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Logistics, Market Size and Giant Plants in the Early 20th Century: A Global View

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ABSTRACT

Around 1900, the businesses of developed Europe – transporting freight by a more advantageous mix of ships, trains and horses – encountered logistic barriers to trade lower than the tyranny of distance imposed on the sparsely populated United States. Highly urbanized, economically integrated and compact northwest Europe was a market space larger than, and - factoring in other determinants besides its (low) tariffs - not less open to inter-country trade than the contemporary American market was to interstate trade. By the early twentieth century, the First European Integration enabled mines and factories – in small, as well as large, countries – to match the size of United States plants, where factor endowments, consumer demand or scale economies required that.

"We found there, as every attentive and expert traveller will find everywhere in the civilized world, some things better and some things less good than with us."

1906 German Official Report on US Visit (Hoff and Schwabach, *North American Railroads*, p. 412)

The United States, by the middle of the twentieth century, had achieved an, historically unprecedented, economy-wide, productivity advantage. In 1950, its GDP per head was ahead of western Europe's by around twice Britain's lead over its continental competitors during the first industrial revolution.[1] The USA's real GDP was then larger than the whole of western Europe's, nearly three times the USSR's, more than four times the UK's and more than five times Germany's. At that time the USA's giant industrial corporations were even more dominant: they outnumbered those of the whole of Europe by two or three to one.[2] Some investigators of the sources of American industry's productivity lead thus naturally linked it to the unparalleled opportunity to achieve scale economies offered by the United States' exceptionally large domestic market.[3] Subsequent historians have followed this lead. Alfred Chandler, for example, identified the smaller British market as one of the reasons why he believed its firms early in the century did not invest in large plants, distribution systems and managerial hierarchies on a sufficient scale, seeing the creation of a continent-wide market by the railroads as a major driver of what he thought was the exceptional development of giant American corporations.[4] "New economic geographers" also emphasize that trade costs, scale economies, imperfect competition and knowledge spillovers interact to give large countries a disproportionate share of world industry.[5]

The interactions among market size, firm size, and productivity are complex and change over time. The United States overtook the real GDP of the largest

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[1] Maddison, *World Economy*, pp. 261-2.
[2] Hannah and Wada, *Miezaru*, p. 58.
[3] Though Rostas (*Comparative Productivity*, pp. 58-9) and Frankel (*British and American Manufacturing Productivity*, pp. 64-80) also cautioned that some small countries achieved high productivity and that the same may not hold for 1900.
[4] Chandler, *Scale*, p. 250.
[5] Krugman and Venables, "Globalization."

European nation in the 1870s, but its manufacturing productivity may have forged ahead of Europe's before it attained that scale advantage.[6] Moreover, market size is not simply determined by national boundaries: for many factories it will be smaller (a city or a region). It is affected not only by tariff levels (quite low in Europe before 1914), but also by transport costs and other factors, such as linguistic or monetary homogeneity or urbanization. Britain and Germany (together, before World War One, having the same real GDP as the USA) – along with France, Switzerland, Belgium and the Netherlands - formed the largest compact urban market in the world and the massive trade flows of north-west Europe still accounted for most global manufacturing trade. This factor has been neglected by postwar historians, impressed by Europe's 1950-1975 catch-up, that was driven partly by reversing the destruction of people and property and tariff escalations that had blighted its economic performance during its vile military conflicts, cold wars, partitions, nostrifications and dictatorships of 1914-1945. This article argues that the leading European producers typically had access to at least as wide a market as American firms earlier in the twentieth century and that they faced levels of cross-border market integration not dissimilar to today's. There was simply no market scale reason why European plants around 1900 could not be as large as American ones; and, as it turns out, they *were* as large.

[6] Broadberry ("How did the United States"), though aggregation problems/quality differences may nullify some results.

The choice between the two main logistic options of the nineteenth century - ships and rail - depended partly on geography: there were no ships in Santa Fe and no trains to Hawaii. Yet, rail and water were substitutes on many long-haul routes, in global historical fact, as well as in Fogel's counter-fact. As today, in tonne-kilometre terms, water transport dominated long-haul, though by the early twentieth century the balance varied, with rail being exceptionally important for the USA and Russia.[7] The data in Table 1 relate to transport *use*, not *production*: the latter would increase water's share for the UK and Germany (large net exporters of shipping services) and lower it for Russia and the USA (the latter's share of the world's seagoing fleet had shrunk from 20% to 3% over a half-century, its imports and exports being carried overwhelmingly in foreign-flagged ships; Russia also depended heavily on foreign ships).

The reliability of the table falls off to the right: rail (and some domestic water) freight is reasonably hard data, the rest being crudely estimated from a coefficient relating the capacities of arriving and departing cargo-ships, voyage lengths and freight carried.[8] The precise quantities cannot be relied upon, though the orders of magnitude are broadly plausible. Islands or peninsulas - Britain, Italy, Japan – naturally used ships

[7] Original data in Imperial, American or nautical measures have been converted to metric, with the French spelling of the metric *tonne* adopted to minimize confusion. 1 km=0.62 miles and one metric tonne (1,000 kg)=1.10 short tons (2000 lbs) or 0.98 long tons (2,240 lbs), so a tonne-km is about two-thirds of a ton-mile. A nautical mile is 19% more than a "statute" mile, while a nautical ton's weight (it being a volumetric measure - 40 cubic feet - of ship capacity) varies with load density.

[8] The assumption implicit in column 4 is that all seagoing steamships, whatever their flag, plying internationally from or to the named countries in the stated year had the same annual average voyage lengths and load factors as Hoffmann's (itself heroic) estimate for all German-flagged steamships plying internationally in 1913. Pirath's (*Grundlagen*, p. 79) estimate that 62% of *world* freight tonne-kms in 1930 were by water is lower than the eight-country total in Table 1 (81%) and may be accounted for by

Table 1. Freight Market Shares, ca. 1906.

Country and Date	Rail (Domestic and International.)	Water Transport Inland.	Cabotage.	International.	Total Freight Market	Share of Rail
		(units: billion tonne-km)				
USA 1906	320	69	60	264	713	45%
"Europe"*	177	49	72	1419	1718	10%
of which:						
Russia 1913	76.4	28.9	20.3	74.0	199.6	38%
Germany 1906	48.3	12.5	1.5	181.6	243.9	20%
UK 1910	22.1	1.1	33.5	585.7	642.4	3%
France 1906	18.2	5.1	1.9	247.5	272.7	7%
Belgium 1912	6.4	1.6	na	84.8	92.8	7%
Italy 1906	5.2	na	15.1	245.8	266.1	2%
Japan 1908	3.0	na	25.0	244.9	270.2	1%

* "Europe" is the rounded sum of the six European countries shown.

Sources: Cols. 1-3: Barger, *Transportation Industries*, pp. 184, 254-6; Bureau, *Transportation*, p.33 (USA, with Barger's 1889 water traffic distance coefficients, derived from interwar data, applied to the 1906 regional tonnages); Scherer, *USSR*, p. 231 (Russia, post-1945 USSR borders, which approximate to those of the 1913 Tsarist Empire excluding Finland); Hoffmann, *Wachstum*, pp. 406-18 (Germany); Armstrong, "Role," p176 (UK); Toutain, "Transports," pp. 81, 158, 197 (France); Laffut, "Belgium," pp. 217-218 (Belgium); Mitchell, *International Historical Statistics*, pp. 688 (Italy, with ratio of Italian cabotage derived from Schram *Railways*, p. 151 estimate for 1880/1); Minami, *Railroads*, p. 194 (Japan, with cabotage estimated by the author from indications in Ericson, *Sound,* pp.39-40, 397-8). Col. 4: Hoffmann's estimates for the relationship between registered ship capacities, loads and voyage lengths are taken as the base to

intervening investment in rail, road and pipeline freight, higher representation of continental nations, or the Hoffmann coefficient being too high.

derive a coefficient, which is then applied to the national port data on the capacity of steamers entered and cleared with freight for the relevant year given in Anon, *Statistical Abstract 1901/12*, pp. 36-57 and Woytinsky, *Welt,* 5, p.77. International rail freight is apportioned in national statistics according to the distance traveled within each country; for international sea freight I have apportioned 50% of voyage distances to destination and departure countries.

prolifically, as did a littorally-settled continent like Australia (not shown).[9] Yet America's use of rail was massively higher even than the continental expanse of Germany; only Russia approached America's rail-dependence. The USA and Europe overall made roughly similar use of inland waterways (the Great Lakes and the Mississippi were more than a match for the Rhine and the Volga) and cabotage (sea routes between domestic ports). What gave Europe its massive lead in water transport was *international* shipping and especially intercontinental voyages: Europe was - by construction - an equal partner in US-Europe trade, but its global engagement with Asia, Africa, Australasia and South America exceeded the USA's. Despite many common land borders with extensive trade, most of European countries' cross-border trade went by sea rather than rail.[10] Much of this sea-freight was intra-European, and in that sense, treating Europe as one economic area, functionally equivalent to US cabotage.[11] The *Weltbűrger* running a Hamburg shipping enterprise – though not averse to nationalistically-motivated supports that came from Imperial Potsdam – knew his profits fundamentally came from serving customers in St Petersburg, Copenhagen, Cherbourg, London and elsewhere. In like cosmopolitan spirit, the English mariners' term "home trade" referred to voyages to

[9] An indicator of mercantile marine capacity (which is not the same as their *use* of ship transport, irrespective of ownership, shown in Table 1) for a wider range of countries is the proportion of all transport motive power that was installed in ships (as opposed to locomotives), which ranged from 7% in Switzerland (1901) and 8% in the USA (1905), through 12% in Germany (1895), 14% in France (1896), 15% in Belgium (1906), to 34% in Sweden (1896), 47% in the Netherlands (1904) and 88% in Norway (1905), see March, "Statistique Internationale," pp. 10-12.
[10] Anon., *Statistical Abstract 1902-3*, pp. 262-265; Woytinsky, *Welt*, 5, p. 88.
[11] Oppel, "Seestädte," pp. 198, 244.

