Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN 2957-3920 (Online) ISSN 3007-7060 (Print)
Volume 4, Issue 11, November 2025

Technological Innovation, Institutional Change, and the Formation of the Global Market from the Mid-19th Century to the Pre-World War I Era

Wu Shengdong

Department of International History, London School of Economics and Political Science, London, United Kingdom.

Abstract: This article examines the formation of the pre-WWI global market, demonstrating that it was not the product of a single cause but of the combined force of technological innovation (which provided the physical infrastructure) and institutional change (which established the governing rules). The interplay between these two factors is key to understanding the period's economic integration.

Keywords: globalization, technological innovation, institutional change, gold standard, migration

1 INTRODUCTION

The period from the mid-19th century to the eve of the First World War marked a profound turning point in world history. During this time, a prototype of a truly global market emerged for the first time, where goods, capital, and labor crossed national borders on an unprecedented scale and at unprecedented speed, tightly interconnecting various parts of the world. This profound structural transformation was not driven by a single factor but was rather shaped by the synergistic interaction of two major forces: technological innovation and institutional change. This paper aims to conduct an in-depth analysis of this process, arguing that technological innovation, through its breakthroughs in transportation, communication, and engineering, laid the indispensable material foundation for the formation of the global market. Simultaneously, a series of institutional changes implemented at both international and domestic levels—including the establishment of the international gold standard, relatively open migration policies, and complex adjustments in national trade policies—constructed the critical institutional framework necessary for the effective operation of this global market. By examining the dialectical relationship between the possibilities created by technology and the realities forged by institutions, we can achieve a more comprehensive understanding of the dynamic mechanisms and complex landscape underlying the formation of the global market from the mid-19th century to the outbreak of the First World War.

2 TECHNOLOGICAL CHANGE AND THE GLOBAL MARKET

Technological innovation was an intuitive and powerful driver of this wave of globalization. This innovation was concentrated in the fields of transportation, communication, and industrial production. It drastically compressed space and time, reduced the costs of transnational transactions, and created the physical possibility for the large-scale flow of goods, capital, and labor, constituting the "material foundation" of globalization.

First, revolutionary breakthroughs in transportation technology were the primary prerequisite for opening up the global market. The widespread application of steam power was the hallmark of this period. The refinement and application of steam power technology fundamentally altered the landscape of international trade. The speed of steamships continuously increased during this period, while freight costs consistently declined, leading to a significant reduction in the cost of transoceanic trade. Concurrently, a large number of railways were successfully built in the United States during this period (Wang & Mao,2020). These railways connected major US ports and large cities, leading to a significant increase in transport efficiency and decrease in transport costs during this period (O'Rourke, 1997) . The most direct international impact of steam power was the continuous narrowing of the price gap for agricultural products between Britain and the United States. Research by O'Rourke (1997)shows that between 1870 and 1913, the wheat price gap between the UK and the US decreased from 54.1% to almost

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN 2957-3920 (Online) ISSN 3007-7060 (Print)
Volume 4, Issue 11, November 2025

zero, the barley price gap fell from 45.9% to 10.9%, and the oat price gap plummeted from 138.1% to 28.1% (as shown in Figure 1). This astonishing price convergence was inextricably linked to the decline in transport costs. The United States, as a grain exporter, could send its grain to Britain more quickly and cheaply via new transport technologies. Simultaneously, this transatlantic price convergence also demonstrated the formation of a global market.

Besides revolutionary breakthroughs in transport technology, advances in communication technology were equally crucial. In 1837, the Englishmen Charles Wheatstone and William F. Cooke applied for the first electromagnetic telegraph patent in Britain, marking humanity's acquisition of the capability for rapid long-distance communication. By the 1850s, ideas about establishing telegraphic connections between Europe and North America were numerous. In 1851, the first submarine cable across the English Channel was successfully laid (Müller,2016). This signified the maturation of submarine cable technology. After several failed attempts, the first commercial transatlantic telegraph was finally completed in 1866 by a consortium including the Atlantic Telegraph Company and other Anglo-American joint enterprise groups and contractors (Müller,2016). While this cable was laid from Ireland to Canada, its connection to existing telegraph lines in Europe and North America successfully linked the two most important international financial centers of the time: New York and London. Simone Müller(2016), in her research, points out that the transatlantic telegraph enabled large-scale transnational transactions to proceed smoothly and made the "world economy" people spoke of at the time a reality. From this case, it is evident that advances in communication technology significantly promoted the formation of the global market from the mid-19th century to the pre-WWI period.

