Rise and Fall of Empires in the Industrial Era: A Story of Shifting Comparative Advantages

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Abstract

The last two centuries witnessed the rise and fall of modern empires. We construct a model which rationalises this in terms of the changing trade gains from empires. In the model, empires are arrangements that reduce the cost of trade between an industrial metropole and the agricultural periphery. During early industrialisation, the value of such comparative-advantage based bilateral trade increases, and so does the value of empires. As industrialisation diffuses and differentiation within manufactures increases, trade becomes more multilateral and intra-industry, thus reducing the value of empires. Our results are consistent with long-term changes in the number of sovereign entities, international income distribution and trade patterns. We provide qualitative evidence supporting our mechanism from policy narratives of the day and from the arguments previously made by historians.

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I Introduction

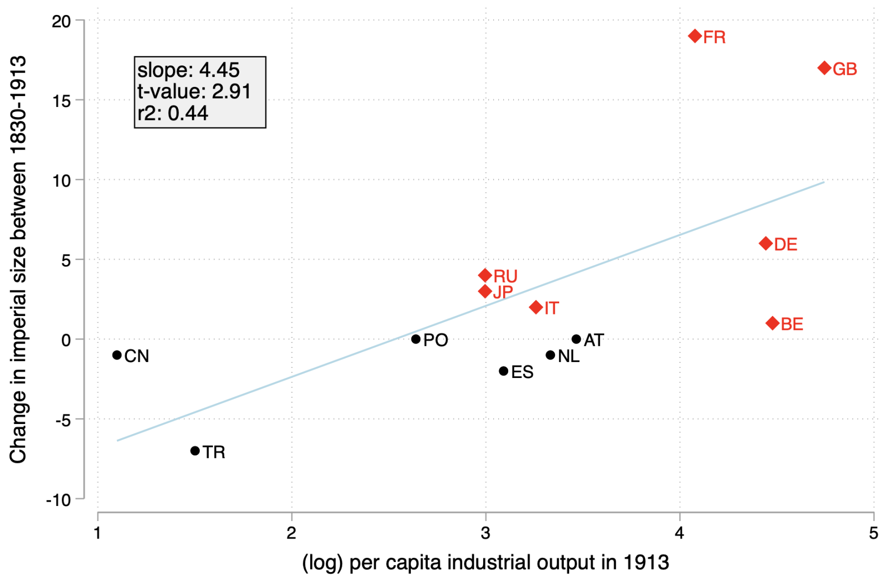
History has witnessed the rise and fall of empires, defined as large territorial states imposing a common set of institutions across their domain. In turn, common economic institutions within empires helped reduce the costs of trade and investment. While economists have studied the impact of empires on trade flows, they devoted relatively little attention to how trade may affect the evolution of empires. In this paper, we provide a theory of endogenous empires driven by trade.

In doing so, our focus is on the global economy and the international political order in the industrial era, rather than the empires of the distant past. Figure I displays a fact which is novel in its presentation but will not come as a surprise to the well-read reader: between 1830 and 1913, the fortunes of the 13 existent empires went hand in hand with their levels of industrialisation. The vertical axis plots the change in imperial size during this time period, where size is defined as the number of countries that will be independent in 2001 but are within an empire in these earlier years. The horizontal axis plots per capita industrial output in 1913. The correlation between the two variables is a statistically significant 0.59. Seven of these empires that have expanded during this time period—Belgian, British, French, German, Italian, Japanese and Russian, red colored with diamond-shaped markers—tend to be more industrialised relative to their region or on the cusp of rapid industrialisation. This set stands in contrast to the stagnation and decline of the other empires, which tend to be either less industrialised as of 1913 —as in the case of China, Turkey, Portugal and Spain— or facing secession in their industrialising European domains as in the case of Italian and Belgian independence from Austria and the Netherlands, respectively.

How did these expanding industrial empires fare in the long run, and how did they affect the international political order? In the left panel of Figure II, we plot their total size until 2000. Their initial expansion was followed by subsequent dismantling thanks to independence movements and decolonization. In the right panel, we plot the U-shaped number of independent countries, including those that devolved from all the 13 empires. While the initial consolidation of global political boundaries reduced this number, the second half of the 20*th* century witnessed a proliferation of sovereign states, mirroring an inverse image of the trajectory in the left panel. The empirical Section VI discusses these facts in further detail.

We offer an explanation for this phenomenon through a concurrent process which we take as exogenous: industrialisation in the United Kingdom, and its gradual diffusion to other countries around the globe. We construct a model in which otherwise symmetric locations are at any point in time either technologically able to produce a differentiated manufacturing

Figure I: **Industrialisation and Imperial Growth**



Notes: Empire labels are British (GB), French (FR), Austrian (AT), Belgian (BE), German (DE), Italian (IT), Dutch (NL), Japanese (JP), Spanish (ES), Portuguese (PT), Russian (RU) and Ottoman (TR). Imperial size (y-axis) is defined as the number of countries that will be independent in 2001 but are within that empire in an earlier year. Red colored observations with diamond-shaped markers distinguish expanding empires. Data for the y- and x-axes are from Wimmer and Min (2006) and Bairoch (1982), respectively. See text and Appendix B for details.

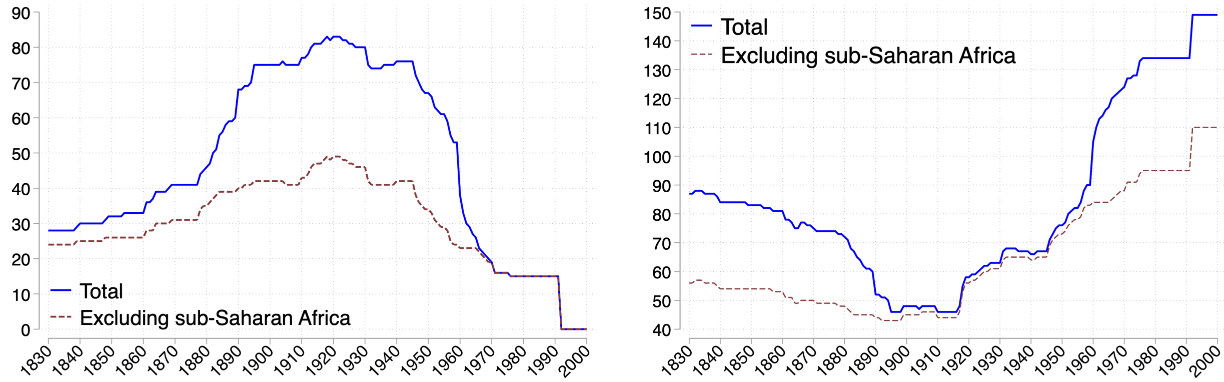
good ("industrial locations"), or just primary commodities alone ("agricultural locations"). Industrialisation (i.e. the emergence of the first industrial location) and its diffusion create comparative advantages, and thus gains from trade between the industrial and agricultural locations. At the same time, industrial diffusion makes intra-industry trade between the industrial locations increasingly important. As diffusion progresses, trade becomes more multilateral, as the agricultural locations spread their manufacturing expenditure over a larger number of sources, and the industrial locations export more of their manufacturing good to other industrial locations.

We model empires as a costly technology, e.g. modern governance, which reduces trade costs between an industrial location (the imperial power) and a set of agricultural locations (the colonies). In addition, the imperial power can tax the colonies, subject to a revolution constraint. Thus, empires create gains from trade, to which the imperial powers are the residual claimant. The imperial powers set the size of their empire to balance the marginal benefit from increasing trade with one additional territory, to the marginal cost of bringing modern governance to that territory, and of keeping it under control militarily. As the structure of international trade evolves, so do the gains from trade created by empires, and their optimal size. At first, industrialisation makes empires very attractive institutions, given that trade between the agricultural locations and any one of the first few industrial locations represents a large share of trade for both. Thus, large empires form in this phase.

Figure II: **Evolution of the International Political System**

(a) Size of Expanding Empires

(b) Number of Independent Countries



Notes: Both panels use data from Wimmer and Min (2006). Underlying entities counted in both panels correspond to the geographic boundaries of countries that existed in 2001; i.e., pre-unification German and Italian states are not counted. The left panel plots the number of these 'future countries' within the jurisdiction of seven expanding empires (Belgian, British, French, German, Italian, Japanese, and the Russian empire, treating the USSR as its continuation), excluding the imperial metropoles themselves (total in solid blue, excluding the sub-Saharan region in the dashed-red line). The right panel plots the number of independent countries.

With industrial diffusion, intra-industry trade in differentiated manufactured varieties grows at the expense of inter-industry trade based on comparative advantages, and empires—which facilitate an increasingly small share of world trade—become smaller and eventually break apart. As a second and interrelated feature of industrial development, we analyze the implications of increased product differentiation in manufacturing. As industrial varieties become more differentiated over time, captured by a declining elasticity of substitution in the model, the gains from intra-industry relative to inter-industry trade increases. Since empires facilitate only the latter, the process of increased differentiation also contributes to the decline of empires.

