton, "British Cereals," 39-40.
[86] John Percival, *Wheat in Great Britain* (Reading: 1934). Jago and Jago, *Breadmaking*. Jones, *Millers*.
[87] Percival, *Wheat*, 72.

As the milling process became more specialized and sophisticated, the *differences* in quality between varieties as well as the *consistency* of quality in a given variety became crucially important. Measuring quality was necessary to achieve the desired quality of flour, and to enable the millers to remain profitable. Throughout most of the nineteenth-century millers continued to rely upon the visual inspection of samples to purchase grain, testing for density, colour, texture, and the extent of cleanliness. Millers purchasing domestic grain continued to do so, although the importance of domestic wheat had diminished by the twentieth century; only about 19 percent of home grown wheat was used for bread making by 1914, down from 60 percent in c1860.[88] As the volume of imported grain increased and the number of varieties available multiplied, the millers began to rely upon the grades and standards set by the various commodity associations, such as the LCTA or the Liverpool Corn Trade Association.

Notwithstanding this shifting reliance on grades, assessing the quality of grain still depended upon the 'empiricism of the practical miller'.[89] This became evident during the process of mixing grains into a 'grist', i.e. flour that British bakers would accept. Millers had to consider, for each variety of wheat, whether it would contribute to one or more aspect of flour quality: strength, colour, taste or general appearance. Thus, one miller described an 'ideal' grist composed of 20 *bolls* each of No. 1 American, Canada Club, Saxonska, Californian or Oregon and British wheats (each *boll* being equivalent to *240lbs*). These 100 *bolls*, according to this miller, could yield 60 sacks of fine flour, an additional 5 sacks of 'overheads' (a lower grade of flour), 15 *cwt* of 'feeding' seconds, and about 30 *cwt* of bran. The gross margin in this case was estimated to be about £12 and 5s. In response to this, another miller claimed that,

[88] Perren, "Flour Milling," 425. Refer table 1. Jones, *Millers*, 59. Percival, *Wheat*, 71.
[89] Jones, *Millers*, 61.

using a different configuration of machinery, for the same grist combination, he could obtain 23 sacks of 'new process' flour, 44 sacks of first grade flour, 8 *cwt* of 'thirds' and 32.5 *cwt* of bran at a gross margin of £22 and 18s.[90]

When another miller invited comment on whether his mixture (3 sacks red winter; 2 sacks Michigan; 2 sacks No. 2 spring and 5 sacks of English white) 'ought to make a good sack of bakers flour', he received at least five different suggestions from other millers.[91] One correspondent suggested that the proportion of English wheat was too high and instead recommended that 3 sacks of Michigan be used instead of 2, and that English white be limited to 2 sacks. Another correspondent suggested the original mixture would result in 'lack of strength and colour' and suggested eliminating English white altogether and adding an extra sack of No. 2 spring to the mixture: alternatively, the red winter, No. 2 spring and the English white could be mixed in equal proportions. A third correspondent suggested leaving the English white out altogether, grinding the remaining mixture separately, and then letting the meal sit in the sack for a few days before mixing. The fourth correspondent suggested that if this was milled in the country then 6 parts each of No. 1 American spring with 'sound' new English white wheat, mixed well in a bin a week before grinding, could give the desired results. The fifth correspondent recommended one sack each of Dantzic and American spring, three sacks each of American white and American winter and four sacks of English white (part new and part old).[92]

The importance of grain quality in the grist was underscored by the economics of flour extraction that created a direct volumetric relationship between grain inputs and flour output. Consider this example from more

[90] *Miller*, Letters on 'Milling Reform', Apr 1 and May 6, 1878.
[91] *Miller*, Feb 2, 1880, Letter no. 669, p. 922.
[92] *Miller*, Letters: reply to 669, Mar 1, 1880, p. 45-46; Apr 5, 1880, p. 119.

recent times. In 1973, the Chicago (CBT) grade number 2 soft red winter wheat (SRW) specified 58 *lbs* per bushel density as a grading criteria. If the miller assumes a 73% flour extraction rate, this implies that 2.36 bushels would be required to produce 100 *lbs* of flour. A reduction of density from 58 *lbs* to 57 *lbs* per bushel has two implications. First, at the same extraction rate, the miller now needs 2.40 bushels of wheat to produce 100 *lbs* of flour. Second, a reduction of test weight, and hence quality of the grain, is likely accompanied by a reduction of extraction rate to say 70% which further increases the quantity of grain required, 2.50 bushels, to produce the same quantity of flour. The resulting cost differential of wheat to flour is not always reflected in the price discounts for the different wheat qualities.[93]