and among nearby German, Dutch, Belgian and French ports between Hamburg and Brest. A large sample of crew agreements for 1863-1900 indicates that 43% of British steamer voyages were then within European waters, while a 1911 survey showed 21% of British shipping capacity operating within Europe.[12] By Hoffmann's calculation, 43% of German shipping capacity in 1913 was plying to European destinations, though he reckoned these exclusively European voyages probably accounted for only 11% of sea-freight tonne-km (oceangoing ships were larger, faster and spent most time at sea, while downtime in port, loading and unloading cargo, was the lot of short-haul captains).[13] Yet voyages he designates as intercontinental also served intra-European trade: fast liners plying from Hamburg to New York called at Cherbourg or Plymouth to pick up and set down small, high-value cargoes, as well as passengers; steamers from northern Europe that were Yokohama-bound docked at Mediterranean ports. The slightly more numerous foreign ships entering and leaving German ports (most European-flagged) were also likely mainly engaged in intra-European trade, but are excluded from Hoffmann's calculations.[14] Europe's "domestic" sea freight also had a higher value-to-volume ratio than the oceanic trades, perhaps reflecting the high share of manufactures and fuel carried.[15]

Ships had lower infrastructure costs (the sea was free) and also had the advantage of greater fuel-efficiency and lower terminal costs (cranes were ubiquitous in the main ports, and tramps carried their own lifting equipment for small ports, but manhandling – still widespread at all transport nodes - remained common in rail trans-

[12] Sager and Panting, *Maritime Capital*, pp. 205-6; Fayle, *War*, p.7.
[13] Hoffmann, *Wachstum,* pp. 412-13.
[14] See the voyage data in Danmarks Statistik*, Statistisk Aarbog*, pp. 79-83.
[15] Oppel, "Seestädte," pp. 198, 244.

shipment).[16] Ships offered tonne-km freight rates only a half or a quarter of those of land transport, even, sometimes, as low as the one-seventh achieved by the modern development of supertankers and container shipping.[17] Yet trains could still compete if speed counted, though running at higher speeds was expensive in both modes. British freight trains averaged around 32 kmph and American ones around 17 kmph, though they could, if required, go faster (one source mentions 77kph); at sea, tramps and tankers managed 15-17 kmph and some coastal liners 25 kmph, but 44 kmph - the top speed of ships - was attained only by a few transatlantic liners.[18] Rail was also used if there was no access by water, or it offered more direct routing. Some routes - Galveston to Key West, Duluth to Cleveland, Stockholm to St Petersburg, Newcastle to Hamburg, Trieste to Brindisi, Antwerp to Bilbao and Barcelona to Genoa – were more direct (and often faster) by boat. Even circuitous routes, like Odessa to London (2,308 km as the crow flies, but 6,326 km by steamer via the Bosporus, Mediterranean and Atlantic), were cheaper than the rail equivalent, especially for low-value traffic with low inventory costs.

Marine geography, and a semi-depleted continent's global quest for raw materials that America found abundantly in its virgin interior, no doubt partly explain Europe's marked preference for ships, but relative prices also played a role: US rail

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[16] Pirath, *Grundlagen*, pp. 126, 209. An English collier could be unloaded in Hamburg in only 12-15 hours (Baedeker, *Northern Germany*, p. 164). The global investment in harbors, canals etc before 1914 was estimated (Woytinsky, *Welt,* 5, p. 19) at $14-19 billion and in ships at $6-7 billion, compared with the $55 billion total investment in railways, though the latter accounted for fewer tonne-km.

[17] Toutain, "Transports," pp. 166, 199; Armstrong, "Freight pricing policy," and compare Limão and Venables, "Infrastructure," p. 452.

[18] Fast passenger expresses by 1900 on rail routes like New York-Buffalo or Paris-Bayonne achieved average speeds of about 85kmph, while "ocean greyhounds" were crossing the Atlantic at 44 kmph (and both carried some freight), but specialist freight trains and ships went more slowly (and cheaply): see Anon., "Fast-train runs;" A. W Gattie, in Acworth and Paish, "British Railways," p. 737; *Historical Statistics*, p. 4-929; Woytinsky, *World Commerce*, p. 435 and Armstrong, "Freight pricing policy," p. 192.

freight rates were below the European norm, while US cabotage rates were not.[19] Among the possible reasons are factor costs, different freight mixes, speeds and journey lengths, railroad land grants, ownership/regulation/competition, higher European rail safety spending, the US ban on foreign crews and on foreign cabotage (compared with Europe's, largely open, ports), and the failure to invest in Panama as speedily as Europe invested in ship canals.[20] Some of these possible determinants are compatible with marginal social costs differing less than observed market prices. Whatever the reasons, the upshot is clear: the American *domestic* market was glued together primarily by the train, but the First European Integration was driven by the ship. Europe's long-haul costs per tonne-km were thus below what they would have been with a US ship-train mix. The European imperialists who argued for emulating the transcontinental railroads of the USA and Canada on what Europeans then thought of as *their* frontier – whether unifying the Tsar's Empire with the Trans-Siberian railway or consolidating control of Africa with a Cape-to-Cairo line - were deranged dreamers, not transport economists: ships were the efficient option for Vladivostock or Cape Town, as within Europe.[21] The future belonged substantially to sea-routes and already their advantage over land transport was clear.

The major logistical bottleneck of 1900, in which there were also large international differences, was transport by road. At the turn of the century, this was, of

[19] Barger, *Transportation Industries*, p. 184; Toutain, "Transports," pp. 278-9; Transvaal Chamber, *Diagrams*, exhibit 25; Pratt, *American Railways*, pp. 48-9; Ross, *British Railways*, pp. 182-4; Hoff and Schwabach, *North American Railroads*, pp. 269-320. Reported national average tonne-km freight rates vary because of different freight mixes, journey lengths, car-provision and trans-shipment services, but there was a consensus that, even allowing for such factors, US rail rates were cheapest for bulk long-haul.
[20] The only major European powers matching America's ban on foreign cabotage were Russia and France, and protection appears to have weakened the merchant marine of all three.
[21] Transvaal Chamber (*Diagrams*, exhibit 28) shows the high cost of African rail compared with sea. The Trans-Siberian was completed in 1905 and was unprofitable; the Cape-to-Cairo remains unbuilt. The purpose of the (shorter, and sometimes profitable) railways that *were* built in Africa (or Latin America) was, of course, as in the US interior, primarily supporting white settlers and farming/mining; though in India the railways mainly served indigenous demand.

course, principally by horse-drawn wagon or what in Asia was called the *jinrikisha* (literally "man-power-vehicle"), but, for most countries, such freights are a statistical desert. Road was unimportant in overall tonne-km terms because, given its cost, it was (before the motorized truck and improved intercity roads) sensibly avoided, where possible, for long-haul freight (and is therefore omitted from Table 1).[22] Yet, for the same reason, when there was no alternative and for short-haul trips and final delivery, it added massively to logistical costs. We might reasonably suppose, following the contemporary European stereotype encouraged by American cowboy showmen, that America was much more of a horse-riding and horse-drawn society than western Europe and (despite probable undercounting) the census data on teamsters and horses confirm this. In 1901, for example, there were perhaps 3.3 million horses in Britain, while the number in US cities alone equaled that and in the nation as a whole exceeded 24 million.[23] The huge extent of the American demand for road transport is also shown by the national production of carriages, wagons, carts and similar mobiles. In 1904 more than 1.7 million carriages and wagons, worth $97 millions at the factory gate, were produced in the USA: a level of unit sales per head of population not to be equaled by the new-fangled US automobile sector until the 1920s.[24] Around the turn of the century, the French were only producing 36,000 horse-drawn passenger vehicles annually, worth 35 million francs ($6.8 millions) and it was reckoned that the total *in service* was only 1.5 million; the stock of

[22] In France, for which contemporary survey data exist, road transport on principal roads would add only 2.8B to the 25.2B tonne-km domestic total in Table 1.
[23] Thompson, "Nineteenth-Century Horse Sense," p. 80; McShane and Tarr, "Centrality," pp. 106-7. In Europe, only Russia came near to matching the US per capita horse population: of course, horses were extensively used for farm power and breeding for export, as well as domestic transport.
[24] Bureau, *Manufactures,* p. 840.

freight vehicles is not recorded.[25] Thompson suggests that in Britain there were perhaps 702,000 freight carts, vans and wagons in service in 1901 and about the same number of passenger carriages, so the *annual production* of horse-drawn vehicles in the USA was of about the same magnitude as the *total stock outstanding* in Britain.[26] The UK output of all "carriages and carts for animal traction" in 1907 was around $6 millions, possibly, given higher British prices, little more than 20,000 units.[27] If that is right, the production of these road vehicles for all private, business, public hire and self-drive (passenger and freight) use was *sixty* times higher *per capita* in America than in Britain. Surprisingly, the American road vehicle manufacturing industry, despite the best efforts of Henry Ford and Alfred Sloan, was not able to maintain anything remotely like this early lead in the later age of the mass-produced automobile.[28]

The United States evidently *entered* the twentieth century as an exceptionally road-using society. Of course, much of the logistical need met by the teamster and his horses in America was performed by the denser European steam railway network.[29] In 1900 the USA's rail system, at 311,287 km, was understandably a third longer than Europe's west of Russia, but it served only 76 million people (compared with Europe-ex-Russia's 285 million, in an area only half the size), so the services provided were less close to the median producer or consumer and less frequent (most was still single track). The mid-Atlantic region was the most densely networked and included four of America's seven largest cities (New York, Philadelphia, Pittsburgh and Baltimore) as

[25] Lavollée, "Carrosserie," p. 756.
[26] Thompson, "Nineteenth-Century Horse Sense," p. 72.
[27] Ibid., p. 61, n.3.
[28] In 1937, US automobile and truck unit output was only 3.5 times the per capita British level, compare Maxcy and Silberston, *Motor Industry*, p. 223 with *Historical statistics*, p. 4-831.
[29] Van Vleck ("Delivering coal") is the revisionist account of small wagons and dense railways; Scott ("Path Dependence") qualifies the revisionism; both arguably underplay dense rail's advantage for general merchandise and the scale economies of coal transport by ship.

well as major operations of its largest corporations.[30] This region more closely resembled highly urbanized and industrialized north-west Europe and had a land area and track length only a little below the UK's. Typically in such regions, on both sides of the Atlantic, lines were double-tracked (permitting around five times the traffic flow), though British railway managers were required to schedule higher-intensity traffic on their network: twice as many locomotives serviced a UK population one-and-a-half times larger than the mid-Atlantic region's.[31] London, alone, had, in the early twentieth century, 500 passenger rail stations (where parcels could be received or delivered: the railways competed with the Post Office and road hauliers for this business) and 74 goods depots (for heavier traffic like coal and timber, with 770 freight trains a day running among them).[32] Rail companies in Britain were among the largest importers and owners of horses, but only for the short collection and delivery runs necessary in such densely rail-served cities. In Germany, too, the railways were more involved in the distribution of parcels and finished manufactures (and less in raw materials) than in the USA.[33] With this well-organized and competitive delivery network (doing work differently divided among express companies, manufacturers' wagon fleets and self-drive farmers and storekeepers in the USA), European factories and warehouses could outsource distribution to tens of thousands of retailers more cheaply than their American counterparts (who were accordingly more likely to integrate forward to distribution).[34]

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[30] The Interstate Commerce Commission definition of mid-Atlantic (Region II) is used here, incorporating much of Pennsylvania, New York, New Jersey, Delaware and Maryland.