While admittedly simple and stylized, our model is not only capable of rationalizing the historical trajectory of the number of sovereign entities since the industrial revolution, but also consistent with several other economic outcomes, as well as long-standing historical arguments on the economic origins of 19*th* century imperialism and 20*th* century decolonisation. In particular, industrial diffusion generates the inverse U-shape of global per capita income dispersion, displaying initial divergence and subsequent convergence as documented and discussed by, among others, Comin and Mestieri (2014), Benetrix, O'Rourke and Williamson (2015) and O'Rourke, Rahman and Taylor (2019). It is also consistent with the long-run change in international trade patterns: as more countries industrialise, comparative advantage based trade gives way to intra-industry trade. While the increasing importance of intra-industry trade in the postwar era has been documented for multiple countries (e.g., Brülhart, 2009), analysis on earlier time periods is lacking. The second contribution of the paper is novel evidence from historical British international trade statistics showing that the upward trend in intra-industry trade pre-dates the $20th$ century, consistent with the implications of our model.

Our model builds on the notion that empires reduced trade barriers within their domain. Evidence on this for late $19th$ century empires has been provided by Mitchener and Weidenmier (2008) and Jacks, Meissner and Novy (2010). Factors contributing to this "empire effect" in trade included the freedom of mobility for the citizens of the metropoles across their domains, currency unions, adoption of a common language and the establishment of legal institutions that reduced contracting costs within the empire. Some of these factors outlasted formal empires, which could explain the finding that empires had a persistent effect on trade flows even after they were dismantled (Head, Mayer and Ries 2010 and Gokmen, Vermeulen and Vézina 2020).

Our paper is related to the literature on endogenous borders. Friedman (1977) analyzes the equilibrium size and shape of countries in the context of alternative fiscal policies including taxation of trade. In their seminal work, Alesina and Spolaore (1997) focus on the trade-off between increasing returns to country size in the provision of public goods and increasing cost of cultural heterogeneity captured by distance to the political centre. In subsequent work, Alesina, Spolaore and Wacziarg (2000) introduce a trade cost-reducing role for country size. Their central result is that the optimal number of countries should be smaller (and countries should be bigger) when cross-country trade costs are higher relative to within-country trade costs. While this can rationalise the increase in the number of countries associated with the decline in cross-country trade costs in the second half of the $20th$ century, it has a harder time explaining the decline in the number of countries during the first globalisation of the $19th$ century. In contrast, our story of shifting comparative advantages can explain both.

To the best of our knowledge, Gancia, Ponzetto and Ventura (2022) provides the only existing economic rationalisation of the entire evolution of the number of countries presented above. Constructing a model in the tradition of Alesina, Spolaore and Wacziarg (2000), they identify the decline in trade costs during the first and second waves of globalization as the driving force behind the U-shaped pattern in the number of countries. In their model, too, empires emerge in response to an expansion in world trade. In their story, however, empires do not fall because the share of world trade that they facilitate eventually decreases—in fact, from a trade perspective, their optimal size increases monotonically—but because of their increased inefficiency as providers of undifferentiated public goods to populations with heterogeneous preferences over them. When empires become too large, they are thus abandoned—assuming the right mix of economies of scale and scope—in favour of a two-tier governance structure, in which the role of facilitating trade is delegated to large supranational institutions. We take an alternative and complementary approach by focusing on other fundamental economic changes which occurred in this period—the early concentration and subsequent diffusion of industrial manufacturing, and increasing product differentiation. Our framework extends a workhorse model of trade with a simple political process featuring a one-tier governance structure, in the original spirit of Alesina, Spolaore and Wacziarg (2000). We show that shifting comparative advantages are enough to drive the rise and subsequent falls of empires, because the share of world trade that empires facilitate first increases, and then decreases. Moreover, we show that a number of additional distinctive predictions of our model are borne out by the data, and that our story is consistent with historical accounts of the relationship between modern empires and changing trade patterns.

Our paper also relates to Bonfatti (2017) who provides a model with mercantilistic colonial policies to rationalize the breakup of American colonies from the British and Spanish empires in late 18*th*-early 19*th* centuries. While both papers highlight trade-related motives in the evolution of empires, they differ in historical episodes under study and particular mechanisms driving the changes.

There is also a diverse literature seeking to explain the existence and function of empires. Findlay (1996) provides a theory of pre-modern empires as a trade-off in allocating labour between farming and conquest where the latter may be purely predatory or aimed at expanding productive land holdings. Economic theories of modern empires show a variety of approaches. Following Hobson (1902) and Lenin (1917), a Marxist literature purports that the driver of modern imperialism was profit-seeking in colonies in response to declining rates of return to capital at home. Further highlighting its distributional aspect within the metropoles, Veblen (1918) and Schumpeter (1951) contended that imperialism served the predatory interests of the elite. Compared to these older contributions, we formalize how the rise and subsequent weakening of comparative advantage-driven trade can account for both the expansion and dissolution of modern empires.

At this point, we would like to be clear about what this paper does *not* propose: it does not propose that empires were the equivalents of modern-day deep trade agreements from which all parties, including the periphery, benefited. Our model has an explicit role for redistribution within empires as industrial metropoles appropriate the trade gains of the colonies through military coercion. The paper also does *not* propose that imperial market expansion during the first wave of globalisation caused or contributed to industrialisation. To the contrary, it assumes the industrial revolution and its diffusion as exogenous phenomena, and highlights a new mechanism through which they affected the global pattern of trade and its political underpinnings.

Relatedly, the reader may wonder about how to reconcile the proposed notion that trade considerations were a driving force in the evolution of modern empires with the fact that trade with some colonies occupied a relatively small share in the industrial countries' total trade. The answer lies in not confusing the initial size of imperial trade for the imperial power, with the marginal benefits and costs of empire in those colonies. To be sure, some colonies, such as India for Britain, Algeria for France, or Ethiopia for Italy, represented an important share of the trade of the imperial powers.[1] But many others, especially in Africa, did not.[2] In our framework, it is okay for a number of marginal colonies to represent a small share of trade for the imperial power, so long as the trade gains by annexing them is large enough compared to the cost of doing so. It is reasonable to conjecture that many colonies fell into this category. In terms of benefits, recent historical evidence suggests that, even for Africa, trade considerations were an important factor in colonisation (see e.g. Frankema, Williamson and Woltjer 2018, which is further discussed in Section 2). On reflection, this makes sense: even though the exports of some colonies might have been small, they were very lucrative for the imperial powers. Tadei (2020) and Tadei (2022) document that the anti-competitive practices employed by both the French and the British resulted in African producers receiving only a small fraction of the competitive price of their produce, resulting in an estimated loss of 2% of GDP yearly for French Africa in 1898-1959. In addition, while our framework does not entail distributional aspects of imperialism within the metropoles, those who captured the trade gains from empire were often important political players with disproportionate influence over colonisation policy.[3] Thus far for the trade gains of empires. In terms of costs, evidence suggests that the cost of annexing marginal colonies must have reflected the fact that, in many of these, imperial investment did not exceed the bare minimum required to facilitate exports, with some of this also funded by colonial public revenues. Moreover, at least some of the military costs of defending these colonies—e.g., some of the cost of the navy—must have been sunk at the point of conquest, having been already paid to defend

[1]In 1913, British India absorbed as much British exports (excluding re-exports) as Germany and the USA combined (Source: Statement of Trade of the UK, 1914 issue, Vol. 2, Table 2). In the same year, Algeria was the fourth most important export markets for France, ahead of the USA and just behind Germany. With the annexation of Ethiopia in 1935-36, the share of Italian colonies in Italian exports rose from 5% in 1934 to 25% in the 1937 (source: RICardo Project website). Panel data evidence by Mitchener and Weidenmier (2008) suggests that membership in an empire increases trade by at least 43% according to their most conservative estimate (their Table 2, column 4). Ayuso-Díaz and Tena-Junguito (2020) provides similar evidence on the trade increasing effect of imperial expansion in the Japanese context.

[2]Frankema, Williamson and Woltjer (2018) document that although tropical Africa represented a significant share of French trade in the late 19*th* century, it was less important for Britain. This has led some scholars to argue that the scramble was primarily motivated by strategic, rather than economic considerations—see Chamberlain (2014) for a comprehensive account.

[3]For example, reviewing the determinants of 19*th* century French imperialism, Hopkins (2018) reports that "The Lyon silk industry was effective in pushing for control of Indo-China; merchants in Marseilles helped to draw the French government into Dahomey; the railway lobby lay behind French plans to expand in North and West Africa." (pp. 279-80).

the most important colonies. Consistent with this view, Huillery (2014) finds that French expenditure on the colonisation of West Africa accounted for only 0.29% of total French public expenditure in 1844-1957 (most of which accounted for by military expenditures), with pre-world WWI peaks at 0.3-0.4 in 1884-1885 (for the construction of the Dakar-Saint-Louis railway) and 0.5 in the 1890s (for initial colonial conquest).

In the next section, we provide further perspectives from historical and political scholarship on modern empires in support of our mechanism. Motivated by these accounts, we then present the model, the equilibrium and its comparative statics in sections III, IV and V, respectively. Section VI documents three historical trajectories: first, the evolution of the international political order, already plotted above but to be elucidated in detail; second, global income dispersion and finally, the trade patterns of the UK. Through numerical comparative statics generated by the parameterized model, this section then demonstrates how our framework can quantitatively rationalize all these interrelated outcomes. Section VII concludes by discussing how our baseline model can be extended or interpreted in light of the historically related factors that we abstracted from.