Of course, to the British miller in the late nineteenth-century it was not only the price of individual variety of wheat that was of ultimate importance, but the relative costs differentials between the individual varieties due to the mixing of grains for the grist. The miller had to balance his margins according to the price of bread and the price of wheat. Comparing the price of flour to the price of bread and wheat over a 52-week period between 1894 and 1895, we see the degree to which the millers had to manage this balancing act. Figure 5 compares the price of wheat to flour assuming that the following mixture of grains is used to make the grist: 30% each of No. 1 Spring American and Fine Russian and 20% each of Red Winter and Fine English. Moreover, millers were often forced by competition to sell flour at less than its value as compared to wheat or to the corresponding quality of the flour to make its price remunerative.[94]

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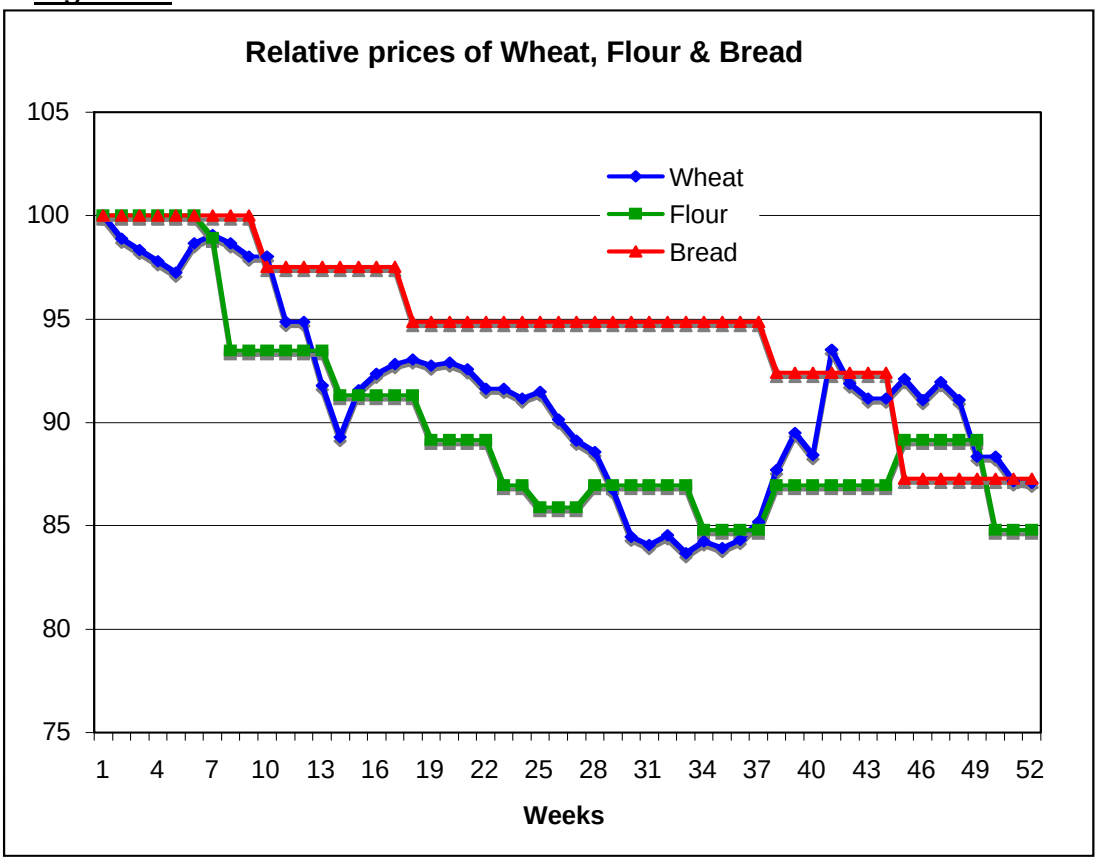
[93] Eluned Jones, "The Role of Information in Us Grain and Oilseed Markets," *Review of Agricultural Economics* 21, no. 1 (1999): 250-251.
[94] J Kirkland, "The Relative Prices of Wheat and Bread," *The Economic Journal* 6, no. 23 (1896): 481-482.