[31] Author's calculations based on the sources for Table 1 and Interstate Commerce Commission, *Statistics.*

[32] A. W. Gattie in Acworth and Paish, "British Railways," p. 738; Turnbull, *Traffic,* p. 139. The freight (parcels and mail) revenues of passenger trains in the UK added about 15% to freight train revenues around 1910.

[33] Huebner, "Prussian Railway Rate-making," p. 79; Woytinsky, *Welt,* 5, p. 89..

[34] Pratt, *American Railways*, p. 275; Turnbull, *Traffic*, pp.123-148; Fox, *Working Horses*; Hoff and Schwabach, *North American Railroads*, pp. 351-3; Gomel, "Camionnage." The US Post Office (unlike

Again, then, Europe probably had a logistical advantage. In France, horse on major roads cost 4.8 cents per tonne-km in the early twentieth century (against just over 1 cent per tonne-km on French railways), while short-hauls on central London roads cost 14.8 cents per tonne-km, though Van Vleck argues that the horse/rail fuel cost ratio - oats to coal - was more favorable in the USA.[35] Many Americans had less choice than Europeans: only *one* of hundreds of Belgian rural communes was further from a railhead than the 17km *average* for American cotton and wheat farmers. The rural rate by horse-drawn wagon to railheads in 1905 was, according to the US Department of Agriculture, 12.5 cents per tonne-km for wheat and 18.8 cents for cotton, against an average rail freight rate of 0.5 cents per tonne-km.[36]

MARKETS WITH AND WITHOUT BORDERS.

At critical points on the logistics spectrum, then, the United States was different: using trains where Europeans used ships, horses where Europeans used trains. Europeans thus had a scale economy advantage in transport: the horse-drawn wagon carried up to 4 tonnes, the railcar 8-50 tonnes and the ship upwards of a hundred tonnes

European equivalents) did not offer parcel service until 1913 and express companies (which had 300 offices in New York City, some at stations, but most using wagons and ferries to connect to the railhead) usually had exclusive railroad agencies, with some pricing power. Manhattan stabled one horse for every 6.5 humans in 1900, a higher figure than is plausible for London, compare Thompson, "Nineteenth-Century Horse Sense," pp 70, 75, 80.

[35] Toutain, "Transports," p. 278; Armstrong, "Freight pricing policy," p. 183; Van Vleck, "Delivering coal," pp. 151-3. The US price data suggest higher labor costs, however.

[36] Laffut, "Belgium," p. 211; Andrews, "Freight Costs." The US national accounts define the farm gate as the railhead, but, on Andrews' data, some 7.2% of the recorded value of wheat shipped from the railhead was, in fact, the cost of horse transport, though this may exaggerate the opportunity cost of the time of farmers and farm horses.

to tens of thousands.[37] While we do not have satisfactory price and quantity data for all modes, it is clear that - allowing for greater European use of ships and greater American use of horses – their costs per tonne-km were closer together than unadjusted rail rate comparisons suggest and it is not inconceivable that average freight rates were similar for both continents.[38]

Critically, whatever their relative freight *rates,* Americans had to contend with the distances of a relatively empty continent, while European businesses benefited from the mutual proximity of dense settlement. The overall rate of urbanization in Europe west of Russia and the USA was similar, with 41-42% of people living in towns of more than 5,000 by 1910, but what was extraordinary about turn-of-the-century northwest Europe was the nine large conurbations of more than a half-million affluent consumers in a compact area (not to speak of 15 more cities of that size in the rest of Europe, against only seven in the whole USA). The average UK rail haul in 1910 was only 64 km, and in France 190km, against 402km in the USA, and this tyranny of distance is also reflected in the USA's large requirement of (especially domestic) tonne-km in Table 1.[39] The average distance between all *nine* north-west European 500,000+ population city pairs - London, Birmingham, Glasgow, the Lancashire and Yorkshire

[37] In 1900, the capacity of a typical seagoing ship was 4,000 tonnes, a vessel on the Rhine 1,000 tonnes, a freight car 36 tonnes in the USA, 15 tonnes in Germany and 8 tonnes in the UK (Woytinsky, *World Commerce*, p. 308).

[38] Rail freight rates per tonne-km in 1905 in 11 continental European counties averaged nearly double US rates, see Webb, *New Dictionary*, p. 292, but compare note 19, above. The French data permit reliable calculation of the all-mode average. Combining the data in Table 1 with Toutain's price data and road transport output estimates, gives an average French price of 2.4 centimes per tonne-km, compared with 5.4 centimes for rail alone. If the outputs and prices of US horse and ship tonne-km netted to the same as its 1906 rail rate of 0.5 cents (2.6 centimes) per tonne-km, US all-mode freight rates would have been higher. Broadberry's ("How did the United States") three-country comparison of transport productivity, because it omits horse and most shipping output, cannot provide a useful alternative guideline.

[39] Armstrong, "The role," p. 176; Toutain, "Transports," p. 158; Barger, *Transportation Industries*, p. 203. Rostas (*Comparative productivity*, pp. 83-7) was making essentially the same point when he suggested that, when corrected for longer distances, the apparent American 1930s productivity lead in transport disappeared.

conurbations, Amsterdam, Paris, the Ruhr conurbation and Hamburg - was around 500 km and none of them were 1,000 km apart. The average distance between all *seven* American cities with that population (New York, Chicago, Boston, Philadelphia, Pittsburgh, St Louis and Baltimore) was 762 km and Boston to St Louis was 1,670 km; the European cities were also generally larger than the American. The United States was distinctively a land of small towns (and correspondingly fragmented markets).[40] Of the world's dozen busiest transport nodes, seven – London, Liverpool, Cardiff, Newcastle, Antwerp, Rotterdam and Hamburg - were in northwest Europe, against only two – New York and Chicago - in the whole USA.[41] Europe's trade was - with larger urban markets, shorter distances and a cheap transport mix – arguably less logistically constrained than in America.

Other factors limited the First European Integration, most notoriously its patchwork quilt of customs barriers, particularly exacerbated by the *Zollverein's* 1879 tariff and the French Meline tariff of 1892, but these should not be exaggerated. In 1900 British import duties amounted to only 4.6% of import values, German to only 8.1% and French to only 8.8%: all well below the prohibitive levels imposed in the USA (27.6%) and Russia (32.6%), levels generally avoided in western Europe before the 1930s.[42] In some industries like tinplate, British producers, locked out of the American market, were able successfully to shift their export focus to lower-tariff Germany and the Netherlands.[43] The contemporary protectionist drift was much more extreme in the USA

[40] As is suggested by its proliferation of newspaper titles (whose circulation then often defined local markets): the 15,904 titles published in the USA in 1900 exceeded the figure for all Europe (Barwick and Eccles, "Newspapers," p. 209).
[41] The others were Berlin, Suez and Hong Kong. All of these were served by both water and rail, but probably only in Chicago and Berlin did rail dominate the freight throughput.
[42] Broadberry, *Productivity race,* pp. 139-41; Capie, "Tariff Protection," p. 21.
[43] Minchinton, *British Tinplate Industry*, pp.63, 80.

than in Europe, and *all* European countries exceeded the low US trade/GDP ratio that resulted from its extreme protectionism. British tariffs did not seriously inhibit trade: they were "revenue" tariffs, levied only on goods not produced in Britain or paralleled by excise duties on domestic products.[44] Low tariff policies, with only mild protectionist effect, were also followed by small European countries, notably Belgium, the Netherlands, Denmark, Norway and Switzerland. With Britain, they collectively amounted to a "common market" not much smaller than the USA, with the added advantage of equally low import barriers against neighbors.[45] Transport costs for American mines and factories were often a higher proportion of cost and a more significant barrier to internal trade than such European tariffs.[46]

In higher tariff countries, many goods were on the free list (half the imports of France, Germany and Italy were duty-free), the major European countries all had extensive bilateral most-favored nation treaties and, where intermediate goods were not tariff-free, the effective protection rate for final production could be much lower than the nominal rate.[47] Despite a range of continental tariffs on sewing machines and parts that led to complex sourcing decisions, rather than simple exports of complete machines from the main Scottish factory, the market came close to being a single one by Marshall's touchstone of the "law of one price:" European-manufactured Singers were available

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[44] Irwin, "Free Trade."
[45] The familiar tariff-growth correlation need not invalidate this perspective, see Irwin, "Interpreting."
[46] For a later period, see Finger and Yeats ("Effective Protection"). We cannot make precise statistical comparisons earlier, because input-output tables typically incorporate only rail transport costs, though these alone were 20% of US coal prices (Leontief, *Structure*, appendix table for 1919), while tariffs on coal were zero in much of Europe. James ("Structural Change," p. 446, n. 17) notes the significant role of transport costs in reducing the minimum efficient scale in American industries. Jacks et al ("Trade Costs") suggest that in 1913 the median country-pair total trade cost was equivalent to a 76% tariff, thus implying that tariff rates at typical European levels were not the most critical trade inhibitors; they also draw attention to proximity, culture, language, information flows and other factors endowing northwest Europe with the world's lowest *international* trade costs, as indirectly measured by their gravity model.
[47] Woytinsky, *World Commerce*, p. 252; Liepmann, *Tariff Levels*, pp. 56-186.