II Historical Accounts of Trade and Empire

During the heydays of imperialism and decolonization, politicians often advanced trade-related arguments in their speeches and writings. In turn, scholars of modern history and politics have since debated the salience of such factors in explaining the rise and fall of empires. Our aim in this section is to provide an overview of such narratives in order to support the relevance of the key assumptions and mechanisms of our model.

In their authoritative book on the history of the British empire, Cain and Hopkins (2014) highlight the political and economic differences between pre-modern, mercantilist, "military-fiscal" empires primarily driven by rent seeking, and modern empires driven by commercial interests (p.707-714). In their view, the entrepreneurial political class of the latter progressively dominated the aristocratic political class of the former between 1815 and 1850, turning the empire into a "transnational organisation that reduced transaction costs by extending abroad the institutions associated with the metropolitan economy."

Similarly, in his seminal book on the economics of empires, Fieldhouse (1973) states that "Even in a free trade world there were obvious practical advantages in political control over trading partners in the less developed regions, notably common language, currency and governmental institutions (p.12)." Consistent with this view, Frankema, Williamson and Woltjer (2018) find that the relative price of African exports dropped dramatically after colonisation, despite rapidly increasing volumes, and Mitchener and Weidenmier (2008) find a strong effect of empire in a gravity-based analysis of late 19*th* century trade flows (for similar findings, see Jacks, Meissner and Novy 2010). Motivated by these arguments, we add to an otherwise standard model of trade an institutional arrangement, i.e. empires, that reduces the cost of trading between an industrial center and the agricultural periphery.

A key mechanism of our model is that the emergence of industrialisation encourages the formation of empires by making trade between the initial industrial locations and the periphery more important. Such an argument is recurrent in the historical literature, and was common in the words of contemporaries.

In an early article influential among historians, titled "The Imperialism of Free Trade," Gallagher and Robinson (1953) asserted that, at least for the British, the motivation for empire was fostering free trade and market access:

> "The growth of British industry made new demands upon British policy. It necessitated linking undeveloped areas with British foreign trade [...] the general strategy of this development was to convert these areas into complementary satellite economies, which would provide raw materials and food for Great Britain, and also provide widening markets for its manufactures."

Public debate of the day suggests that politicians were keenly aware of the commercial nature of modern empires, as reflected by the following 1896 quote of Joseph Chamberlain, the Secretary of the British Colonial Office of the time:

> "The Foreign and Colonial Offices are chiefly engaged in finding new markets and in defending old ones [...] Therefore, it is not too much to say that commerce is the greatest of all political interests, and that Government deserves most the popular approval which does the most to increase our trade and to settle it on a firm foundation." (Joseph Chamberlain talking to the Birmingham Chamber of Commerce in 1896; cited by Ferguson 2004, p. 210)

In defense of his expansionist policies, Jules Ferry, an influential politician who served as the prime minister of the French Republic in the 1880s, was making the following argument:

> "Colonial policy is the daughter of industrialisation. For rich states where capital abounds, [...] exports are essential to political good health. Europe's consumption is saturated: it is essential to discover new seams of consumers in other parts of the world." (Jules Ferry, 1890; cited by Fieldhouse 1973, p. 24)

Such sentiments were not confined to Great Britain and France. Friedrich List is known for his advocacy of industrial policy in Germany (List, 1841). Less known to economic historians is the economic imperialism he prescribed for Germany once it would unify and industrialise itself:

> "The highest means of development of the manufacturing power, of the internal and external commerce proceeding from it, of any considerable coast and sea navigation, of extensive sea fisheries, and consequently of a respectable naval power, are colonies [...] The mother nation supplies the colonies with manufactured goods, and obtains in return their surplus produce of agricultural products and raw materials; this interchange gives activity to its manufactures, augments thereby its population and the demand for its internal agricultural products, and enlarges its mercantile marine and naval power." (Friedrich List, 1841; cited by Ince 2016, p. 389)

In more recent scholarship, Frankema, Williamson and Woltjer (2018) provide novel evidence of a steep rise in the relative price of African commodity exports between 1835-1885, which was exceptional even in comparison with similar trends in other parts of the world. They argue that although French plans to conquer West Africa were already a serious political consideration in the 1850s (inspired by the conquest of Algeria in the 1830s), the above-mentioned surge in prices can explain why they were only carried out in the 1870s. They also argue that trade considerations explain why the scramble from Africa started in West Africa, and why the French played the leading role in it. Overall, they argue, "The nineteenth century commodity export boom was crucial in shaping an economic context in which the partition of Africa became politically defensible." (p. 233).

According to our theoretical framework, the diffusion of industrialisation and increased product differentiation contributed to the demise of empires, by incentivising intra-industry trade between developed countries relative to inter-industry trade within empires. References to this mechanism permeate Hopkins (1997) who discusses the cost-benefit analysis of the British empire commissioned by Harold Macmillan, the prime minister of the time, in 1957. According to Hopkins:

> "[in the mid 1950s] There were signs, particularly through the growth of intra-industry trade and the redirection of overseas investment, that the expansion of the international economy would take place increasingly between advanced economies [...] Colonial trade, like colonial investment, was becoming less attractive. The pattern of specialisation that had promoted economic integration in the world economy since the nineteenth century was beginning to weaken, and the empires that were its political expression were losing their rationale."

(Hopkins 1997, p. 256).[4]

Similarly, Stockwell (2004) argues that the "1950s were critical years in economic decolonization" as Britain's trading interests were shifting away from the empire-Commonwealth towards European economies. Furthermore, facing the "reluctance on the part of other Commonwealth governments to extend the imperial preference system established at Ottawa in 1932," and the incompatibility of the imperial trade block with the General Agreement on Tariffs and Trade (GATT), many in the British political system threw their lot with the multilateral economic order favoured by the United States. In addition to trade, Krozewski (1993) highlights the re-direction of UK's foreign investments towards the developed world as its investment in India had fallen sharply since the 1930s. According to Krozewski, "the path to decolonization was eased, if not opened" due to the "shifting financial and monetary priorities of the centre" away from the sterling area.

A similar argument is made for France by Marseille (2005), who posits that, overall, French big business evolved from supporting the empire before World War I to seeing it as a waste of money by the 1950s, largely due to its falling importance in world trade. Interestingly, the same author argues that while a majority of French industries were in favour of decolonisation in the 1950s—being increasingly attracted to the markets of developed countries—older industries which depended on imperial markets, such as the cotton textile industry, were strongly against it (see "Conclusion Générale", pp. 536-544).

Consistent with our framework, industrial diffusion was also changing trade patterns for colonies, and thus their incentives to trade with the metropole. According to Schenk (1996), "Malaya was importing half of its iron and steel from Japan by 1959, and also an increasing proportion of textiles, as well as electrical and metal-working machinery. The remnants of Imperial Preference were not sufficient to maintain the British share of this market." For the early post-decolonization period, Kleiman (1977) systematically documents the rapid decline of British and French trade shares in their former dependencies, and the concurrent diversion of former colonies' trade toward Germany, Japan and Italy. This pattern is consistent with both the increasing industrial prowess of the aforementioned rising trade partners and the increasing cost of trade with former metropoles.

Before presenting a model which formalises and rationalises the ideas encapsulated by these historical accounts of the nexus between trade and empire, we note that the concluding Section VII will discuss other relevant drivers of the life cycle of modern empires that we abstract from.

[4] The original quote reads "inter-industry trade," but in our correspondence, the author confirmed that he meant 'intra' according to the current distinction (which was not present in the 1950s), and authorised us to modify the text.

III Model Environment

Consider a world with an integer number $N > 1$ of locations, each containing a mass one of atomistic workers. There are two goods: a homogeneous primary (agricultural) good z, and a bundle of differentiated manufacturing varieties,

$$X = \left(\sum_{i=1}^{n} x_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

with an elasticity of substitution between manufacturing varieties $\sigma > 1$.

Locations can be of two types, "industrial" or "agricultural." There is an exogenous integer number $n \in [0, N]$ of industrial locations, corresponding to the number of national (Armington) varieties in the CES composite (1). The remaining $N - n$ agricultural locations can only produce the primary product using technology

$$z = L_z,$$

where L_z is labour employed in that sector. Industrial locations can produce both the agricultural good and their manufacturing variety, using technologies

$$z = \alpha L_z \qquad \text{and} \qquad x = \alpha L_x,$$

where $\alpha > 1$. Thus, industrial locations have a comparative advantage in manufactures. Letting the TFP of both sectors be the same in industrial locations simplifies our exposition but is not fundamental for any of our results.