The formation of the global market from the mid-19th century to the pre-WWI period was also closely related to breakthroughs in engineering technology. The Suez Canal is an extremely typical case. The concept of the Suez Canal was proposed as early as the 18th century during Napoleon's expedition to Egypt. However, it remained unrealized for a long time. With continuous progress in engineering technology, after ten years of excavation, the Suez Canal finally opened in 1869. The opening of the canal did not immediately guarantee navigability. According to research by Valeska Huber (2013), records from 1870 showed the canal's depth was only 7 meters at most, a situation that led to multiple grounding accidents. However, with ongoing advancements in engineering technology, by the 1880s the Suez Canal had been deepened to 9 meters and equipped with a night lighting system to ensure night navigation (Huber,2013). The construction of the Suez Canal was of great significance for the formation of the global market, especially for the British Empire at the time. As a global empire, the Suez Canal directly connected the sea route from Great Britain to India, facilitating Anglo-Indian trade. Additionally, Port Said at the canal's entrance developed into one of the world's largest coaling stations, where almost all ships traveling between Asia and East Africa needed to replenish fuel (Huber,2013). This situation also, to some extent, promoted the globalization of the fuel trade. The case of the Suez Canal shows that breakthroughs in engineering technology allowed global colonial empires to trade more efficiently and also gave rise to new international trade nodes, advancing the formation of the global market from the mid-19th century to the pre-WWI period.

3 INSTITUTIONAL CHANGE AND GLOBALIZATION

Technological innovation provided the possibility for the formation of the global market, while institutional change turned this possibility into reality. From the mid-19th century to the pre-WWI period, the establishment and transformation of a series of international and domestic institutions created a favorable environment for the global flow of goods and factors of production, ensuring the basic stability and predictability of the global market. These institutional arrangements not only reduced transaction costs but, more importantly, established a rule system for transnational economic activities, enabling market actors from different countries to make decisions in a relatively predictable environment.

The establishment and actual operation of the international gold standard constituted the most critical institutional innovation of this period. By the end of the 19th century, the world's major economies had widely adopted the gold standard. As an institutional arrangement, the gold standard required participating countries to peg their currencies to gold at a fixed rate and guarantee free convertibility between currency and gold. In 1870, the only major power on the gold standard was Britain; Germany switched to the gold standard shortly thereafter, and by 1910 most countries had abandoned silver standards, bimetallism, or fiat paper money systems in favor of the gold standard. Cambridge University scholar Christopher M. Meissner (2005), in his research on the gold standard, pointed out that a common monetary system could effectively reduce costs associated with international trade; moreover, due to the characteristic of relatively stable exchange rates under the gold standard, its adoption was seen as a sign of good creditworthiness, thereby reducing borrowing costs in international capital markets. Thus, it can be seen that the widespread use of the gold standard and its advantage of lowering borrowing costs in international capital markets greatly promoted the formation of the global market from the mid-19th century to the pre-WWI period.