Figure 5:



Source: Based on price data reported for 52 weeks between Mar 1894 and Feb 1895 in Kirkland, "Bread prices," 481-82

By the last quarter of the nineteenth-century, techniques for assessing the quality of wheat were still fairly uncertain. One expert wrote in 1890 that 'it will be well for mixing purposes to consider wheat as coming under one of three heads – strong, coloury or neutral (*sic*)'.[95] He further pointed out that wheat buying was governed by experience, general principles and by what varieties of wheat happened to be available in supply. After 1880, changes in milling technology were accompanied by development and improvements in testing and measuring the different quality attributes. The increased understanding of the chemical composition and properties of gluten, the substance in grain that lends strength to the flour, aided these developments. Various testing

[95] W R Voller, *Modern flour milling*, Gloucester, 1889, as cited in Jones, *Millers*, 59.

methods and instruments were made available for assessing the quality of flour: Pekar's method of assessing whiteness of flour, Boland's aleurometer to test the strength of gluten, and Robine's method for estimating quantity and likely bread output are some examples.[96] Even so, each miller had to discover for himself the strength of any given flour, as there was 'no satisfactory method of numerically registering strength except through a baking test'.[97] Even so, *final* assessment and testing remained the miller's responsibility; they had to rely upon baking tests and other measurements to ascertain quality *ex post*.

Although the milling industry developed more sophisticated ways of assessing the wheat quality, towards the end of the nineteenth-century, milling itself remained an acquired skill based upon experience and experimentation; for instance, many millers could not agree on what constituted an 'ideal' grist. Wheat buying was governed by experience, general principles and a considerable degree of detailed knowledge, even by the end of the nineteenth-century. Nevertheless, the correspondence between millers indicates a shifting trend away from visual inspection as they sought to capture the grain composition in more explicit terms of gluten and protein content. We discern a gradual acceptance of the grading and standards developed by the various commodity associations as British millers began to rely upon the grades established by LCTA. This was an iterative process with the grading of quality helping the milling industry to become more professional, which in turn, and in conjunction with other changes in the industry, required further refinement of the quality grades themselves. The industry thus played an important role in the standardization of *ex ante* assessment and guaranteeing of wheat quality.

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[96] Jones, *Millers*, 59-61.; Grain chemists continue to use some of these quality tests to this day (see www.aaccnet.org).
[97] Jago and Jago, *Breadmaking*, 291. Also, Jones, *Millers*, 60-61.

V

What does the analysis of the wheat-grain commodity chain reveal about ‘deep integration’ in the international grain markets of the nineteenth century? The answer to this question is considered on the basis of three important issues revealed by the analysis: the institutional changes necessary to eliminate product differences, the endogeneity of such changes, and the manner in which institutions and standards helped to reduce transaction costs. The commodity chain analysis suggests that coordination in the international wheat markets occurred at multiple levels (firms and committees) and in several different ways (integration, co-specialisation, governance structures, voluntary consensus, regulation, etc.). The analysis also demonstrates that standardisation, upon which fungibility and coordination was dependant, was a long and involved process spanning nearly the second half of the nineteenth century. Moreover, it shows that firms and markets were able to capture the externalities of lowered transaction costs as a result of increased coordination, standardisation, and governance structures. Thus, the formation of a global value chain can be considered as undeniable evidence of ‘deep’ market integration.

The analysis shows how this particular ‘trader driven’ commodity chain was characterised by loose networks of trading firms linked with a professional downstream industrial firms (the millers). The chain was also characterised by the broader institutional framework of organised commodity exchanges and industry associations. This was an ‘extra’ layer of coordination over the trade networks – a type of shared collective institutional arrangement – that enabled the traders to reduce costs and risks, which in turn ensured the reliability of supply, and increased sales.