Europe-wide at around $30 each (compared with the $50 - highly protected - American domestic price).[48] More than two-thirds of "world" trade in manufactures at the turn of the century was intra-European and there was a sense in which the Ruhr, Luxemburg, north-eastern France and Belgium were more closely inter-connected than any of them were to Berlin or Marseilles.[49] When we talk about globalization in the period before 1914 we are talking of a process driven by the First European Integration: the intra-continental and transoceanic trades of its western European heartland were both growing fast.

International trade was relatively unimportant for Russia (imports plus exports of $10 per head in 1913) and the United States ($43), but a high proportion of incomes for Belgium ($207), Switzerland ($162), the UK ($134) and Denmark ($126), and not trivial for Germany ($73) and France ($70).[50] The British are sometimes accused of having focused on trade with Anglophones (the USA and the Empire), neglecting their European neighbors. The accusation is not without foundation, for language, culture and kinship *did* count in defining markets. US-UK trade exceeded that of any other country pair and an English tourist could reasonably expect to find his Lea & Perrins Worcestershire sauce in a Mississippi steamboat restaurant. It was cheaper, with the inauguration of the "Imperial Penny Post" in 1898, to send a letter from London to Vancouver (7,606 km) than from London to Paris (341 km) and, when the USA joined

[48] Godley, "Global Diffusion," p. 28.
[49] Maizels, *Industrial Growth*, p. 92. Luxemburg was in the German *Zollgebiet*, as was annexed Alsace-Lorraine; Belgium and the Netherlands had low tariffs; so only (modest) German tariffs inhibited eastward trade and (modest) French tariffs westward trade within the core of what later became the heartland of the European Coal and Steel Community.
[50] Woytinsky, *World Commerce*, pp. 63-4.

the system (diplomatically re-branded the "Ocean Post") in 1908, the whole English-speaking world was united by one postal rate.

Yet the UK was hardly constrained by such links. A country that added to its geographical advantage of island status the created advantage of free trade policies naturally won a quite disproportionate share of *all* world manufacturing exports: its businessmen, effectively, answered the inappropriate question "European or Anglophone?" with the sensible "both." Within the European economic space, the best customer for exports from Germany, France, Scandinavia, Iberia and Greece in 1900 was the free-trading UK. Yet the top export customer of the UK itself – and of Switzerland, Italy, the Netherlands, Belgium, Russia and Austria-Hungary - was mildly protectionist Germany, which consistently imported more manufactures than the UK.[51] In the decades before the First World War increasing US protectionism curtailed America's import growth, but Germany's rapid industrialization proceeded, more conventionally, on the basis of increasing the ratio of imports to national income. Europe accounted for more than three-quarters of "world" trade and most of that was intra-European.[52] Investment sometimes led or followed trade (and, then as now, much international trade was intra-company trade). It is true that regions of recent settlement exerted a powerful attraction for international investors - by 1914 $7.1 billion was invested in the USA alone - but Europeans also invested prolifically across their own borders: France had $5.3 billion

[51]Anon., *Statistical Abstract*, pp. 172-203; Liepmann, *Tariff Levels*, pp. 201-339; Maizels, *Industrial growth*, p. 436.
[52] In 1913, 40% of world trade was intra-European, 37% between Europe and elsewhere and only 23% between non-Europeans (Woytinsky, *World Commerce*, p. 71).

invested elsewhere in Europe, Germany $3.0 billion, Britain $1.1 billion and smaller countries perhaps a further $3.3 billion.[53]

Moreover, modern studies suggest that factors beyond tariffs and transport costs - including currency unions and cultural links – encourage trade.[54] Political union (the recent unifications of Germany, Greece and Italy apart) did not drive the First European Integration, but trans-European policy cooperation minimized potential disadvantages relative to the dollar area (itself a patchwork quilt of barely integrated banking regions, with less interstate banking than Europe). International agreements guaranteed unhindered passage on major waterways like the Sound, Bosporus, Suez, Rhine and Danube; while cross-border rail traffic was smoothed by the International Rail Traffic Association in Berne (also home to the International Telegraph Union and Universal Postal Union). German was the official language of several countries and widely spoken throughout northern and eastern Europe; French had a similar franchise, extending also to Rumania and Russia; while many merchants, given the importance of trade settlement by the bill on London and the ubiquity of British ships, understood commercial English. The educated elite were often trilingual: Queen Victoria could converse in either language with her grandson, Kaiser Wilhelm, or at her favorite vacation spot, the Promenade des Anglais in Nice. Passenger fares within Europe were generally lower than in the USA and even the more difficult, multi-mode journeys such as London to Berlin (via the Vlissingen ferry) could be completed slightly faster (under

[53] Wilkins, *History*, pp. 147-50; Maddison, *Monitoring*, p.63.
[54] Jacks et al., "Trade Costs" is a pioneering attempt to measure these using a gravity trade model for 1870-1913.

22 hours one-way) and at the same price ($20 first class) as the longer New York-Chicago run. Passports were required for neither trip.[55]

Communication by telegram - then the favored medium for time-critical business communication - was as effective between countries as domestically and it was as cheap to cable London from Berlin as New York from Chicago.[56] In the smaller countries - Scandinavia, Belgium, the Netherlands and Switzerland – nearly half the telegraph traffic was "international" (but overwhelmingly intra-European); even one-third of German cables were cross-border.[57] The Latin currency union meant that the Swiss, Belgian and French francs, Italian lira and other southern currencies were identical; there was also a Scandinavian currency union; while both unions and the two large independents, the mark and the pound sterling, had a fixed (gold standard) relationship, eliminating exchange rate uncertainty from most cross-border trade dealings. A German visitor did not consult a conversion table to work out the value of an English gold sovereign (20 shillings): she could *see* and *feel* it was the same weight and value as her *Doppelkrone* (20 marks). The First European Integration was, on some dimensions, more palpable than the postwar European Union.

[55] Bradshaw, *Through routes,* p. 2; Baedeker, *United States*, p. 342. Only travelers to Rumania and Russia required passports within Europe. Passenger fares per km in 11 continental European countries in 1905 averaged little more than half the American rate, see Webb, *New Dictionary*, p. 292.
[56] Lew and Cater, "Telegraph;" Baedeker, *Northern Germany*, p. xvi; *World Almanac 1909*, p. 283.
[57] Anon., *Statistical Abstract1902*/1903, pp. 270-77.

THE UPSHOT FOR TRADE

If European markets were becoming more integrated before 1914, one would expect to find national specialization developing in some sectors.[58] This is most evident in mining, which had to be located where the deposits were, though some industrial processing often followed. In 1900 Russia produced 94% of Europe's crude oil, 89% of its gold and 74% of its manganese, Italy mined 98% of its sulfur, Spain mined 68% of its copper ore and 58% of its mercury, Britain accounted for 55% of its hard coal production and Germany 42% of its zinc.[59] These high national market shares were largely a result of differing resource endowments (though also owe something to mining and metallurgical expertise and depletion in some regions, which could also change specializations). They are no more surprising than that much American copper came from Montana or much of its petroleum (in 1900) from Pennsylvania, West Virginia and Ohio. Natural resources were not, however, permitted to have a similar effect in agriculture, where - except in Britain, Belgium, the Netherlands and Denmark - autarkic policies generally delayed trade-driven agricultural restructuring and forestalled efficiency gains on the scale America experienced.

In manufacturing and services, natural resources and protection played a smaller part. Retail banks and insurance companies were, in order to serve their customers, necessarily spread throughout Europe, but the Bank of England, with an international as well as national role, was bigger than the Reichsbank, Banque de France

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[58] Paralleling similar developments among US states in 1860-1930, see Kim, "Expansion".
[59] Statistique Générale, *Annuaire Statistique 1938.*In all cases percentages are of European (including Russian Azerbaijan in the case of petroleum) production, ignoring imports from outside Europe (but including Europe's exports).

and Banque Royale (Belgium) combined.[60] Other wholesale, or specialist, financial and commercial services also centered on the UK. The assets of overseas banks with offices in London exceeded those of all British domestic banks and most foreign investment emanated from there; more securities were quoted there and more companies were formed there than in the whole of the rest of Europe; London insured most foreign (as well as British) ships and cargoes, though in the re-insurance industry (that is wholesale insurance) Germany took the lead.[61] National post offices monopolized domestic telegraphs, but the worldwide web of international cables was mainly in private sector hands: 57% of the European undersea cable network was run by London-headquartered companies.[62] It is more difficult to be precise about Britain's share in the operations of international trading companies, partly because the sophisticated mix of financial, managerial, risk control, exploration, engineering, investment and logistic services they provided make defining the borders of the business impossible, partly because there were some powerful Dutch, French, Greek, Swiss, Swedish and German (not to speak of American and Japanese) competitors and partly because firms operating in the UK were so cosmopolitan as to defy any simple classification by national identity.[63] However, the main, separately identifiable tradable service - shipping – *was* clearly measurable and 60% of Europe's capacity in 1900 was in British-flagged ships. Much global shipping movement was directed via cable communication with the ports (and, increasingly, directly to ships by Marconi radio) by the polyglot owners and shipbrokers of the

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[60] Central banks were investor-owned utilities: my size estimates are based on stock market capitalizations.
[61] Hannah, "Pioneering;" Fayle, *War,* p. 6; Woytinsky, *Welt,* 5, pp 315, 331.
[62] *Statistisches Jahrbuch 1909*, pp. 36-7.
[63] Chapman*, Merchant Enterprise;* Jones, ed*., The Multinational Traders*.