Besides the international gold standard, open immigration policies were also an important institutional cause for the formation of the global market from the mid-19th century to the pre-WWI period. According to research by economics scholar Sidney Pollard (2001), throughout the long nineteenth century, about 50 million Europeans emigrated overseas, especially from the mid-19th century to the pre-WWI period. In the 1810s, only about 10,000 people left annually; in the 1820s, 25,000; and by the turn of the 20th century, the wave of emigration far exceeded one million people per year. Starting from the 1840s, the Irish began to emigrate in large numbers; by the mid-19th century, Germans joined the ranks of emigrants; in the second half of the 19th century, Scandinavians also joined. From the 1890s

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN 2957-3920 (Online) ISSN 3007-7060 (Print)
Volume 4, Issue 11, November 2025

onwards, Italians and immigrants from Spain and Portugal also formed large groups. Early immigrants mostly went to North America, but by this time, many turned to Latin America in search of opportunities. In the two decades before World War I, Russia and Austria-Hungary also exported increasing numbers of emigrants, with the main direction of migration again pointing to the United States. This situation shows that from the mid-19th century to the pre-WWI period, Europe and the United States did not impose many restrictions on the outflow or inflow of immigrants, especially white immigrants, and generally maintained an open attitude in immigration policy. Figure 2 originates from a study by scholar Jeffrey G. Williamson (1996). This figure shows the convergence rate (λ) for major Western countries from 1870 to 1938. A positive λ value indicates that convergence is occurring; the larger the value, the faster poor countries are catching up with rich ones. If we look solely at the data from 1854 to 1913, we find that λ values for this period are all positive, meaning the wealth gap between major Western countries was narrowing during this time. However, an important reason for the reduction in the global wealth gap during this period was the wave of migration. Jeffrey G. Williamson (1996), in a simulation study, pointed out that without large-scale migration, the real wage gap would have increased by 42% between 1870 and 1910, whereas in fact it decreased. This research indicates that the wave of migration brought about by open immigration policies from the mid-19th century to the pre-WWI period largely shaped the global market at the time, especially the labor market.

Institutional changes in trade policy were also a significant factor affecting the formation of the global market from the mid-19th century to the pre-WWI period, and presented a more complex picture. As shown in Figure 1, between 1870 and 1913, the wheat price gap between the UK and the US decreased from 54.1% to almost zero, the barley price gap fell from 45.9% to 10.9%, and the oat price gap plummeted from 138.1% to 28.1%. It was previously noted that the occurrence of this situation was closely related to revolutionary breakthroughs in transport technology. However, if we observe subsequent sets of data, especially between the United States and continental European countries such as France and Bavaria, we can see that some grain price gaps decreased slightly, while others even widened. This phenomenon cannot be explained solely by progress in transport technology. One very important reason for the continuous narrowing of the agricultural product price gap between Britain and the United States was the repeal of the Corn Laws in 1846, pushed through Parliament by Conservative Prime Minister Sir Robert Peel. This meant that Britain implemented a free trade policy in the grain sector(O'Rourke, 1997). However, as can be seen from Figure 3, facing grain output from the United States, many continental European countries gradually turned to protectionism(O'Rourke, 1997). Between 1909-1913, the average tariff on grains in France was about 26.6%, while in Germany it was as high as 40.0%(O'Rourke, 1997). This divergence in trade policies indicates that the formation of the global market was not smooth sailing, but was full of strategic interactions based on the respective interests of nations. At the same time, it also shows the powerful influence of trade policy on the formation of the global market from the mid-19th century to the pre-WWI period.

4 Conclusion

In summary, the formation of the global market from the mid-19th century to the pre-WWI period was a complex historical process driven by the dual and intertwined forces of technological innovation and institutional change. On the one hand, technological innovation constituted the "material foundation" of globalization. The revolution in transport technology, particularly the expansion of steamships and railway networks, drastically compressed space and time and reduced the cost of transoceanic trade, directly reflected in the significant convergence of agricultural prices between Britain and the United States. The leap in communication technology, marked by the successful laying of the transatlantic telegraph, enabled instant connection between financial centers like New York and London, providing key support for transnational capital flows. Meanwhile, breakthroughs in engineering technology represented by the Suez Canal not only reshaped global shipping routes and gave rise to new international trade nodes but also greatly enhanced the efficiency and connectivity of the global trade network.