Before the birth of modern industry ($n = 0$), utility is linear in z. After the industrial revolution—which corresponds to $n > 0$ in our model—utility is Cobb-Douglas in all locations, industrial or agricultural, with a share $\beta \in (0, 1)$ of expenditure allocated to the manufacturing bundle X and the remaining $1 - \beta$ to the agricultural good:

$$U = z^{1-\beta} X^{\beta}. \tag{2}$$

Note that this framework is isomorphic to letting preferences be linear in the consumption of a non-tradable final good with the production function (2) taking as inputs both primary factors z (e.g., cotton) and an industrial bundle X. Accordingly, we interpret the increase from $\beta = 0$ for $n = 0$ to $\beta > 0$ when $n > 0$ as the emergence of the modern, factory-led manufacturing technology. In Appendix A.1, we demonstrate that the baseline model can be micro-founded from the production side as a choice between a traditional vs modern manufacturing technology, with the former being available to all locations but the latter only being available to the industrial locations. In such a framework, the non-industrialised locations endogenously abandon traditional manufacturing and specialize in the primary sector after the industrial revolution. This is in line with a historical literature emphasizing the possibility of de-industrialisation due to openness to trade, such as the demise of labour-intensive, artisanal textile manufacturing in India, Egypt and the Ottoman Empire (e.g., Williamson 2013).

The agricultural good can be traded freely between locations, and we use it as the numeraire. Manufactures, instead, are costly to trade: in the absence of political arrangements, they can be traded between any two locations at an iceberg trade cost $\delta\tau$, where $\delta, \tau > 1$. While δ captures *shipping* costs between locations, there exists a cost-reducing technology that certain blocs of locations can use in order to reduce τ, the *institutional* costs of trading. Specifically, each industrial location has the capacity to form an *empire*, by annexing a measure $E > 0$ of workers from agricultural locations. If it does, then manufactures can be traded between these workers and the industrial location at a reduced cost δ. Empire is thus a technology eliminating the institutional costs of trade, τ. Appendix A.2 demonstrates the robustness of the main results in a more general model where empires reduce the cost of trading in the agricultural good, too.[5]

The assumed impact of empires on trade costs can be justified with the observation that different locations will initially have different societal features, for example in terms of institutions, legal systems and language, implying a high cost of trading amongst them. As emphasised by the literature reviewed in Section II, however, to join under the same jurisdiction can make it easier to adopt common features, and hence reduce trade costs. Obviously, there must be at least one industrial location within an empire, or else the reduction in internal trade costs would have no material consequences in our setting. It is also reasonable to imagine that the societal features which are put in common are those of an industrial location, given that they will be the most "advanced" available within the empire, and hence the best suited to facilitate trade. At the same time, it is reasonable to imagine that an industrial location, having developed complex societal features of its own, will find it harder to adopt the features of another industrial location, relative to an agricultural location. These considerations hint at a possible micro-foundation of the assumption that there can be at most one industrial location within an empire, based on the

[5]In this generalisation, we take $\phi, \xi \in [0, 1]$ and let the cost of trading in the agricultural good and manufactures be $\delta^{1-\phi}\tau^{1-\xi}$ and $\delta^{\phi}\tau^{\xi}$, respectively. Within empires, these costs abate to $\delta^{1-\phi}$ and δ^{ϕ}. This general model nests the baseline model for $\phi = \xi = 1$.

notion that empires are not the most cost-efficient technology to reduce trade costs amongst industrial locations.

We refer to E_i as the size of industrial location i's empire. We assume that industrial locations can annex whole agricultural locations as well as just a fraction of them at the margin. That is, if E_i happens to be an integer, it is also equal to the number of whole agricultural locations included in the empire. If it is not, then the number of whole agricultural locations is equal to the smallest integer less than E_i, with the rest being a measure of workers who have been separated from another agricultural location.[6] We henceforth refer to industrial locations who form an empire as "imperial powers," and to agricultural locations which are part of an empire (or measures or workers which have been separated from an agricultural location to become part of an empire) as "colonies." The notation $E_i = 0$ indicates that i does not have an empire.

Once an industrial location establishes a colony, it also acquires the capacity to impose an income tax t on it. Such a tax captures a variety of tools used by the colonisers to appropriate colonial income, such as institutions of forced labour, land alienation, and the appropriation of colonial public revenues to pay for the high salaries of European administrators, or to contribute to the imperial power's war finances.[7] In addition to appropriating income, however, the colonisers also manipulated the colonies' terms of trade to their advantage, for example by creating monopsonist buyers of colonial produce.[8] We thus show in Appendix A.3 that an alternative formulation in which t represents a mark-down by a monopsonist buyer of z (or equivalently, an export tax) yields qualitatively similar results.

Colonies have the capacity to stage a revolution against the empire. For simplicity, and following Acemoglu and Robinson (2001), we assume that the revolution is always successful in restoring a colony's independent status, but destroys a share $\mu \in [0, 1)$ of the colony's

[6] Allowing empires to include parts of agricultural locations makes the empire formation problem continuous, simplifying the description of the equilibrium. In reality, empires often annexed parts of pre-existing countries.

[7] For example, in French Africa, locals were forced to cultivate cash crops at fixed prices, and to work in European plantations (Tadei 2022, p. 567). In Kenya and Southern Rhodesia, "... *the British made effective use of large-scale land alienation [...] to raise revenue, enabling European settlers to develop commercial agriculture [...] at the same time converting African farmers into wage workers to run the plantations and mines*" (Frankema and Van Waijenburg 2014, p. 391). Huillery (2014), p. 6, calculates that in French West Africa, the salaries of eight governors and their cabinets, and about 120 district administrators, together accounted for more than 13% of colonial public expenditure. She also finds (p. 21) that French West Africa's transfers to France boomed during the World Wars, and in the French reconstruction years.

[8] Even before the introduction of formal marketing boards in the 1930s, the French and the British authorities promoted or tolerated *de jure* or *de facto* monopsonies by metropolitan trading companies in their African colonies (Tadei 2022, pp. 563-568). Tadei (2020) estimates that, on average in French Africa in 1898-1959, "[...] *prices at the producer were one-third less of what they should have been in a competitive market, without monopsony and labor coercion*" (p. 8).

income.[9] The parameter μ captures the colony's capacity to rebel against the empire, or their relative military power of colonies vs the mother country. In equilibrium, it will constrain the capacity of the imperial power to tax the colony. We assume that, if a colony rebels, than its trade costs return to be those of an independent agricultural location.

An empire has an administrative cost for the imperial power, which is increasing and convex in its size. We model this by assuming that every worker added to the empire costs $c(E)$ to be administered, where $c(\cdot)$ is a positive, continuous and differentiable function, and $c'(\cdot) > 0$. The cost $c(E)$ is only incurred if a worker is added to the empire, but not if they remain independent. Thus, it should be interpreted as additional to any (not modelled) administrative cost that even independent agricultural locations have to pay. For example, even in the absence of empire, independent agricultural locations would have to pay for their internal security, basic infrastructure and legal systems, and so on. Our favourite interpretation is that $c(\cdot)$ captures the cost of bringing modern governance to the annexed territories (making a reduction in their trade costs possible), as well as the military cost of establishing political control. Its convexity may thus reflect limited administrative or military capacities by the mother country. We assume that the expenditure associated with $c(E)$ takes place in the colonies, and is allocated to z and X according to the same Cobb-Douglas rule followed by consumers. Any tax revenues which are left over after the cost of empire has been paid are transferred to citizens of the imperial power.[10]

We restrict the parameter space in three ways. First, we assume the marginal cost from annexing the first agricultural location to an empire to be smaller than the maximum possible marginal benefit to the imperial power from doing so:

$$c(1) \ < \ \frac{\tau^{\beta} - (1-\mu)}{\tau^{\beta}}. \qquad \text{(Assumption 1)}$$

Under this assumption, empires are not always trivially small in equilibrium—encompassing less than an entire agricultural location—so that their formation may affect the number of countries in the model. The derivation of this expression will be obvious below, when we solve for the optimal size of empires (in particular, see footnote 19).

[9] In the case of a measure of workers who have been separated from an agricultural location to become part of an empire, we may imagine that they re-join their location of origin after the revolution rather than establishing a new political entity; but this is immaterial for our results.

[10] Alternatively, $c(E)$ could capture the cost of cultural heterogeneity within large jurisdictions, as in the optimal size of nations literature. For example, following Alesina, Spolaore and Wacziarg (2000), each worker in the empire could bear a heterogeneity cost $h(E)$, with $h'(E) > 0$ and $h''(E) \geq 0$. Then, the total cost of empire would be $h(E)E$, and its marginal cost $c(E) = h'(E)E + h(E)$ (note that, as assumed above, it is $c'(\cdot) > 0$). Footnote 15 shows that such an alternative formulation would lead to identical results.

Second, we require the industrial locations to be productive enough,

$$\frac{\beta}{1-\beta} \cdot \frac{N-2}{1+(\delta\tau)^{1-\sigma}} \; < \; \alpha. \qquad \text{(Assumption 2)}$$

This condition is sufficient to ensure that, whenever $n > 1$, industrial locations are imperfectly specialised in equilibrium (see Appendix A.4 for a proof). This simplifies producer prices of manufactures to one, allowing us to abstract from complicated terms of trade considerations in the formation of empires. We discuss in subsection IV.E the implications of allowing for perfect specialisation in our setting.