(modestly-named, but actually global) Baltic Exchange in London.[64] The UK was the first country to derive most of its national income from the service sector, helped by European market integration driving this specialization in service exports.[65]

In basic industries, where German catch-up was clearer, access to cheap coal supplies remained critical for many processes. Coal-producing regions like the Ruhr, Silesia, Wales, Scotland and northern England had advantages in iron and steel manufacture, relative to Italy and France (which imported coal from Britain). The UK and Germany in 1900 jointly produced three-fifths of Europe's iron and steel and both were large exporters, though Britain was cutting back (relatively speaking) in such basic intermediates.[66] In other European industries, the leading country market shares were already less evenly spread. The UK alone had 58% of Europe's cotton spindles, while Italy produced as much as 84 % of Europe's silk in 1900.[67] In some more technologically challenging industries, there were also clear divisions of European labor: around 1900 the UK produced 90% of Europe's sewing machines, more than two-thirds of its ships and 57% of its soda ash, Germany made perhaps 40% of its electrical equipment, half of its pianos (then vying with sewing machines and stoves as the leading consumer durable) and nearly all its dyestuffs, while France accounted for 79% of its automobiles.[68] Other

[64] Board of Trade, *Position*, p. 252; Lew and Cater, "Telegraph, p. 151,
[65] Deane and Cole, *British Economic Growth*, p. 291; Lewis, *Growth*, p. 263. The USA did not match this until the 1950s (when its real GDP per head was more than twice Britain's in 1900), suggesting that specialization through trade (rather than affluence) created the world's first service economy.
[66] *Annuaire Statistique 1938*, p 337; Raffalovich, *Le Marche Financier en 1901*, p. 570.
[67] Picard, *Bilan*, pp. 323, 387; Federico, *Economic history*, p. 35.
[68] Pollard and Robertson, *British shipbuilding industry*, p. 249; Woytinsky, *Welt*, 4, pp. 222, 225, 311-26; Ungewitter, *Chemie,* p. 19; Ehrlich, *Piano*, p. 222; Laux, *European Automobile Industry*, p. 8.

manufactures - such as paper, sugar, cigarettes, stoves, agricultural machinery and locomotives - were more evenly spread around industrialized Europe.[69]

By these indicators, European economies appear *more* integrated during the First European Integration than today.[70] Following postwar integration, at the 2-digit manufacturing industry level, only Italian leather goods manufacturers (with 52% of the European industry's output) have a degree of dominance similar to the higher levels in the prewar examples in (then very large) manufacturing industries like silk, cotton, or ships.[71] It is possible to interpret this as a sign that extensive specialization through trade was better developed in well-integrated European markets before 1914 than within the modern European Union, with non-tariff barriers and market interventions now inhibiting fuller integration. Yet such a conclusion is unsafe. More benign factors, like the spread of industrialization and catch-up in living standards, especially in Europe's south and east, explain some of the contrast. There was parallel regional de-specialization in the United States from around 1930, caused by southern economic development, less resource-intensive manufacturing production, new (and more mobile) energy resources and more reliance on created (and mobile) human capital. Such factors probably also account for much of the reduced modern manufacturing specialization among European countries

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[69] In some cases, these industries appear more regionally concentrated in the USA: for example, cigarettes in North Carolina, Virginia and New York, agricultural machinery in the Midwest.

[70] It might be objected that the examples given for 1900 are, in modern terms, at the 3-digit not 2-digit industry level, generating artificially higher specialization indexes. But modern 2-digit industries do not map easily onto 1900 data: ships or cotton textiles then accounted for such a high share of manufacturing employment (textiles alone accounted for more than a third in many countries) that a 1900 statistician devising categories of reasonably equal size would have made these separate 2-digit industries.

[71]Europe-wide manufacturing industry data for 2000 show Germany as the largest European producer in 16 of 22 2-digit industries, with its highest shares in automobiles (40% of total EU 25-country production) and electrical machinery (39%), though its average share in the other 14 industries was just below 25 %, with a range from 18% to 34%. Italy was the largest European producer in four of the remaining six industries, in one of which, leather, its share reached the exceptional level of 52% (its share of clothing was 35%, textiles 30% and furniture and miscellaneous 22%). France dominated "other transport equipment" (that is, ships, aircraft and trains) but its share was only 30%, while the UK was the largest producer of office machinery and computers, with a 27% share (all figures calculated from sales data for 2000 on the Eurostat website).

relative to the higher level attained in the different regime of trade, technology and income distribution that obtained before 1914.[72] What is clear is that the factors identified here did make Europe – and particularly its highly developed northwest - a large, integrated trading and investment area. The European economic space is not – before 1914 - sensibly treated as a series of isolated countries, fatally divided by protectionism and national identity.

GIANT INDUSTRIAL PLANTS

If European firms likely had access to at least as wide a market as American ones at the turn of the century, then why did Europe not have plants and firms as large as the USA's? The literature on why France or Britain failed to develop large plants and firms is extensive, though the same factors are often presumed not to apply to Germany: rapidly developing and with a population one-third greater than the UK or France.[73] However, these sharply differentiated national industrial landscapes, confidently identified by narrative historians, proved suspiciously invisible to the unimaginative bureaucrats who conducted national business censuses. Kinghorn and Nye have pointed out that the average employee numbers in early twentieth century manufacturing plants was much the same in Britain (64) as in the United States (67) and – though plants were generally smaller on the continent – they were actually larger in

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[72] On the US de-specialization, see Kim, "Expansion.".
[73] Landes, *Unbound Prometheus*, p. 247; Kindleberger, *Economic Growth*, pp. 161-82; Elbaum and Lazonick, *Decline*, p. 2; Chandler, *Scale*, pp. 239-94, 397-502.

France (26) than in Germany (14).[74] Of course, much production everywhere remained in a long tail of handicraft trades and small factories, often with purely local markets, which generate such low averages. For our purpose, the focus needs to move to the larger plants that typically required a broader market for their output. Table 2 shows the location of most 'giant' manufacturing plants – those employing more than one thousand people - along with some data on 'giant' mines around 1907.

There were perhaps 3,000 such giant manufacturing plants globally at this time, more than half in Europe, less than a fifth in the USA.[75] The choice of plants employing 1,000+ is not arbitrary: not only was it the touchstone of giant scale favored by contemporary statisticians (hence the availability of census data), but it clearly required a shift toward professional management. An owner-entrepreneur's family might run a plant with 200 employees, or, with the help of a few senior clerks, even stretch that to 500, but supervising 1,000 people typically required the recruitment of more non-family managers, with greater professional specialization of functions like payroll, book-keeping, production and sales.

The importance of distinguishing manufacturing from mining is evident from the table: studies which group them as "industry" (especially if they add in construction firms and utilities), and compare differently defined census results, are

[74] Kinghorn and Nye, "Scale," p. 97. I use the terms plant and factory interchangeably, and to include also what the US census calls an establishment (including not only two factories under one ownership making the same product on the same site, but even non-contiguous, commonly-owned factories *in the same city or county*), a broader concept than European censuses. National censuses also treated integrated or diversified plants variously, sometimes dividing them into several component product plants.

[75] The 2,228 cases in the table exclude many countries. I have, for example, excluded seven small countries – Rumania, Greece, Norway, Denmark, Argentina, New Zealand and Australia - whose census data suggest from only one or two giant factories up to, at the outside, a dozen such plants totaling less than 25,000 employees. In 1914, the *average* number of workers in India's 271 textile mills was as high as 976 (*The Indian Year Book 1918*, p. 331), and, though information on their size distribution is unavailable, it is possible that most of these employed 1,000+, including salaried workers. Other omissions include China, Mexico, the Ottoman Empire and Spain.

Table 2. ‘Giant’ factories and mines (1000+ employees) in the early 20th century.

Country/Date.	Number of giant plants.	Numbers employed. Total in ‘giants’	Average per giant plant.	Proportion of workforce in ‘giants.’
MANUFACTURING				
Brazil 1920	29	46,057	1,588	16.7%
Russia 1907**	302	623,888	2,066	14.6%
USA 1909	550	1,155,345	2,101	14.1%
UK 1907*	na	784,171	na	12.4 %
Canada 1922*	na	45,857	na	9.9%
Sweden 1913**	22	30,982	1,408	8.8%
Germany 1907	350	718,428	2,053	8.6%
France 1906	162	296,625	1,831	8.5%
Austria 1902*	na	235,262	na	8.3%
Hungary 1900	29	49,346	1,702	8.3%
Japan 1907	100	236,697	2,367	7.4%
Belgium 1910	27	46,913	1,738	6.7%
Netherlands 1906*	na	36,019	na	6.6%
Italy 1911	105	<214,095	na	<5.8%***
Switzerland 1910*	na	25,089	na	4.8%
“World” ca. 1907.	2,228§	<4,544,764	2,040	<10.4%
MINES.				
Transvaal 1898/9*	58	77,800	1,341	77.8%

Japan 1907	55	126,116	2,293	70.9%
Germany 1907	236	660,424	2,798	69.2%
France 1906	45	165,486	3,677	62.4%
USA 1909	125	540,342	4,323	48.7%
Hungary 1900	12	20,148	1,679	35.7%
UK 1907	214	323,102	1,510	30.4%
Belgium 1910	16	21,710	1,357	12.8%
"World" ca. 1907	761	1,935,128	2,543	49.6%
(Russia 1910	31	84,872	2,735	partial listing)
(China 1912	10	49,760	4,976	partial listing)

*estimated

** including some mines, within an undifferentiated "metallurgy and mines" category.

*** If the 105 Italian giant plants (exceptionally for smaller European countries) had matched the global average of 2,040 employees, they would have accounted for 5.8% of Italian manufacturing employment in 1911.

§ estimated on the basis that the average employment in the giant plants of countries without data is a weighted average (2,040 employees) of those for which data exists (1,676 plants).

Sources: USA: Bureau, *Manufactures*, p. 185, *Mines and Quarries*, p. 35; Lebergott, *Manpower*, pp. 514, 516. UK: Home Office, *List of Mines*, *List of Quarries* and see note 93. Germany: Kaiserlichen Statistischen Amte, "Gewerbliche Betriebstatistik," pp. 4-13, 58-153 (excluding construction, gas and laundries). Netherlands: Van Gerwen and Seegers, "De industrialisatie," p.156. France: Statistique Générale, *Annuaire 1909,* p. 188. Austria, Italy, Canada: Woytinsky, *Welt*, 4, pp. 42-5, 49. Belgium: Ministère, *Recensement.* Russia: Rashin, *Formirovanie*, pp. 42, 96; Peacock, *Russian Year Book*, pp. 185-7. Sweden: Statistiska Centralbyrån, *Statistisk Arsbok*, p. 106. Switzerland: Statistischen Bureau, *Statistisches Jahrbuch*, p. 114. Hungary: Ungarischen Statistischen Zentralamt, Volkzählung, pp. 203*-205*, 259-62. Brazil: Ludwig, *Brazil*, p. 287. Japan: Bureau, *General Information*, pp. 10-29 (mines); Ministère des Finances*, Annuaire*, pp. 74-5 (with further tobacco factory breakdown from Anon., *Tabako Senbaishi*, pp. 622-4; Anon., *Kojo Tsuran*. Transvaal: Chamber, *Tenth Annual Report*, pp. 55, 452 and see n.75.