On the other hand, institutional change translated the possibilities created by technology into a stable and predictable reality. The widespread adoption of the international gold standard, by stabilizing exchange rates and establishing national credit, significantly reduced transaction costs for international capital flows. The relatively open immigration policies of European and American countries facilitated historically unprecedented transoceanic labor flows, which not only directly shaped the global labor market but also had a profound impact on global income disparities through the convergence of factor prices. The field of trade policy presented a more complex picture, where British free trade coexisted with continental European protectionism, precisely illustrating that the formation of the global market was not a linear process of integration, but rather the result of the interaction of national interests and institutional strategies.

In conclusion, technological innovation provided the physical possibility for the birth of the global market, while institutional change laid the tracks and rules for its operation. Both were indispensable and together form the core key to understanding the wave of globalization during this period. This historical experience also reminds us that the depth of global economic integration depends not only on the level of technological progress but also on the quality and coordination of the institutional arrangements that support its functioning.

5 Figure List

Journal of http://www.satursonpublishing.com/
Research in Multidisciplinary Methods and Applications
ISSN 2957-3920 (Online) ISSN 3007-7060 (Print)
Volume 4, Issue 11, November 2025

Figure 1

TABLE 1
INTERNATIONAL GRAIN PRICE SPREADS, 1870–1913
(percentages)

Grain	Countries	1870	1913
	Panel A. Transatlantic Price Gaps		
Wheat	Britain-United States	54.1	-0.8
Barley	Britain-United States	45.9	10.9
Oats	Britain-United States	138.1	28.1
	Panel B. Anglo-Scandinavian Price Gaps		
Barley	Britain-Denmark	42.0	-2.0
Oats	Britain-Sweden	55.3	5.0
Oats	Britain-Denmark	46.8	7.1
	Panel C. United States-Scandinavian Price Gaps		
Wheat	Denmark-United States	28.9	-4.6
Barley	Denmark-United States	0.4	11.4
Oats	Denmark-United States	60.1	19.4
Rye	Denmark-United States	44.7	5.3
Wheat	Sweden-United States	18.7	17.3
Barley	Sweden-United States	-6.0	17.6
Oats	Sweden-United States	53.4	22.3
Rye	Sweden-United States	39.2	26.1
	Panel D. Continental European-United States Price Gaps		
Wheat	France-United States	43.8	29.3
Barley	France-United States	6.1	15.4
Oats	France-United States	117.7	61.0
Rye	France-United States	61.1	16.9
Wheat	Bavaria-United States	44.0	37.1
Barley	Bavaria-United States	5.4	43.6
Oats	Bavaria-United States	82.6	106.3
Rye	Bavaria-United States	66.5	48.5
	Panel E. Western European-Odessa Price Gaps		
Wheat	Britain-Odessa	37.9	6.5
Wheat	Denmark-Odessa	15.7	4.9
Wheat	Sweden-Odessa	9.4	35.9
Wheat	France-Odessa	28.0	48.8
Wheat	Bavaria-Odessa	25.3	43.8
	Panel F. Intra-European Price Gaps		
Wheat	Britain-France	5.8	-23.5
Wheat	Denmark-France	-11.2	-26.2
Wheat	Sweden-France	-17.1	-9.2
Wheat	Bavaria-France	0.6	7.1

Source: Predicted values are from regressions of price gaps on time and time-squared. The underlying price data is as described in Appendix 1.

(O'Rourke, 1997)

Figure 2

TABLE 1
COEFFICIENTS OF VARIATION OF REAL WAGES, 1854–1939

	Full Sample			Full Sample Less North America			Full Sample Less North America and Iberia	
	C(13)	C(17)	C(16)	C(12)	C(15)	C(14)	C(10)	C(13)
1854	0.326			0.308			0.340	
1870	0.254	0.255		0.224	0.223		0.229	0.232
1890		0.199			0.114			0.102
1913		0.191			0.068			0.039
1914			0.103			0.085		0.068
1926			0.148			0.146		0.138
1927		0.188	0.147		0.186	0.142		0.131
1939		0.285			0.200			0.138