Third, we assume that N is large enough, so that industrial locations setting up empires never hit the boundaries of the world. Subsection IV.D specifies this assumption in precise terms, and Section V argues that to relax it would not qualitatively change our comparative statics.

The timing of the model is articulated in three stages. In the first stage, empires are formed. We consider a non-cooperative game in which the industrial locations simultaneously choose the size of their empires to maximise their real incomes. In the second stage, the imperial powers set taxes and transfers, after which the colonies decide whether to rebel or not. In the final stage of the game, production, trade and consumption take place.

IV Equilibrium

We begin this section with a description of the case with no empires as a useful benchmark. We then characterise the equilibrium of the model, proceeding through the stages of the model in reverse order in Sections IV.B-IV.D.

IV.A Benchmark Case: Equilibrium with No Empires

If $n = 0$, then all locations produce and consume z only, and no international trade takes place. If $n > 0$, the producer prices of all goods are equal to one under imperfect specialisation.[11] The consumer price of z is also equal to one everywhere, while that of variety i is one in location i, and $\delta\tau$ everywhere else.

[11] For $n = 1$, Assumption 2 does not rule out that the only industrial location be perfectly specialised. If it is, then the price of the unique variety is obtained by equating export supply and demand, $\alpha p(1-\beta) = \beta(N-1)$. Since all results derived under imperfect specialisation hold in this special case, we do not consider it separately. Note that, in this special case, p does not depend on the size of the empire, because the latter does not affect the expenditure that agricultural locations allocate to the variety (and hence export demand), but only the amount of the variety that they receive net of trade costs. This does not generalise to the case of multiple empires.

The agricultural locations only produce the primary good z, their wages and incomes being equal to one. They import manufactures from each of the industrial locations, exporting z in exchange. The industrial locations produce both z and their manufacturing variety, their wages and incomes being equal to α. Each of them exports its variety to everyone else, importing z from the agricultural locations and the other varieties from the other industrial locations.

Real incomes are as follows. For agricultural locations,

$$U_I = \frac{1}{P_I} = \frac{1}{[n(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}}, \tag{3}$$

where a subscript I identifies agricultural locations that are independent, as opposed to being colonies (note that U_I and P_I will turn out to be the same independently on whether empires exist or not). As for industrial locations, real income is given by

$$\frac{\alpha}{[1 + (n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}}. \tag{4}$$

As industrialisation spreads ($n \uparrow$) and manufactures become more differentiated ($\sigma \downarrow$) real incomes grow around the world, for two reasons. First, for every unit increase in n, one additional location becomes industrial, making this location's real income jump from (3) to (4). Second, real incomes grow everywhere, due to a larger and more differentiated set of varieties becoming available as n increases and σ decreases. By the first effect, as n increases, global income dispersion—measured for example as the ratio of highest to median real income of locations—first increases (as income concentrates in the first few industrial locations) and then decreases (as industrialisation diffuses).

To characterise trade flows, note first that each agricultural location's imports of manufactures inclusive of trade costs amount to β in total, or β/n from each industrial location. Under balanced trade, its total exports of the primary good also amount to β. As for the industrial locations, consider first their exports of manufactures to (or equivalently, imports of z from) the sum of all agricultural locations.[12] We call this "North-South trade." It can be written as

$$X_{NS} = \beta \frac{N-n}{n}. \tag{5}$$

[12] Since trade between each industrial location and each other industrial location must be balanced, so must each industrial location's aggregate trade with all agricultural locations. We do not impose the balanced bilateral trade condition required to ensure that trade between each industrial location and each agricultural location balances. However, this only becomes consequential when we allow for a positive trade costs in z, as we do in Appendix A.2.

Consider next an advanced location's exports of manufactures to (or equivalently, imports of manufactures from) the sum of all other industrial locations. We call this "North-North trade." Expressed as a ratio of North-South trade, it can be written as

$$X_{NN/NS} = \frac{n-1}{N-n}\left[\frac{\alpha\left(\delta\tau\right)^{1-\sigma}}{1+(n-1)\left(\delta\tau\right)^{1-\sigma}}/\frac{1}{n}\right]. \tag{6}$$

The term in square brackets is the ratio of exports to a single industrial location, to exports to a single agricultural location (after β drops from the numerator and denominator). To arrive at aggregate relative trade, the first term multiplies this ratio by the number of industrial locations, divided by the number of agricultural locations.

We also consider the Grubel-Lloyd (GL) index of an industrial location's manufacturing trade. As is well known, such index is equal to zero when trade is entirely inter-industry (the location exports manufactures but does not import them) and equal to one when it is entirely intra-industry (the location's imports of manufactures equal its exports). The GL index can be written as[13]

$$GL = \frac{2X_{NN/NS}}{1+2X_{NN/NS}}, \tag{7}$$

and is therefore increasing in $X_{NN/NS}$. Intuitively, North-North trade is intra-industry in nature, while North-South trade is inter-industry.

As industrialisation spreads ($n\uparrow$), the agricultural locations' trade spreads over a larger number of industrial locations. At the same time, for industrial locations, North-North trade (relative to North-South trade) becomes more important, a pattern that is reinforced as manufactures become more differentiated ($\sigma\downarrow$). The effect of these changes on the industrial locations' trade is due to the industrial locations becoming more numerous relative to the agricultural locations (an increase in the first term in equation 6), but also to the fact that exports to a single industrial location increase relative to exports to a single agricultural location (an increase in the term in square brackets in equation 6). Intuitively, as varieties become more numerous and differentiated, industrial locations allocate a larger share of expenditure to foreign varieties, as opposed to the domestic one. As North-North trade becomes more important relative to North-South trade as n increases and σ decreases, the industrial locations' GL index also increases. At the same time, the share of the agricultural good in the industrial locations' imports, which is equal to $1/(1+X_{NN/NS})$, decreases.

[13]Let X_{NN} denote an industrial location's aggregate imports from (and exports to) all other industrial locations. The GL index can be written as $GL = \left(X_{NS}+X_{NN}+X_{NN}-|X_{NS}+X_{NN}-X_{NN}|\right)/\left(X_{NS}+X_{NN}+X_{NN}\right)$. Dividing both numerator and denominator by X_{NS}, we obtain the expression in the text.

Finally, we characterise the degree of industrialisation of the industrial locations, defined as the share of labour that they allocate to manufacturing. For $n > 0$, this can be shown to equal

$$\text{Manufacturing Labor Share} \;=\; \min\left[1\;,\;\beta\left(1+\frac{N-n}{n\alpha}\right)\right], \tag{8}$$

which by Assumption 2 is always less than one for $n > 1$, as demonstrated in Appendix A.4.

IV.B Stage III: Equilibrium for Given Empires

We now characterise the equilibrium of the model, starting from the third stage in which empires are taken as given.

Suppose that, in the first stage of the game, empires have been formed. Such empires must still exist in the third stage, since it is not in the imperial power's interest to trigger a revolution in the second (see the next subsection). So, colonies co-exist with independent agricultural locations, and imperial powers potentially co-exist with industrial locations who have not formed an empire (though the latter will not exist in equilibrium). With the numeraire being freely traded and the industrial locations being imperfectly specialised, the existence of empires does not affect producer prices, which are still one. Consumer prices also remain the same, with the exception that, if an industrial location has an empire, then the price of its variety in its colonies falls from $\delta\tau$ to δ.

Pre-tax real income is the same for all colonies, and is equal to

$$U_C \;=\; \frac{1}{P_C} \;=\; \frac{1}{\left[\delta^{1-\sigma}+(n-1)(\delta\tau)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}} \;>\; U_I, \tag{9}$$

where a subscript C identifies colonies, and U_I is the real income of independent agricultural location, as defined in (3).[14] The reduction in trade costs means that colonies have a higher pre-tax real income than independent agricultural locations.

IV.C Stage II: Taxes and Revolution

Let t_{ij} denote the tax imposed by imperial power i on colony j at the start of this period. Given this choice of tax, for colony j not to rebel against the empire, it must be the case

[14] Because prices in independent agricultural locations are not affected by empire formation, the real incomes of such locations are still as defined in the benchmark case with no empires.

that its real income within the empire is at least as high as its outside option, i.e.

$$U_C(1 - t_{ij}) \geq U_I(1 - \mu). \tag{10}$$

At the beginning of the period, imperial power i imposes the highest possible t_{ij} which does not trigger a rebellion. That is, the no-rebellion constraint in (10) holds as an equality:

$$t_{ij} = t^* = 1 - (1 - \mu)\frac{U_I}{U_C} \in (\mu, 1). \tag{11}$$

The existence of a no-rebellion constraint implies that the tax that the imperial powers can impose on colonies is limited by two factors: the gains from trade generated by empire, and the colony's capacity to rebel against the empire. If empires did not generate any gains from trade, i.e. if $\tau \to 1$ (implying $U_C \to U_I$), then the equilibrium tax would be μ, reflecting only the colony's capacity to rebel. Conversely, if the colony had a perfect capacity to rebel, i.e. if $\mu = 0$, then the equilibrium tax would only reflect the gains from trade generated by empires, that is it would equal $(U_C - U_I)/U_C$.