China: Woodhead and Bell, *China Year Book*, pp. 62-73 (multi-shaft companies counted as one mine); and see notes 77-9, for major adjustments made.

misleading. The mining industry (mainly, at this time, coal mines) was, indisputably, characterized by large workplace units: perhaps half the world's miners worked in giant mines, but only one in ten manufacturing workers were in similar-scale factories.[76] (In this table, US mines were the largest and Britain's and Belgium's the smallest, though, since this resulted more from differential geology than from managerial choice, it is perhaps of limited interest).[77] It is also important, for countries (like the USA) which excluded very small producers from their census, to add back the un-enumerated workers to the denominator of the last column, for comparison with countries that conducted a full census. Where census tables do not include government plants (common in mining, munitions, shipbuilding, explosives, railway equipment, tobacco and printing), consolidated totals are required.[78] Finally, some censuses enumerated only blue-collar workers, so an adjustment is required for comparison with those including administrative,

[76] For Transvaal the data relates to its (dominant) gold mines only, though there were also coal mines there. Mine size was estimated on the basis that any company reported as recently recruiting 700 or more from the Rand Native Labour Association employed 1,000+ and that that distribution is representative of total mine employment averaging 100,000 in 1898/9. The data on individual mines in the Rand Mines group and averages for other groups (Transvaal Chamber, *Diagrams*, especially exhibits 20 and 23) support these assumptions and suggest that employment below 1,000 was common only in mines not yet producing; the average in the table is based on the 58 producing mines only, from exhibit 13.

[77] Church, *History*. Some countries not shown had smaller mines: in New Zealand, for example, all 150 coal mines operating in 1911 employed fewer than 1,000 (Fraser, *New Zealand Official Year Book*, p. 632). That mine size is geology- rather then culture-driven is suggested by the role reversal in gold, with small US mines (low-tech, near-surface nuggets) and massive British-owned Transvaal mines (the Rand's geology requiring very deep shafts and capital-intensive surface ore processing).

[78] Government plants were more concentrated than private ones (24% of German, 59% of French and 79% of Japanese state manufacturing employees were in giant plants) and accounted for 9% of German, 15% of French and 53% of Japanese workers in giant factories shown in column 2. The US census reports 40 government manufacturing establishments (printing works, armories etc) employing 32,519 wage-earners, but gives no size breakdown. I have arbitrarily assumed ten of these employed 1,000+, with the same average employment as private giant plants, or 21,020 in total (and, for the purposes of Table 3, that three of these employed 9,000 in shipbuilding, from among the 12 US government shipyards recorded as employing 14,540 wage-earners).

technical and clerical workers (typically, at this time, 5-10% of employees).[79] I have attempted to standardize the data in all these ways. The figures marked with a single asterisk are estimated from size classes other than 1,000+ and even the latter may use inconsistent definitions of plants, so modest national differences should not be accorded any significance.[80]

Factories employing 1,000+ had probably overtaken the number of giant mines globally in the late nineteenth century. In Germany, there had been only 40 giant factories in the private sector in 1882 (half the then number of giant mines), but this rose to 144 in 1895 and 315 by 1907, with the proportion of all manufacturing employees in these giant plants rising from 2.4 % to 8.1% over the same period. In French manufacturing the number of giant plants rose from 108 in 1896 to 162 in 1906, in Hungary from 11 in 1890 to 29 in 1900, in Belgium from 8 in 1880 to 27 in 1910, in the USA from 443 in 1899 to 648 by 1914 and in Russia from 243 in 1901 to 372 in 1914. Given these rates of increase, the US census timing (1909) possibly exaggerates its plant sizes, relative to the four largest European countries (reported for 1906-7).

85% of the giant US plants were in the industrial northeast (178 in the mid-Atlantic states, 159 in New England, 115 in the east north central states) and more than half were in six census categories: cotton goods (77), steelworks and rolling mills (57), construction and repair shops owned by steam railroads (44), foundry and machine

[79] I assumed that giant Belgian, Canadian, Japanese and US plants had the same proportion of salaried employees as their average plant, or, in the absence of such data, that 7.5% of employees were salaried. No allowance was made for salaried employees increasing the *number* of plants above the 1,000-employee threshold, so there remains an underestimation (columns 1, 2 and 4) or overestimation (column 3).

[80] Based on average plant sizes within the known ranges, relative to the known French size distribution, the proportion in 1,000+ plants was estimated as 45% of employees in 500+ plants for Switzerland, 50% of those in 500+ plants for Canada and 28% of those in 200+ plants for the Netherlands. For Austria, the estimate is based on the Hungarian proportion of those in 20+ plants.

shops (41), woolen textiles (24) and slaughtering and meatpacking (23).[81] European census categories differ somewhat, but the industrial distribution of giant plants appears broadly similar, meatpacking apart (Europeans killed their locally-reared meat in small slaughterhouses or, for the chilled product, had their Australian and Argentine cousins do the mass destruction job for them). In Germany, the industries with most large plants - also accounting for more than half the total - are otherwise similar: machinery and equipment (77 plants), rail and other vehicle-building (39), textile weaving (34), iron and steel (31), and textile spinning (28).[82] At least in relatively mature industries with some evolutionary track record, the determinants of optimal scale – whether technological, managerial or market access – appear to be operating world-wide.

It may seem surprising that most of these factories (and most giant mines) were investments in basic technologies developed before 1850, or, in the case of major breakthroughs in an old product, steel, in 1850-70. Yet to contemporaries these *were* the aspirational targets, whether for a Russian, Japanese or Italian (contemplating industrialization as an escape from poverty) or for an American (now rivaling Old World living standards, not just with advantageous land endowments, but because US manufacturers rivaled theirs). Indeed, in steel and some advanced machine-making, giant

[81] Bureau, *Manufactures,* pp. 207, 235.

[82] Kaiserlichen Statistischen Amte, "Gewerbliche Betriebstatistik," pp. 2-13. The first category – machinery and equipment - is unhelpfully broad, including locomotives, steam engines, boilers and elevators, as well as all kinds of agricultural, textile, sewing, building, printing, brewing, distilling and miscellaneous machinery, many separately itemized in the US census. The French census categories are also broader and less easy to compare, but a similar pattern is evident in the first three of the four largest categories of textiles (40 plants), metallurgy (17), metalworking (17) and state factories (14). (This is 1901 French data; 1906 to be substituted when data located). In Britain, we can only compare large firms (employing 3,000+), but the distribution is not dissimilar: the largest categories are machines and equipment (23), textiles (17), ships (16), iron and steel (13), food (11, though these are branded goods manufacturers, not slaughterhouses) and railway workshops (8). Britain was more regionally specialized: for example, the world's largest city - London - had almost no giant manufacturing plants (Bowley, "Survival," p. 114 shows 1 industrial plant employing 1,000+ and 2 employing 500-999), while there were dozens of giant plants in (less financially and commercially specialized) Berlin and New York.

plants required more know-how, skilled workers and/or capital than countries like Japan, Russia or Italy could muster. These countries were only developing them experimentally or modestly – often with foreign technicians, investors and managers - at the close of the nineteenth century.

Really "modern" industries of the second industrial revolution, though growing rapidly in relatively advanced economies, still had few giant plants, in some cases no more than several dozen worldwide. However, as can be seen from their (bracketed) workforce shares in Table 3, in these industries giant units were more dominant, a trend that was particularly strong in shipbuilding and electrical manufacturing. National variations were also more apparent here: there were 20 giant German chemical plants, 19 in shipbuilding and 15 in electrical, but, in the USA (an economy twice Germany's size), only 7 in chemicals and 11 each in shipbuilding and electrical. Contrariwise, in the, then most widespread, branded packaged product, Germany had only 3 giant tobacco factories, but there were as many as 13 in the USA. In the most recent innovation - automobiles - America also led, with 15 plants employing 1,000+, against Germany's one. In 1906/7 aggregate European car production still just exceeded that of the USA, but the industry prospered outside Germany: there were several large automobile plants in the UK, Italy and Belgium, but France - conventionally specializing in hand-crafted, luxury items (which, of course, is what most cars then were) - had the most.[83]

The nearest comparable British data, which are for the largest *firms* in

[83] Laux, *European Automobile Industry,* pp. 8, 28, 36-41; Shaw, "Large Employers;" Ministère, *Recensement,* p. 213; Laux, *In First Gear*, pp.185-6, 212, 216.

Table 3. Employment in 'Giant' Plants (1,000+ employees, Germany, USA) or Firms (3,000+ employees, UK) in 'Modern' Manufactures, ca. 1907.

Country/date	Chemicals	Electrical	Ships	Tobacco	Automobiles
	Number of employees in 'giants.' (and their share in each industry's total employment).				
Germany (1907)	42,159	62,684	65,332	4,962	1,165
	(23%)	(39%)	(75%)	(3%)	(12%)
USA (1909)	15,413	50,481	28,151	22,286	27,715
	(7%)	(48%)	(54%)	(11%)	(32%)
UK (1907)	26,400	25,242	104,805	15,500	3,200
	(20%)	(40%)	(49%)	(41%)	(11%)
	(Labor productivity: USA=100)				
Germany	na	na	54	98	44
UK	66	na	131	166	23

Source: Employment: as Table 2 (with US wage-earners adjusted upwards for salaried employees by industry-specific ratios; and British employment figures for multi-industry firms apportioned equally between industries). Labor productivity: Broadberry, *Productivity Race*, pp.164, 178 (chemicals - mean of oilseed, soap and fertilizers – and automobiles, 1907/9); Lorenz, "Evolutionary explanation," p. 915 (shipbuilding, 1900); Hannah, "Whig Fable," p. 59 (tobacco, 1912)

na: not available

these industries - those employing 3,000+, of which the UK had 6 in electrical, 5 in chemicals, 2 in tobacco, 1 in automobiles and 16 in ships - are also shown in Table 3.[84] If these figures are a reasonable proxy for the numbers employed in large *plants* in these industries (as they probably are), then the conventional notions of early twentieth century UK "backwardness" in large-scale production of electrical equipment, German "backwardness" in automobiles and tobacco and American "backwardness" in ships are confirmed. These rankings would not change on an output basis, if the crude comparative productivity data – shown in the lower half of the table – are an appropriate guide.[85]