Several international grain traders (such as the Ralli brothers) transformed into multinational trading firms, through investments in producer countries (US, South America, India, etc.) and the integration of

exporting, shipping and importing functions.[98] Such strategies ensured that the traders could secure continuous supplies, manage and spread risks, maintain effective communications, and reduce transaction costs. Nevertheless, both international traders and domestic merchants organised themselves into trade associations and exchanges, both in producer as well as importing nations. The CBT was formed in the US during the late 1840s as a voluntary association of traders and began defining wheat grades as early as 1856.[99] In the UK, the LCTA was formally constituted in 1878, although its origins lie in the much older Baltic Exchange founded in the mid-eighteenth century. This institution had its origins in the Virginia and Baltick Coffee House of Threadneedle Street in London, a place where merchants involved in the international trade would meet. The members included importing merchants, foreign merchants, shippers and prominent millers. In the auction room of the Baltic Exchange, oil and tallow were offered for sale initially, and after the repeal of the corn laws, wheat and other grain were auctioned. It became the headquarters of the London Corn Trade Association (LCTA) once it emerged in the mid-nineteenth century and practically all London grain dealers were members of both the Baltic Exchange as well as the LCTA.[100]

Non-trading groups within this chain also exhibit similar institutional frameworks. The British millers set up several industry associations after c1870, which at first sought to regulate the conditions for sale of flour, but later became a forum to establish procedures and governance mechanisms, and to serve as nodes to disseminate knowledge and information. Regional associations included the Sheffield Association

[98] Morton Rothstein, "Multinationals in the Grain Trade, 1850-1914," *Business and Economic History* 12 (2nd Series) (1983). Jones, *Merchants*.
[99] Hill, *Grain, Grades and Standards*, p. 14.
[100] Hugh Barty-King, *The Baltic Story : Baltic Coffee House to Baltic Exchange, 1744-1994* (London: Quiller Press, 1994). Forrester, "Commodity Exchanges," 200-201. Smith, *Organised Produce Markets*, 30.

(founded 1873), the London Association (founded 1878), Liverpool and Manchester District Association (active c1878), etc.[101] However, the association that undoubtedly had the greatest impact on the industry was the National Association of British and Irish Millers (NABIM) formed in 1878.

NAIBM received strong support from millers in London, Liverpool, Sheffield, Leeds, the Bristol Channel and South Wales area, Northamptonshire, and other locations where large milling firms were established; in-country and small milling firms failed initially to see the benefit of this association.[102] The association acted as a 'pressure or lobby group' on behalf of its members, and the British milling and wheat marketing trades more generally. It could canvass the views of regional and local millers associations, corn merchants and agriculturists and lobby state departments (e.g. The Board of Trade) or merchant associations (e.g. LCTA).[103]

Above all, the association functioned as a 'clearing house' for knowledge and information. For instance, a series of annual conventions were organized by NABIM between 1884 and 1890 on topics such as 'Bookkeeping for millers', 'Gradual reduction milling', 'The Carter and Zimmer sorting system', 'The world's wheat crop and wheat values', etc. It also acted as the 'educator' and a promoter of milling as a 'science' beyond its obvious industrial origins. The association, and the individuals associated with it such as William Voller and William Dunham, provided the general structure and supervision of technical education and

[101] H Macrosty, "The Grainmilling Industry: A Study in Organization," *The Economic Journal* 13, no. 51 (1903): 331.
[102] Jones, *Millers*, 141-144.
[103] The National Archives, Board of Trade Papers, BT 101/43, letter by William Chatterton, president of NABIM, Nov 7, 1878. Arbitration Subcommittee, *LCTA,* entry for 1896.

complemented the various efforts that were underway to establish some sort of organizational structure for technical education in general.[104]

There is thus strong evidence that the coordinating layer of a broader institutional framework existed or emerged sometime during the nineteenth century along a developing global commodity chain. Almost certainly it enabled a more efficient structure to share information and knowledge by complementing the structures of the trading networks. The crucial point is that the information and governing structures in the institutional frameworks emerged endogenously through voluntary consensus. This is neatly exhibited in the analysis of the quality conventions and standardisation in the global wheat-grain commodity chain.