Note that all imperial powers impose the same tax on all colonies, independently on the size of their empires. This is because of the symmetry of our model, but also because of the assumption of imperfect specialisation, which ensures that to expand an empire does not have any general equilibrium effect on producer prices. Then, all colonies have the same real income (U_C), even if empires are of potentially different size.

The equilibrium tax, t^*, is also the constant marginal benefit of empire. Using (3) and (9), it can be written as

$$t^*(\mu, n, \sigma) = 1 - (1 - \mu)\left(\frac{n}{\tau^{\sigma-1} + n - 1}\right)^{\frac{\beta}{\sigma-1}}. \tag{12}$$

A central result of the paper is that as industrialisation spreads ($n \uparrow$), and manufactures become more differentiated ($\sigma \downarrow$), the marginal benefit of empire reported in (12) decreases (see Appendix A.5). This is because as these changes occur, the gains from trade generated by empires—one of the two factors limiting the tax that the imperial powers can impose on the colonies—decrease. This can be seen by noticing that, as $n \uparrow$ and $\sigma \downarrow$, the real income of independent agricultural locations, U_I, catches up on the pre-tax real income of colonies, U_C. Intuitively, empires reduce the cost of trading in one variety only. Then, their trade value must decline as the number of varieties increase, and as varieties become more complementary.

When the equilibrium tax is taken into account, the real income of colonies is $(1 - \mu)U_I$, that is only $1 - \mu$ times that of independent agricultural locations. The real income of industrial location i is

$$U_i = \frac{\alpha + R_i}{[1 + (n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}}, \qquad (13)$$

where

$$R_i = t^*(\mu, n, \sigma)E_i - \int_0^{E_i} c(x)dx \qquad (14)$$

are net revenues from the empire. We also refer to R_i as to "colonial extraction", since it identifies the burden of taxation on the colonies after netting out the administrative cost of empire.[15]

The real income of a hypothetical industrial location who has not formed an empire is captured by setting $E_i = 0$ (and thus $R_i = 0$) in the equations above. However, it is clear from those equations that if an industrial location has formed an empire, then all other locations must have also done so, and they must have all formed empires of the same size, which we will formally prove in the next subsection. Thus, for the rest of this subsection, we drop the subscript from E_i and R_i. Comparing (13) to (4), it is immediately clear that empires increase the imperial powers' real income by the real value of extraction (R).

In summary, the distributional consequences of empires are to reduce the real incomes of colonies, to increase the real incomes of imperial powers, and to leave everybody else unaffected.

We next study the impact of empires on trade flows. In independent agricultural locations, imports of manufactures (and exports of primary products) are still β. In colonies, on the other hand, trade flows depend on colonial extraction. Specifically, total imports of manufactures by an empire are

$$E\beta(1 - t^*) + \beta \int_0^E c(x)dx = E\beta - \beta R$$

[15] Such an interpretation seems most appropriate when $c(\cdot)$ mainly captures the cost of improved governance brought in by the empire: since revenues spent on this are productivity-enhancing from the colonies' point of view, they should be subtracted from total colonial taxation to arrive at colonial extraction. If $c(\cdot)$ mostly captures military costs, instead, expenditure on it is pure waste from the colonies' point of view. Then, colonial extraction is more appropriately characterised as $t^*E_i > R_i$. Note that if $c(\cdot)$ mostly captured the cost of cultural heterogeneity, and would thus be born by the colonies directly as specified in Footnote 10, then the equilibrium tax would be $\widetilde{t^*} = t^* - h(E_i)$. Net revenues from the empire would still be as in (14), or $R_i = \widetilde{t^*}E_i = t^*E_i - h(E_i)E_i = t^*E_i - \int_0^{E_i} c(x)dx$. Then, the empire formation stage would be the same as in the current formulation, leading to identical results. In that alternative formulation, colonial extraction would be more appropriately characterised as $R_i + h(E)E$, and would thus be again equal to t^*E_i.

and are thus *lower* than they would have been without the empire ($E\beta$). Intuitively, colonial extraction reduces expenditure in the colonies, and thus also expenditure on manufactures. Note however that due lower trade costs within empires, if extraction is not too high, it is possible that *consumption* of manufactures in colonies is higher than it would have been without the empire.[16] As for exports of primary products by each empire, they are

$$E[1-(1-\beta)(1-t^*)]-(1-\beta)\int_0^{E_i} c(x)dx = E\beta + (1-\beta)R.$$

and are thus higher than they would have been without the empire ($E\beta$). This is because colonial extraction reduces colonial expenditure on primary products, thus increasing the amount that can be exported. It follows that colonies display a trade surplus, equal to R for the empire as a whole. Intuitively, colonial extraction corresponds to an amount of z which is exported, but does not result in imports.

Since the empires have trade surpluses, the imperial powers have corresponding trade deficits. It is then necessary to consider their exports separately from their imports. It is possible to show that the imperial powers export more manufactures to their own empire than they do to a foreign empire. Moreover, if colonial extraction is not too high, then exports to their own empire may be higher than they would have been without the empire. In contrast, exports to a foreign empire are always lower than they would have been in the absence of that empire.[17] On overall, North-South *export* trade—now carrying a superscript e, to mark the fact that it only identifies an imperial power's *exports* of manufactures to the sum of all agricultural locations—is lower than without empires,

$$X^e_{NS} = \beta\frac{N-n-nR}{n},$$

reflecting the fact that aggregate expenditure by the agricultural locations is decreased by the sum of colonial extractions. Conversely, North-North export trade relative to North-South

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[16] The empire's consumption of the manufactured bundle is $(E\beta-\beta R)/(P_C)^{\frac{1}{\beta}}$, which is larger than $E\beta(1-t^*)/(P_I)^{\frac{1}{\beta}}$. Compare the last expression with consumption of the manufactured bundle in a mass E of independent agricultural locations, $E\beta/(P_I)^{\frac{1}{\beta}}$, using $1-t^*=(1-\mu)*P_C/P_I$ from equation (11). It is easy to see that the former is greater than the latter if and only if $\mu<1-(P_C/P_I)^{\frac{1-\beta}{\beta}}\in(0,1)$. Thus, the last condition is sufficient for the consumption of manufactures in colonies to be higher than it would have been without empire.

[17] To see this, note that it is $\beta/[1+(n-1)\,\tau^{1-\sigma}]<\beta/n<\beta\tau^{1-\sigma}/[1+(n-1)\,\tau^{1-\sigma}]$, where the three terms in the inequality indicate the share of expenditure allocated to the mother country's variety, respectively in its own empire, in independent agricultural locations, and in a foreign empire. Since expenditure in each empire is $E-R$ while expenditure in an equal mass of agricultural locations is E, it follows that, for $R\to 0$, expenditure on the mother country's variety is highest in its own empire, intermediate in an equal mass of agricultural locations, and minimum in a foreign empire.

export trade is higher than without empires,

$$X^e_{NN/NS} = \frac{n-1}{N-n-nR}\left[\frac{(\alpha+R)\,(\delta\tau)^{1-\sigma}}{1+(n-1)\,(\delta\tau)^{1-\sigma}}/\frac{1}{n}\right] \tag{15}$$

reflecting lower North-South trade (captured by the $-nR$ term in the denominator) but also a higher expenditure by each industrial location, made possible by colonial extraction (the $+R$ term in the numerator).

Assuming that the imperial powers transfer all R home before spending it, they then have an aggregate trade deficit equal to R vs their own empire, but a trade balance vs other locations.[18] Then, it is possible to show that imports from own empire are larger than imports from a foreign empire, and that the positive gap between the two is even more pronounced than the corresponding gap for exports. North-South *import* trade, intended as imports from the sum of all agricultural locations, is

$$X^i_{NS} = X^e_{NS} + R = \beta\frac{N-n}{n},$$

and is thus the same as without empires. North-North import trade relative to North-South import trade is still higher than without empires,

$$X^i_{NN/NS} = \frac{n-1}{N-n}\left[\frac{(\alpha+R)\,(\delta\tau)^{1-\sigma}}{1+(n-1)\,(\delta\tau)^{1-\sigma}}/\frac{1}{n}\right] \tag{16}$$

again reflecting a higher expenditure by each industrial location, made possible by colonial extraction.

Since producer prices are constant, it may seem that empires do not benefit the terms of trade of the imperial powers. On a closer look, however, this is not entirely correct: by taxing the colonies, the imperial powers can grab some z for free, which implies that for every unit they receive, they in fact pay $1-t$ instead of one. Thus, empires do effectively benefit the terms of trade of the imperial powers in this model, though only vs their colonies and not also vs other agricultural locations. This point is explicitly made in Appendix A.3, where we show that an alternative formulation in which a monopsonist buyer from the imperial

[18] The model is silent on whether the imperial power brings R home before spending it, in which case the colonies will have a trade surplus vs the imperial power but a trade balance vs all other locations, or if instead it spends some revenues directly from the colonies, in which case the colonies will also have trade surpluses vs the foreign locations that the imperial power spends the revenues in. In the latter case, the imperial power is effectively using colonial trade surpluses vs foreign locations to finance its own trade deficit vs those same locations. A real-world counterpart to this result is Britain's use of its African colonies' trade surplus vs the USA to repay its war debts towards this country in the 1950s (see e.g. Marseille 2005, p. 86).

power (a cartel of private companies, or a marketing board) pays a price $1 - t^e$ for colonial exports leads to very similar results. In that alternative model, consistent with evidence in Frankema, Williamson and Woltjer (2018) and Tadei (2020, 2022) (see Section II), empires explicitly improve the terms of trade of the imperial powers vs their colonies.