Notes: The "full sample" includes the following 13 countries until 1870: Australia, the United States, Belgium, France, Germany, Great Britain, Ireland, Netherlands, Norway, Spain, Sweden, Brazil, and Portugal. In 1870 the following four countries are added to the sample: Argentina, Canada, Denmark, and Italy. Portugal drops from the sample from 1914 to 1926 and then rejoins. The "full sample less North America" excludes Canada and the United States, implying that we start with 12 countries and then increase to 15 in 1870. Again, Portugal drops from the sample between 1914 and 1926. The "full sample less North America and Iberia" excludes the United States, Canada, Spain, and Portugal, implying that we start with 10 countries and expand to 13 in 1870.
Source: Williamson, "Evolution," with Great Britain revised.

TABLE 2
COEFFICIENTS OF VARIATION OF GDP PER WORKER-HOUR, 1870–1938

	Full Sample	Full Sample Less North America
	C(15)	C(13)
1870	0.153	0.169
1890	0.118	0.122
1913	0.107	0.088
1929	0.110	0.080
1938	0.090	0.054

Notes: The "full sample" includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and the United States. It does not include Japan. The "full sample less North America" drops Canada and the United States from the sample.
Source: Maddison, *Dynamic Forces.*

TABLE 3
THE ESTIMATED RATE OF CONVERGENCE (λ) 1854–1939

	Real Wages			GDP per Worker Hour	
Epoch	Full Sample	Less North America	Less Iberia and North America	Full Sample	Less North America
1854–1870	+0.005	+0.006	+0.004	—	—
1870–1890	+0.012	+0.020	+0.021	+0.004	+0.005
1890–1913	+0.008	+0.017	+0.033	+0.007	+0.011
1914–1926	−0.011	−0.016	−0.030	—	—
1927–1939	−0.003	+0.002	−0.001	—	—
1913–1929	—	—	—	+0.002	+0.005
1929–1938	—	—	—	+0.019	+0.024

Notes: The rate of convergence is $\lambda = 1/t \ln(\beta + 1)$, where β is the coefficient in convergence equation on log of initial real wages or GDP per worker-hour, and t is the time span.
Source: Data underlying Tables 1 and 2.

Williamson (1996)

Figure 3

TABLE 2
CEREAL PROTECTION, 1909–1913
(ad valorem equivalents, percentage)

Grain	France	Germany	Sweden
Wheat	38.1	37.2	32.0
Barley	21.0	35.5	42.2
Oats	16.9	45.1	0.0
Rye	20.6	42.9	39.9
Weighted geometric average	26.6	40.0	0.0
Weighted arithmetic average	28.4	40.1	24.0

Source: Tariff data for individual grains are given in Appendix 1. For weights used in computing average tariffs, see Appendix 5.

(O'Rourke, 1997)

REFERENCES

[1]Huber, V. (2013) Channelling mobilities: migration and globalisation in the Suez Canal region and beyond, 1869–1914. Cambridge: Cambridge University Press.

[2]Meissner, C.M. (2005) 'A new world order: explaining the international diffusion of the gold standard, 1870–1913', Journal of International Economics, 66(2), pp. 385–406.

[3]Müller, S. (2016) Wiring the world: the social and cultural creation of global telegraph networks. New York: Columbia University Press.

[4]O'Rourke, K.H. (1997) 'The European grain invasion, 1870–1913', The Journal of Economic History, 57(4), pp. 775–801.

[5]Pollard, S. (2001) 'Free trade, protectionism, and the world economy', in: Geyer, M.H. and Paulmann, J. (eds.) The mechanics of internationalism: culture, society, and politics from the 1840s to the First World War. Oxford: Oxford University Press, pp. 27–53.

[6]Wang, Q. and Mao, B. (2020) 'Impacts of Science and Technology on Transportation', Journal of Transportation Systems Engineering and Information Technology, 20(6), pp. 1–8.

[7]Williamson, J.G. (1996) 'Globalization, convergence, and history', The Journal of Economic History, 56(2), pp. 277–306.