The fundamental measurement problem, discussed previously, implied that standardisation of wheat-grain quality had to be achieved on the basis of common or summary criteria. With the increasing internationalisation, and a proliferation of sources and varieties, the key information issue the measurement problem raised was which set of attributes should form the summary criteria. As the analysis of the standardisation process has shown, the solution involved the adoption of multiple attribute sets: a universal set of attributes did not emerge. This observation conforms to the view that quality is a relative rather than an absolute concept.[105] Not only did the summary criteria differ according to the source, and by implication the variety of the grain, but the millers used different criteria to judge grain quality compared to the traders. Thus, the standardisation of attribute sets depended upon who was conducting the measurements. The fact that finite sets of attributes had to be agreed upon, and that quality measurements according to multiple such sets had

[104] Jones, *Millers*, 148-156. Voller was one of the pioneers of technical education; Dunham was the founder of the trade journal *Miller* (London).
[105] Peter Bowbrick, *The Economics of Quality, Grades and Brands* (London and New York: Routledge, 1992), p.2-11.

to coordinate the movement of the commodity along multiple trade routes implies that the standardisation process was institutionally, rather than technologically driven. In other words, it was endogenous to the value chain.

For example, Pirrong has argued that the differences in the storage and distribution methods in the US compared to other producer nations determined why wheat from US was graded at source compared to wheat imported from other locations, which was graded in the UK.[106] The elevator-based storage system that developed in America in the latter half of the nineteenth-century enabled formal grading, and in fact required it. The grains were graded at the point when the farmer brought it for storage at the shipping point. The elevator agent upon examining the quality of the grain settled with the farmer both the grade of the grain and its value. This grain was stored in the elevator along with grain of similar quality, thus segregating the identity of the grain parcels from that of the individual sellers. The seller (farmer) received value according to the lowest quality that the grain could be graded into. This strengthened the incentives of those shipping the grain to elevators to maintain quality before storage.[107] Once the graded grain was loaded onto ships or railway cars for transport it was nearly impossible to mix grain of varying qualities. Such opportunism problems and malpractices were possible prior to storage. The only dissipation of quality could occur due to damage caused by moisture and poor storage conditions. The incentives to maintain quality prior to shipment was high, but not during the transportation of the already graded grain. This problem was alleviated eventually when moisture content certificates began to be issued, which

[106] Pirrong, "Commodity Exchanges."
[107] James Stewart, "Marketing Wheat," *Annals of the American Academy of Political and Social Science* 107 (1923): 187-188.

could then be used to compare with the actual condition of the grain when it arrived at its destination.[108]

In contrast, handling facilities for grain imported from other countries such as Argentina and Australia were extremely crude. Crude handling methods exposed the grain to varying weather and insect condition and the absence of elevators meant that it was most efficient to ship grain in bags. This made it virtually impossible to create parcels of grain of standardized grades by combining grain from individual growers prior to shipment, as was possible in the elevator based storages of North America. Further, with individual shipments retaining their identity, inspecting quality at the importing country economized on the number of measurements necessary along such a trade route. There were few incentives to prevent dissipation of quality prior to bagging and storage. But all things being equal, this system would have given the shipper an incentive to take care of the cargo at sea.[109] In such practices, quality could not be guaranteed prior to shipment. The FAQ system, an *ex-post* method of grading, was particularly suited in these instances. It adjusted standards to reflect systematic factors affecting the quality of grain from a particular location (level of quality due to grain composition as well as condition due to storage, transport, handling, etc.), and made fewer quality distinctions between different shipments. The method minimized the number of potential disputes regarding product quality. Thus, the institutions developed different grading methods using different summary criteria to measure quality and standardisation in this case did not imply rationalisation of grading methods.

Importantly, the institutional processes were largely driven through voluntary consensus. As the growing literature on voluntary consensus

[108] Merrill, "Grain Grades," 66.
[109] This would also have depended upon the contract and shipping terms, i.e. who had the residual property rights on the cargo and who paid for insurance, freight, etc.

standards argues, this approach to standards setting – i.e. standards setting through committees – is particularly useful in understanding how standards, that are neither *de facto* (i.e. *ex-ante*) nor *de jure* (i.e. mandatory), emerge. The centralising influence of the commodity exchanges is clearly evident in the quality grades they developed – they were certainly not *de facto* standards. And yet, in the nineteenth century, such quality grades did not have the power of legislation enforcing their adoption in the international markets. Adoption of these standards was purely voluntary. That they were universally adopted by the trading community reinforces its consensual nature: of course, internal governance structures (e.g. standardised contract forms) ensured large-scale adoption.