In summary, empires reduce the colonies' total imports (though they may increase their imports from the imperial power) and increase their total exports, resulting in a trade surplus. They also improve the imperial powers' terms of trade vs their own colonies, and increase North-North trade relative to North-South trade.

Finally, it can be shown that empires do not affect the degree of industrialisation of the imperial powers, which remains as in (8). Although colonial extraction by one imperial power increases demand for its domestic variety (since it shifts expenditure from the colonies to the imperial power, where the price of the domestic variety is lower), extraction by the other imperial powers decreases it. Given symmetry of the equilibrium, these two forces cancel each other out.

IV.D Stage I: Empire Formation

We now turn to the first stage of the model, in which the industrial locations may form empires. A comparison of their real income with and without an empire (equations 13 and 4) immediately reveals that an industrial location will form an empire if and only if the resulting colonial extraction is positive ($R_i > 0$). Moreover, if they do form an empire, they will choose its size E_i to maximise extraction (equation 14).

We assume that the industrial locations form empires simultaneously and non-cooperatively. The equilibrium of such a game is described in the following.

Proposition 1. *If the industrial locations simultaneously and non-cooperatively form empires to maximise their real incomes, then at the unique Nash equilibrium of the game, they form empires if and only if $t^*(\mu, n, \sigma) > c(0)$, where $t^*(\mu, n, \sigma)$ is described in equation (12). In such a case, they form equally-sized empires of size*

$$E^*(\mu, n, \sigma) = \arg_E \left[t^*(\mu, n, \sigma) = c\left(E\right)\right] = \arg_E \left[1 - (1-\mu)\left(\frac{n}{\tau^{\sigma-1} + n - 1}\right)^{\frac{\beta}{\sigma-1}} = c\left(E\right)\right]. \tag{17}$$

Proof. Comparing (13) and (4) and using (14), industrial location i's problem can be written as

$$\max_{E_i} \quad t^* E_i - \int_0^{E_i} c(x_i) dx_i$$
$$\text{s.t.} \quad E_i \geq 0.$$

Given that $c(\cdot)$ is continuous and increasing, the maximand is strictly concave in E_i. Then, the necessary conditions for a maximum,

$$t^* - c(E_i) + \lambda_i = 0$$
$$E\lambda_i = 0,$$

where λ_i is the Lagrange multiplier, are also sufficient. If $t^* < c(0)$, then the necessary conditions require $\lambda_i \geq 0$ and $E_i = 0$. Otherwise, they require $\lambda_i = 0$ and

$$E_i = \arg_y \left[t^* = c\left(E\right)\right].$$

□

Proposition 1 is intuitive. Each industrial location chooses the size of empire which equalises the constant marginal benefit of empires, $t^*(\mu, n, \sigma)$, to their marginal cost, $c(E)$. In other words, it equalises the tax that it can impose on the marginal worker added to the empire, to the cost of administering such a worker. This leads to two sub-cases: if the marginal benefit is higher than the cost of adding the first worker, then the industrial location forms an empire, otherwise it does not.[19] Note that an industrial location's choice is independent on the choices of other industrial locations, since empire formation does not affect agents outside the empire (also due to there being enough space for all empires).

We can now formally specify the assumption that N be large enough:

$$N \geq n\left[E^*(\mu, n, \sigma) + 1\right] \quad \forall\, n < N. \tag{Assumption 3}$$

Under Assumption 3, the world is spacious, so that industrial locations setting up empires never hit its boundaries.

Given Proposition 1, equilibrium colonial extraction, that is the net revenues from empire

[19] Note that $t^*(\mu, n, \sigma)$ is highest for $n = 1$, and that setting $n = 1$ and $E = 1$ in equation (17) with an inequality yields Assumption 1. Then, the assumption ensures that, at least when the marginal benefit of empire is at its highest, an empire of size greater than one is formed.

to each imperial power, is the same for all imperial powers, and is equal to

$$R^*(\mu, n, \sigma) = t^*(\mu, n, \sigma)E^*(\mu, n, \sigma) - \int_0^{E^*(\mu,n,\sigma)} c(x)dx \tag{18}$$

The real income of imperial powers is then

$$U_M = \frac{\alpha + R^*(\mu, n, \sigma)}{[1 + (n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}}, \tag{19}$$

where M stands for "metropole."

The aggregate size of empires in terms of whole agricultural locations can be written as $n\underline{E}^*(\mu, n, \sigma)$, where $\underline{E}^*(\mu, n, \sigma)$ denotes the biggest integer less than or equal to $E^*(\mu, n, \sigma)$. Then, the equilibrium number of independent locations is equal to the total number of locations in the world, minus the aggregate size of empires:[20]

$$N^*(\mu, n, \sigma) = N - n\underline{E}^*(\mu, n, \sigma). \tag{20}$$

IV.E Discussion

We conclude this section with three considerations: first, our characterisation of empires as a governance technology; second, how a Social Planner maximizing a global social welfare function would organise the world politically; and third, the case in which the industrial locations were allowed to be perfectly specialised.

The essential assumption of our political model is that locations acquire a new capacity upon industrialising: namely, by annexing some agricultural locations and bringing modern governance to them (an action that comes at military and administrative costs), they can now reduce those locations' trade costs, while at the same time taxing them (subject to a revolution constraint). Even someone who accepts this assumption may object that we are omitting an important part of the story. What if there was an alternative, "informal empire" technology, whereby, at a reduced cost $\hat{c}(\cdot) < c(\cdot)$, an industrial location could improve the governance of formally independent agricultural locations, who would then compensate it for the investment as well as for some of the missed extraction from formal empire? By economising on the costs of formal empire that are pure waste (such as those required to establish political control), efficiency could be improved, and both parties could be made better off. We consciously rule our such an alternative technology on the ground that it was unlikely to be universally available in our setting. On the one hand, informal empire may

[20] Left-over "pieces" of agricultural locations, $n[E^*(\cdot) - \underline{E}^*(\cdot)]$, count as independent in equation (20).

simply not be possible in territories which did not have a pre-existing state infrastructure, since investment in modern governance would necessarily require the kind of major political overhaul which is only achievable through formal control.[21] On the other hand, even where informal empire might be theoretically feasible, its actual realisation may be plagued by commitment problems. It is a well-established rationalisation of political institutions that they help agents solve commitment problems.[22] In our case, if the ruling elite of agricultural locations could not commit to implementing the required reforms, or to compensating the industrial locations for the missed extraction from formal empires, then formal empires might still emerge in equilibrium, even if the informal empire technology was in principle available. Note that, in both cases, formal empires may be welfare improving for the world as a whole, since they alleviate a friction leading to under-investment.[23]

Next, as a benchmark for the Nash equilibrium, imagine a constrained utilitarian Social Planner (SP), who can form empires and implement frictionless transfers of z conditional on not making any location worse off. As in the decentralised case, empires must include one and only only industrial location. We consider two cases: first, when only formal empires can be formed, at a cost $c(\cdot)$ as in the decentralised case, and second, per our discussion above, when the alternative, "informal empire" technology also exists, at a lower cost $\hat{c}(\cdot) < c(\cdot)$. In the first case with formal empires only, the SP would still form empires in some parameter range (see Appendix A.6 for the proof), and these would still be of equal size. They would, however, be of size $E^*(0, n, \sigma)$, that is smaller than those formed in the Nash equilibrium for any $\mu > 0$. Intuitively, this SP only cares about the efficiency gains from empire, and not also about the redistribution that imperial powers can obtain whenever revolution is costly. Thus, compared to this benchmark, the Nash equilibrium features inefficiently large empires. In the second case when the informal empire technology is available, not being constrained by commitment problems, the SP will always prefer informal empires to formal ones, given that they achieve the same efficiency gains but at a lower cost. Their size can be found by replacing $\mu = 0$ in equation (17), and by using $\hat{c}(\cdot)$ instead of $c(\cdot)$ in the same equation. Its

[21] Coining the term "informal empire," Gallagher and Robinson (1953) argued that while British policies to induce trade openness through indirect control were instrumental in South America after its independence, "*in weaker or unsatisfactory states it was considered necessary to coerce them into more co-operative attitudes.*"

[22] For example, in Acemoglu and Robinson (2001), the elite cannot commit to redistributive policies under autocracy. To avoid a revolution, they are thus forced to concede democratisation.