Of course, all of these "modern" industries contain some "old" elements: branded cigars and plug, not "modern" cigarette factories, account for most American tobacco employees.[86] The most expensive and sophisticated contemporary capital goods were warships and liners costing $5 million each: their turbine rooms alone were the size of a central power station and transatlantic liners were so large they could only dock in New York and half a dozen European ports. Yet small coasters and lighters cost no more than the $100,000 for a freight train: both were, in essence, low-tech iron tubs with steam engines attached. If we considered only shipyards building state-of-the-art liners, the USA would disappear from the table (Cramp's Philadelphia yard dropped out of contention when these ships became faster and larger after 1895), while Germany would

[84] Shaw, "Large Employers;" Wardley, "Emergence." Many of these employees were in plants employing less than 1,000, but many others would be employed in plants of 1,000-3,000 owned by firms employing less than 3,000; the reliability of the estimation depends on these two effects cancelling each other out. Applying the same method to Germany (for large German firms employing 3,000+, see Wardley, "Emergence") would result in an underestimation of German employment in large plants in chemicals, automobiles and tobacco and an overestimation in electricals and ships.
[85] Not something that can be taken for granted, see, for example, Leunig, "A British Industrial Success."
[86] Hannah, "Whig Fable," pp. 51, 62.

gain share: the top end of this market was confined to one French, three UK and three German shipyards.[87]

Table 3 suggests stronger British commitment to large-scale in chemicals than the USA. Yet we know the United States' chemical workforce at the dates shown (228,362) was larger than either Germany's (184,482) or Britain's (127,700).[88] However, this industry encompassed a variety of products with different optimal plant sizes and countries had focused their development variously: Germany on dyestuffs (where BASF employed 8,877, Bayer 7,811, and Hoechst 6,000 in 1907, in each case primarily at one central plant), Britain on alkalis and explosives (where two large firms with one dominant site employed 8,000 and 4,000), and the United States on fertilizers (in which the 1909 census records the largest plant employing only 419 wage-earners) and patent medicines and drugs (in which America's largest chemical plant - probably Parke Davis of Detroit - employed 1,789, but the next four only around 600 each).[89] America simply had many, modestly-sized, chemical factories in laundry blue, soap, blacking, polishes, grease, tallow, turpentine, fertilizers, patent medicines and drugs, so less than 7% of its chemical employment was in giant plants (making this one of America's least concentrated industries), compared with 20% in Britain and 23% in Germany (among their modestly concentrated sectors). Mixing water, alcohol, opium and advertising (the main

[87] Rieger, *Technology*; Murken, *Die grossen transatlantischen Linienreederei-Verbände*, pp. 738-41. In the other high-tech sector, warships, the relative strengths were similar, though the US maintained capability there.

[88] author's calculations. I have excluded from the US "chemical and allied products" classification manufactured gas, petroleum refining, baking powder, yeast and salt, to align it with European census definitions.

[89] The US also had 4 giant alkali and general chemical plants, the largest employing 1,473, 1 giant soap plant employing 1,102 and 1 giant explosives plant, employing 1,579. The German census split up the Leverkusen and Ludwigshafen complexes into smaller plants, producing intermediates and dyes. The peculiarity of the US chemical industry has been missed by narrative historians, but was picked up by James ("Structural Change," p. 447, n.20), who noted that in 1890, exceptionally, it showed decreasing returns to scale at its average plant size.

ingredients of contemporary patent medicines), though very profitable, simply required smaller, less capital-intensive plants than synthesizing dyestuffs or producing Solvay soda and dynamite.

National variations in investment in large plants in modern industries may, but do not *necessarily,* imply grave social or entrepreneurial failure. At the technological frontier, it may make perfectly good sense for advanced nations to specialize, according to local factor endowments or demand conditions (or, indeed, randomly) in pioneering breakthrough technologies; or luck may have dealt differentially favorable opening hands. These industries were at an earlier evolutionary stage than the (more evenly spread) large plants in textiles, steel and simpler engineering, so emulation may not yet have had time to work (as is suggested by the, quite pervasive, catch-up by initial laggards in the next decades).[90] However, there were sometimes internal or external economies of scale or learning effects which gave first movers an advantage that locked followers out in export markets as well as at home (as is suggested by the US and UK clawing back markets only by postwar expropriation of German dyestuffs patents and massively protective tariffs). Alternatively (or as well), market demand may have varied, even in apparently similar countries (at one level, it is not difficult to explain why Americans operated relatively few ships, and low British investment in electric tramways and lighting has been similarly excused).

The French and German censuses also enumerate size classes above the 1000-employee mark: showing that, in France 5 manufacturing plants employed 5,000+, and as many as 10 mines (these were the large mines of the Nord and Pas de Calais

[90] Germany's share in world chemical production, for example, fell after 1897 (Ungewitter, *Chemie,* p. 26); Britain's share in shipbuilding was also to decline after 1914.

immortalized in Zola's *Germinal*); while in Germany there were 12 factories and 32 mines employing 5,000+ in the private sector alone.[91] There were probably also about a dozen US factories, and several dozen US mines, of that super-giant size.[92] We also know that there were at least 20 British factories (but not a single mine) above the 5,000-employee threshold, though some were multi-product sites that would have been counted as several plants in the continental censuses. Indeed, Krupp's Essen works – with 33,917 employees by 1909 - may well have been the world's largest, private, multi-product, manufacturing complex by employment size, though it was actually enumerated as several smaller plants in the census.[93] The table shows the danger of extrapolating from that icon of Prussian militarism, for beyond Essen lay a diverse economy of medium-

[91] The German census did not enumerate separately the 5,000+ category for the 35 public-owned manufacturing plants and 16 publicly owned mines employing 1,000+.

[92] The 1899 US census (p. lxxiiv), exceptionally, singled out an Ohio iron and steel mill employing 7,477 (perhaps a Federal Steel plant), a New Hampshire textile mill employing 7,268 (presumably Amoskeag in Manchester), an Illinois agricultural machinery maker employing 6,728 (presumably McCormick or Moline Plow) and a Pennsylvania electrical manufacturer employing 6,318 (presumably Westinghouse's Pittsburgh works). In the 1909 census, it is not possible to deduce whether the single Pennsylvania electrical plant which then had 7,083 wage-earners (presumably again Westinghouse in Pittsburgh) was bigger than any of the two in Massachusetts employing a total of 9,867 wage-earners or the two in New York employing a total of 12,654 (presumably these include General Electric and Western Electric plants, and logically at least one must have employed 5,000+). The steel mills are even more aggregated, making it impossible to distinguish the largest plant in Pennsylvania, Ohio and Illinois, though we know from another source that US Steel's Carnegie (Homestead) plant employed 6,000 around 1905 (Hoff and Schwabach, *North American Railroads*, p. 25). Similar aggregation problems apply to textiles, though one New Hampshire woolen mill employed 5,000. The 1909 census also lists an Illinois rail car manufacturer employing 5,002 (presumably Pullman), a New Jersey sewing machine manufacturer employing 7,444 (presumably Singer), a New York men's clothing manufacturer employing 5,560, a Virginia shipyard (presumably Newport News) employing 5,065, a Pennsylvania coke plant employing 5,214 (presumably US Steel/Frick), and a Wisconsin steam railroad construction and repair shop employing 5,466. This means that 9 US factories can be positively identified as employing 5,000+. It is likely that there were a few more concealed in the aggregations and also dozens of mines in that size category, given that the 125 largest US mines employed an *average* of 4,323 (Table 2)

[93] Krupp, *Statistische Angaben*, p. 11. The German census of 1907 registers one large steelworks in Essen employing 9,945 and a smaller range of giant plants in arms, machinery etc. The equivalent English armaments firm, Armstrong-Whitworth, employed "over 12,000" at Elswick, one of its 4 plants, in 1906, and several other British plants were around that size (Shaw, "The large manufacturing employers," p. 47). The French census identifies the five largest plants with 5,000+ employees as being in chemicals (presumably Saint-Gobain), iron and steel (presumably Schneider's Le Creusot plant) and the state sector (presumably three tobacco or explosives factories). The largest Japanese plant was probably the Yokosuka Naval Arsenal, with 28,920 workers in 1907. There were similarly-sized Russian state armaments operations: the Gau artillery factories employed 33,000 in 1908, see Gatrell, "Defence Industries," pp. 136-7.

scale plants producing beer, cigars, children's toys, pianos, porcelain, sausages and silverware.[94] The proportion of Germany's manufacturing workforce in giant plants was, in fact, below the global average.

Yet Britain and Germany together have substantially more workers in giant factories (whether that is defined as 1,000+ or 5,000+) than the USA (which had a real GDP equal to both combined), and this is consistent with the notion that their manufacturers were not constrained by smaller *national* market size.[95] Germany employed slightly more workers in manufacturing than the USA and a greater *proportion* of American manufacturing employees were in giant plants, while Britain's manufacturing workforce was only three-quarters their size, so the *proportion* of UK employees in giant plants was closer to the American level. Germany's surprisingly modest rank in the last column of Table 2 may be more a reflection of the continuing viability of small-scale craft production in a lower-wage economy, than of what was

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[94] Cassis (*Big Business*) and Wardley ("Emergence") cogently argue similarly in relation to *firm* size, using a variety of measures.