The manner in which the standardisation process played out in this commodity chain has two major implications. First, the process itself was a long drawn-out one, spanning nearly the entire second half of the nineteenth century. While, the formal grading of wheat grains by commodity exchanges developed independently in the US and the UK, the adoption of US grades in the UK was not straightforward. Although CBT graded wheat began arriving in the UK from the third quarter of the nineteenth century, it was not until the twilight years of that century that the US grades were considered to be 'final as to quality.' Standardisation, in terms of elimination of product differences, for non-trading buyers in the UK, i.e. the millers was somewhat more elusive. Institutions such as trade journals and technical institutes, along with advances in the understanding of grain chemistry helped to alleviate the issues of non-standardisation by the end of the nineteenth century. Such endogenous institutional changes clearly indicate a strong element of path dependency.

The second implication of the standardisation process was that fungibility was an institutional construct rather than a technical attribute of

the commodity. To contemporary neo-classical economists, such as Marshall, the extent to which a commodity could be traded depended upon the ability to describe it completely and in known terms. Thus, international division of labour assumed, indeed required, product fungibility, which in turn determined the extent of the market. Fungibility was previously held to be a technical attribute and was costless to achieve. However, the analysis of the wheat grades shows that its fungibility depended upon its alienation (from the producer's identity), rather than its homogeneity – that is, a high degree of sameness of the produce. The grading of wheat grains by the commodity exchanges greatly aided the alienation by de-linking residual rights in the commodity from its physical possession or origin. Tradability no longer depended upon the ability to deliver the physical product. Futures trading in the commodity in fact developed on the basis of such alienation. The instruments so traded did not have to account for the vagaries of the physical cargo (to a large extent) or at least shifted the immediate risk of quality dissipation. In fact, this may have enhanced the incentives to preserve the quality of the physical cargo according to the grain's original grade. It mattered less, for futures trading, that US grades were not universally accepted by the British trade as 'final as to quality' until c1900. Similarly, it mattered less that LCTA grades, based on the FAQ method, could change slightly from year to year. Any potential increase in the measurement and monitoring costs were balanced by the trade's ability to reduce risk by hedging. Either way, fungibility was not a costless process. Nor was alienation tied to technical or technological attributes exclusively. Fungibility, and tradability was a path-dependent, institutional process.

Greater, deeper and more explicit cooordination, as well as standardisation characterised the emergent commodity value chain. Its input-output structure implied that the commodity changed hands several times as it went through the various stages of value addition (figure 3b).

These activities increasingly dispersed internationally during the nineteenth century, lengthening the *value* chain along international routes. The difference between the late nineteenth century and earlier periods of international trade was this: after c1860 wheat was not only grown, but also graded and sorted in foreign locations (particularly in North America), although it was mixed and milled in the UK.

The links along this chain (between the various activities) were established and strengthened by the various governance structures and institutions that emerged during the half-century after c1860. Centralised grading by commodity exchanges, 'official' quality certificates guaranteeing quality, standardised contract terms, arbitration mechanisms, emergence of trade journals and rise of technical education, improving testing methods, metrological standardisation, etc. are some examples of governance structures and institutions that directly coordinated exchange along the global chain. 'Deep' integration was a historical process that international markets experienced as a global value chain emerged during the half century following the repeal of the Corn Laws in 1846.

Conclusions

This paper has shown that (deep) integration was a long-term historical process that involved substantial changes to the market structure, firm strategies, and the nature of the commodity at an international level. New forms of coordination, control and governance emerged, which have endured throughout the twentieth century. The standard contract forms, for instance, that were used by LCTA members after c1880 were the genesis of standardised contracts now used by GAFTA members (Grain and Feed Trade Association). This international association makes available standard trading terms included in a range of

over 80 standard contract forms that cover quality (condition, warranties, guarantees), shipping documents, payment terms, insurance, testing and analysis methods, etc.[110]

The implication of enduring changes goes beyond persistent contract forms and trading standards. The seeds of the current international trading system in grain lay in the manner in which deep integration developed during the late nineteenth century. Demonstrably, achieving this level of coordination was a costly, tangled and messy process. Its effects too were enduring. Deep integration changed the social order in the importing countries like the UK in many ways. While some groups lost (e.g. landowners and farmers), other groups gained (e.g. consumers and millers).[111] Grain producing countries – US, Argentina, India, Russsia, etc. – too experienced significant changes in their respective social orders, and the emergence of new institutions as a result of the international elongation of the value chain. What is true of grain markets, is also true of other primary commodities (rubber, cocoa, cotton, sugar, tea, etc.) as well as manufactured commodities (e.g. textiles and apparels).[112]

The paper also highlights the role of explicit coordination and standardisation in international trade. The implication of multiple levels of coordination, within a single value chain, is that coordination is not a dimensonless process. The ‘depth’ of coordination somehow tends to be collapsed in most stylised models of international trade. The view from convention theory – of multiple levels of coordination in economic organisation – has important insights for coordination within international markets and along long value chains. In the grain markets of the

[110] www.gafta.com
[111] Kevin H. O'Rourke, "The European Grain Invasion, 1870-1913," *The Journal of Economic History* 57, no. 4 (1997). O'Rourke and Williamson, *Globalization and History*. Fairlie, "Corn Laws."
[112] Ponte and Gibbon, "Quality Standards." Daviron, "Standardization." Gereffi, "International Trade."

nineteenth century, we not only notice 'highly filamented upstream networks' combining with downstream firms and industries, we also discern coordination between individuals combined with coordination within and between 'committees.'[113] Firms that engaged in strategic behaviour also cooperate within committees and associations to form consensus. Such *voluntary* consensus forming – to distinguish it from cooperation through regulation – was crucial in shaping the institutions and governance structures that emerged during this period. The standards and grades that emerged as a result of this process were key in ensuring the competitiveness of firms, and fungibility and tradability of the complex and heterogeneous commodity. The fact that quality standards played a strategic role in the competitiveness of firms throughout the value chain is evident from the analysis presented here. Standards help firms and businesses to overcome basic information asymmetries and measurement problems, and generally to capture externalities, as has been seen in many other similar historical cases.[114]

The global integration of trade accompanying the international disintegration of production and consumption centres, as observed by Feenstra (1998), were two sides of the same historical coin. Nevertheless, integration – in the manner demonstrated in this paper – is what made such a disintegration viable in the very long term. The glue that held the long value chains together were the institutions and governance mechanims that developed largely through endogeneous processes. The standards and conventions – technical as well as non-

[113] Peter Gibbon, "Upgrading Primary Production: A Global Commodity Chain Approach," *World Development* 29, no. 2 (2001). Joseph Farrell and Garth Saloner, "Coordination through Committees and Markets," *The RAND Journal of Economics* 19, no. 2 (1988). Also compare this with Kindleberger's 'group behaviour' argument in C. P. Kindleberger, "Group Behavior and International Trade," *The Journal of Political Economy* 59, no. 1 (1951).

[114] Daviron, "Standardization." Jose Morilla Critz, Alan L. Olmstead, and Paul W. Rhode, ""Horn of Plenty": The Globalization of Mediterranean Horticulture and the Economic Development of Southern Europe, 1880-1930," *The Journal of Economic History* 59, no. 2 (1999). Ponte and Gibbon, "Quality Standards."

technical ones including commercial terms, and by extention accounting practices – were crucial in accommodating the expansion in *scope* as well as *scale*.

Finally, the paper highlights the importance of understanding the changes to the commodity itself. Like the trade and networks along which it flowed, the nature of the commodity too was highly dynamic and changed considerably throughout the nineteenth century. Alfred Marshall had described in some detail why wheat had become a product that could be 'easily and exactly' described, and therefore 'universally demanded.'[115] However, it took nearly fifty years for the markets to reach the level where wheat 'described' in the mid-western regions of the US became unequivocally acceptable by the millers in the UK. To reach the level where this commodity could truly bring down the search costs internationally, solely by being listed on an organised exchange alone, required the commodity to change its nature institutionally, not only physically.[116] In fact changes, to wheat, in this tradition continued, for the better part of the twentieth century as descriptions continued to be refined or altered in the grain producing countries.[117] Deep integration was, and continues to be, part of long-term historical processes, rather than an adjustment with a definite beginning and a finite end.

[115] Marshall, *Principles*. p. 285
[116] cf. Rauch, "Networks Versus Markets."
[117] Hill, *Grain, Grades and Standards*.

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