[95] UK production censuses did not report plant sizes before 1930, but Shaw ("Large manufacturing employers") and Wardley ("Emergence") identify over 100 UK *firms* employing more than 3,000 people in 1907. This gives a direct estimate (for 30 single-plant firms only) for some giant *plant* sizes and these giant UK plants were larger than matched pairs which can be identified in the US census (see, for some examples, notes 92 and 93 above). However, Nye and Kinghorn ("Scale") show the *average* size of plants in all size ranges was slightly lower in the UK in 1901 (64 employees) than in the US in 1904 (67), suggesting these plants may not be representative. Conservatively, an estimate of 13.2% of the British workforce employed in giant plants (0.9 of a percentage point below the American proportion) was used as a first approximation. UK figures for total manufacturing employment vary among the censuses of population and production and the Home Office returns, but the definitions used by other countries would give a figure for 1907 of around 6.3 million, suggesting 831,915 employees in UK manufacturing plants in the 1,000+ size range. An alternative estimate can be derived from assuming that the ratio employed in firms employing 3,000+ and in plants employing 1,000+ is a constant (compare n.84, above). Wardley's and Shaw's data on large employers in 1907 show the UK employed 882,882 (14.0% of its manufacturing workforce) and Germany 830,418 (10.3 % of its manufacturing workforce) in 3,000+ firms, suggesting, by extrapolation from the German ratio of employment in 1,000+ plants, that 736,427 were employed in such plants in the UK. The different assumptions behind these alternative estimates may not be warranted (this is the least satisfactory estimation in the table), but the resulting range - 11.7-13.2% of total manufacturing employment (and its mean, shown in the table) – indicates the likely order of magnitude.

happening in its modern factory sector.[96] Indeed, the data in Table 3 imply the proportion of all manufacturing employees in giant plants in "modern" industries was *not* higher in the United States (1.8%) than in Germany (2.1%).

Brazil and Russia top the last column of Table 2 and even Soviet-era economic geographers acknowledged that "(Tsarist) Russia was superior to the advanced capitalist countries in the concentration of industrial production."[97] The lack of any correlation of large plants and development levels in the table counsels caution in using terms like "superior" (or "modern" or "efficient") in this context. The leaders may simply be rapidly developing regions with cheap land - like these and the mid-west US industrializing states – where larger plants could be built on "greenfield" sites than on crowded west European (or Japanese, or American eastern seaboard) urban sites. At this date, the modal giant plant was still the classic Victorian factory: a multi-storey "cube" optimizing steam power distribution and requiring only a modest footprint for 1,000 workers, though already some factories were much larger. 75 miles from St Petersburg, at Narva, the water-powered, vertically integrated Krenholm cotton mill was "considered by many to be the best-managed mill in the world" and was certainly the largest.[98] Built and owned by the Knoop family of Bremen and Manchester (exclusive agents in Russia for

[96] The last column of Table 2 is sensitive to the definition of total manufacturing employment. This boundary was less clear in an era of craft production than in a later age of standard industrial classifications, and choices by census authorities or reporting firms matter (for example, are steam laundries, repair workshops or small bakeries - or the teamsters/waiters/nurses employed by factories - included in "manufacturing"?) In poor countries, like Russia and Japan, most manufacturing workers were still homeworkers, craftsmen or in small workshops, not employed in powered factories: so, in Japan, for example, the proportion of *factory* workers accounted for by the giant plants was as high as 18.9%, more than twice the level reported in the table.
[97] Lavrishchev, *Economic Geography,* p. 93.
[98] Wallace, *Times,* p. 69 and see also Thompstone, "Ludwig Knoop;" Milward and Saul, *Development*, p. 405. My great-great-grandfather was one of the Lancashire cotton expatriates of St Petersburg, where my great-grandmother was born. Although the original factory was destroyed by military action, a successor, British-owned, Krenholm textile enterprise again exists in independent Estonia.

the leading textile machinery manufacturer, Platt Brothers), its thirty British expatriate managers supervised a $19 million investment and 12,000 workers, operating 472,500 spindles (5% of Russian cotton spinning capacity) and 3,672 looms. Extensive assembly sites were also increasingly required by large system integrators of heavy equipment like locomotives, power stations and ships. Sites with larger, single-storey, footprints were also beginning to be developed for electric-powered, flow-production assembly in lighter industries.

The reason for ambiguous impressions of France is readily appreciated from Table 2. It *is* true that Germany employed around three times as many in large plants and mines as did France, but those who seek the reasons in an irrational French preference for small scale are barking up the wrong tree: the balance of French choices, shown in the last column, is insignificantly different from the revealed plant size preferences of German businessmen. The reason that France had fewer large factories and mines was that a smaller proportion of the smaller French workforce was employed in manufacturing and mining.[99]

That national borders may have constrained plant size in smaller European countries is consistent with their clustering at the bottom of the table, though the numbers are small (and within the margins of census definitional variations and estimation errors). Moreover small US states, like California and Florida, were even more bereft of giant plants.[100] The exceptions should also be noted: Belgium and Sweden - with real GDPs

[99] In 1906/1911, in France 26% of 22 million active workers were in mining and manufacturing, a similar proportion to the USA (25% of 37 million), but the proportions were much higher in heavily industrialized Germany (36% of 27 million) and the UK (45% of 18 million), see Bairoch, Deldycke and others, *La Population active*, pp. 53, 83, 96, 98.

[100] The USA showed greater regional concentration of giant plants than is apparent within Europe in Table 2, with highs of 27 % of New England's manufacturing workers in giants, 16% in mid-Atlantic and 15% in east north central, down to only 5% in east south central and 3% in the Pacific region (Bureau,

only 7% and 4% of the USA's - had respectable proportions of giants.[101] Belgium could not vie with the big powers in the size or number of heavy armaments and chemical factories or shipyards, but it had multiple giant plants in steel, glass, railway equipment and textiles and single giants in electricals, small arms, zinc and automobiles. On the other hand, Switzerland (with a real GDP only 3% of the USA's) and even Italy (with 19%) register low portions of manufacturing employees in giants. If the difference is significant, this underlines both the key sources of European market integration and the residual barriers. Belgium had Antwerp – a seaport that vied with Hamburg to be continental Europe's largest - and several low-tariff, high-income countries were but a short sea voyage away; Sweden had similar port access; while Switzerland was landlocked, as well as unluckily bordered by four countries with the highest tariffs in western Europe. Italy's abundant sea lanes mainly facilitated access to itself and other poor Mediterranean countries and its 1880s trade war with a promising potential partner, France, had been misjudged. Europe certainly had some internal trade problems that the US constitution (and the later EU market rules) outlawed, but they *could* be overcome.

Plant employment size is the only yardstick for which extensive internationally comparable data is available in this period, but the *output* of plants in low productivity countries, like Japan and Russia, will be exaggerated by these statistics, relative to countries with higher productivity and more energy-intensive and capital-intensive plants.[102] Yet in some modern plants even Russia and Japan achieved

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Manufactures, p. 235, uncorrected for US census truncation, which would lower the percentages slightly). However, no US region was as large as the UK or Germany and *their* most industrialized regions, the Rhineland and northwest England, may have exhibited ratios approaching New England's.

[101] The pre-1919 Hapsburg Empire (including Austria-Hungary) was, of course, neither small nor land-locked.

[102] There is no standardized capital stock data for continental Europe and Goldsmith's (*Comparative national balance sheets*, p. 40) raw data suggest, somewhat implausibly, that Germany was substantially

productivity levels approaching the USA's, so any blanket correction based on national aggregate productivity differentials is potentially misleading.[103] It is possible that, because more handicraft production could survive in low-wage Germany, its giant plants had higher labor productivity *relative to its manufacturing average* than in a high-wage country like the USA. If so, their figures in the last column, calculated on plant outputs rather than employment, would, despite lower German productivity overall, be closer together.[104] We simply do not know. What we do know is that by 1912 giant manufacturing and mining *firms* in Europe – measured by the market value of their equity (thus focusing on capital-intensive rather than labor-intensive firms) - were slightly less numerous and smaller than those in the United States (except in Britain, where they were still slightly larger).[105] If the USA had any scale advantage, it was in firm rather than plant size, and that lead appears to have been shared by Britain and to be of relatively recent origin in both countries.[106]

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more capital-intensive than the UK and USA. There is also a massive – and unresolved - disagreement about the relative capital-intensity of UK and US production in the nineteenth century between Field ("Land abundance") and Maddison ("Standardised estimates"). An approximation of energy-intensity is the amount of installed steam power (the main power source in transport and industry) per head of population. In 1896 this was 0.35 hp in the UK, 0.25 in the USA, 0.18 in Belgium, 0.16 in Germany, 0.15 in France, 0.12 in the Netherlands, 0.05 in Italy and 0.03 in Russia (author's calculations from data in Woytinsky, *Welt,* 4, p. 59), though there was no doubt some convergence in the following decade or so. James ("Structural Change," p. 442) notes that concentrated US industries had experienced more labor-saving technical change.

[103] Crisp,"Labour," p. 397; Hannah, "Whig Fable," p. 59-61. For widely varying productivity differentials, even in advanced countries, see Table 3. On the other hand the tens of thousands employed in integrated armaments factories in Japan and Russia (and the more modest totals in similar British and American plants, see note 93, above) probably reflect their lower productivity, not higher output.

[104] Output data by plant size is generally not available for European manufacturing in this period.

[105] Hannah, "Marshall's Trees," pp. 263, 277-81. He, arguably, understates giant firms in Europe and Japan because of the omission of some state firms and treating as domestic some South African, Mexican or Russian firms that were, in fact, financed and run by west European capitalists and managers from London or Paris.

[106] An unpublished study by the author shows Britain having almost the same number of giant industrial firms in 1900 as the USA, though Germany then headquartered significantly fewer. Kim ("Rise") emphasizes the marketing, rather than plant-level, economies revealed in the post-1919 US data.

CONCLUSION

The statistical picture painted here, of the world after the turn of the century, is merely a snapshot – with a generous exposure time covering a decade or so of available data points - of a dynamic situation. The later twentieth century was to see momentous developments in the mining and manufacturing sectors – and in logistics - as well as both violent and peaceful dismemberment of the cosmopolitan market of the First European Integration. The race to higher living standards in the next half century was to be decisively won by the United States. On its pathway to economic supremacy, America developed larger plants - and a much larger domestic market - than its European competitors. It did so without the advantages over Europe at the outset with which it has been credited. We should not confuse the chicken with the egg, even if we have a well-founded suspicion that the two are critically and serially inter-related. There was also a good deal more to the twentieth century future than the large-scale production on which narrative historians have focused. The impression of larger American markets and plants around 1900 in some literature is more a symptom of Whig hindsight in diagnosing, largely imagined, root causes of later divergence than an accurate portrayal of turn-of-the-century reality and of the range of potential developments contained within that world. If we are properly to evaluate the contribution to the economic outcomes, for their nations at mid-century, of what Americans did right, or what Europeans did wrong, we should first recognize accurately the varied, but more-or-less level, playing fields on which the New and Old Worlds – or at least their respective north-eastern and north-western segments – started their twentieth century.

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