[23] The experience of international organisations such as the IMF or the World Bank at improving a country's governance from the outside provides plenty of examples of how the misaligned incentives of the ruling elite may make such an effort vain. The incapacity to commit to transfers towards the former imperial powers was clearly visible in the actions of some former colonies in the second half of the $20th$ century, where generous terms initially granted to foreign investors were often later reneged on. For some evidence of under-investment due to this problem, which also became more severe after external political control was loosened, see Paltseva, Toews and Troya-Martinez (2022).

relation with the size of formal empires formed at the Nash equilibrium is ambiguous: as before, the SP only cares about efficiency, which induces it to form smaller empires; at the same time, however, the SP has access to a better technology of empire formation, which induces it to form larger ones.

Finally, if we were to relax our assumption on industrial locations remaining imperfectly specialised, the producer price of varieties would depend on the size of empires, making the problem intractable. Moreover, the equilibrium of the game would be complicated by the fact that, by enlarging their empires, the industrial locations would impose negative terms-of-trade externalities on one another. While it is natural to presume that such a game would feature symmetric empires in equilibrium, and that such empires would be larger than $E^*(\mu, n, \sigma)$ due to the industrial locations attempting to impose negative externalities on one another, we were not able to characterise such equilibrium, nor to rule out the existence of an asymmetric equilibrium. At any rate, it seems reasonable that the main mechanism emphasised in the paper—that the trade value of empires decreases as the trade they facilitate becomes relatively less important—should also apply to the Nash equilibrium(a) under perfect specialisation.

V Comparative Statics

We now explore analytically the comparative statics of the equilibrium with respect to two parameters: the number of industrialised locations (n) and the elasticity of substitution between manufacturing varieties (σ). There are three comparative statics of interest: first, the number of countries and the size of empires; second, global income dispersion; and third, patterns of trade.

1) Size of empires and number of independent locations We begin by considering the equilibrium size of each empire, $E^*(\mu, n, \sigma)$. As industrialisation spreads ($n \uparrow$) and manufactures become more differentiated ($\sigma \downarrow$), $E^*(\mu, n, \sigma)$ decreases (see eq.17). Intuitively, as political arrangements which only reduce the cost of trading in one variety, empires become less valuable as the number of varieties increase, and varieties become more complementary. This results in their marginal benefit, $t^*(\mu, n, \sigma)$, decreasing, while their marginal cost, $c(E)$, stays the same (increases in real terms). Note that the size of empire in terms of whole agricultural locations, $\underline{E}^*(\mu, n, \sigma)$, also tends to decrease as n increases and σ decreases, however because of its discrete nature, it decreases in "jumps" (while staying constant between jumps).

Next, we investigate the comparative statics of the equilibrium number of independent locations, $N^*(\mu, n, \sigma)$. Our main result is enunciated by the following proposition:

Proposition 2. *There exists an integer $\overline{n}$, with $1 < \overline{n} \leq N$, such that:*

- *if $n = 0$ or $n \geq \overline{n}$, then $N^*(\mu, n, \sigma) = N$;*
- *if $0 < n < \overline{n}$, then $N^*(\mu, n, \sigma) < N$.*

In the latter case, $N^*(\mu, n, \sigma)$ is either decreasing or constant in σ.

Proof. If $n = 0$, then $N^*(\mu, n, \sigma) = N$ follows from equation (20). Suppose then $n > 0$. There exists $\overline{n} > 1$ such that $t^*(\mu, n, \sigma) \geq c(1)$ if $0 < n < \overline{n}$, and $t^*(\mu, n, \sigma) < c(1)$ if $n \geq \overline{n}$. This follows from the fact that $t^*(\mu, n, \sigma)$ decreases to zero as n increases to infinity, and $t^*(\mu, 1, \sigma) > c(1)$ by Assumption 1. By Proposition 1, it follows that $\underline{E}^*(\mu, n, \sigma) \geq 1$ if $0 < n < \overline{n}$, and $\underline{E}^*(\mu, n, \sigma) = 0$ if $n \geq \overline{n}$. That $N^*(\mu, n, \sigma) < N$ in the first case, and $N^*(\mu, n, \sigma) = N$ in the second case, then follows from equation (20). Note that, given that $\underline{E}^*(\mu, \overline{n}, \sigma) = 0$, Assumption 3 implies $\overline{n} \leq N$. Finally, the last sentence of the proposition follows from the fact that $t^*(\mu, n, \sigma)$—and hence, by Proposition 1, $E^*(\mu, n, \sigma)$—is increasing in σ, and $\underline{E}^*(\mu, n, \sigma)$ is either increasing or constant in $E^*(\mu, n, \sigma)$. □

The comparative statics of the number of independent locations with respect to n is governed by two opposite forces. As n increases, on the one hand, more empires are formed, reducing the equilibrium number of independent locations. On the other, the value of empires—and thus their size $\underline{E}^*(\mu, n, \sigma)$—decreases, increasing the number of independent locations. The first force is strongest when only a small number of locations have industrialised, since the empires being formed are largest in this period. In contrast, the second force tends to be strongest when more locations have industrialised, since the reduction in size involves the largest number of empires in this period. Governed by these two forces, $N^*(\mu, n, \sigma)$ must display an approximate U-shape as n increases from 0 to N.

Inside this U-shape, a decrease in σ either leaves $N^*(\mu, n, \sigma)$ constant, or increases it. Intuitively, greater product differentiation makes empires less valuable, by increasing the importance of trade which crosses the empires' borders. This decreases the equilibrium size of empires, and hence increases the number of countries. If the decrease in σ happens at the same time as the rise in n, then it should affect the convexity of the U-shape.

While the previous two paragraphs describe the main forces which drive the comparative statics of $N^*(\mu, n, \sigma)$ with respect to n and σ, its exact comparative statics is complicated by the fact that, as mentioned above, $\underline{E}^*(\mu, n, \sigma)$ decreases in jumps n increases and δ decreases. Thus, we will illustrate the relationship between $N^*(\mu, n, \sigma)$ and (n, σ) by plotting their numerical comparative statics in Section VI.A below.

Note that the comparative statics of the number of independent locations does not critically depend on our Assumption 3 that, for any n, the world remains spacious enough to accommodate all empires. The emergence of the first industrial location, and hence the first empire, always reduces the equilibrium number of independent locations. If we relax Assumption 3 and allow for the possibility that, for some $n \in (0, N)$, there is not enough space for n empires of size $E^*(\mu, n, \sigma)$, then for those values of n, any situation in which no empire is greater than $E^*(\mu, n, \sigma)$, and empires include all agricultural locations, would be a Nash equilibrium.[24] At such equilibria, the equilibrium number of independent locations would now be increasing as n increases, since emergent industrial locations would break free and form new imperial countries. Moreover, as $nE^*(\mu, n, \sigma)$ eventually decreases as n increases and σ decreases, the world may become spacious again, after which point our comparative statics would return the one discussed above. Thus, overall, as n increases and σ decreases, the model would continue to predict an initial decline and subsequent rise in the equilibrium number of independent locations.

Finally, it is easy to see that the Social Planner solution discussed above has the same qualitative comparative statics with respect to n and σ as the Nash equilibrium outcome, being equal to $E^*(0, n, \sigma)$ in the case of formal empires, and to an expression with the same qualitative comparative statics as $E^*(0, n, \sigma)$ when the informal empire technology is available (see Section IV.E for more details).

2) Global income dispersion We have argued in Section IV.A that, in the benchmark case with no empires, a rise in n first increases and then decreases global income dispersion, as measured as the ratio of highest to median real income of locations. To determine whether this comparative statics is still valid under endogenous empire formation, we begin by investigating the comparative statics of equilibrium colonial extraction, $R^*(\mu, n, \sigma)$.

It is easy to see that $R^*(\mu, n, \sigma)$ has the same comparative statics as $t^*(\mu, n, \sigma)$: as industrialisation spreads ($n \uparrow$) and manufactures become more differentiated ($\sigma \downarrow$), it decreases. Intuitively, as the gains from trade generated by empires decrease, the imperial powers can extract less from the colonies, since to continue to extract the same would lead to a revolution. Practically, while the total benefit of empire (for a constant size of empire), t^*E^*, decreases, the total cost of empire, $\int_0^{E^*} c(x)dx$, stays constant (or increases in real terms). Notably, these changes occur even if the colonies' capacity to rebel, μ, remains the same.

Relative to the benchmark case, endogenous empire formation thus exacerbates the

[24] To see this, note that no industrial location has a profitable deviation: not to reduce the size of their empire, since this would take them further away from the optimum; not to expand it, since this is not possible give the lack of space. At such equilibria, empires may well be different in size.

pattern of rise and fall of global income dispersion as n increases, for two reasons. On the one hand, as the first few locations industrialise, they now form empires, which further increase their real income. On the other hand, to the extent that the first empires are large enough, they also decrease the income of the location with median income, by making it a colony. Thus, the initial rise in income dispersion is steeper under endogenous empire formation. Conversely, as industrialisation diffuses, colonial extraction decreases, and so does eventually the total size of empires. This penalises the richest locations and rewards the location with the median income, which is now again an independent location. It follows that the fall of global income dispersion as industrialisation diffuses is also steeper under endogenous empire formation.

3) Patterns of trade In the benchmark case with no empires (Section IV.A), as n increases and σ decreases, North-North trade relative to North-South trade, $X_{NN/NS}$, increases. With endogenous empire formation, as these changes occur, $X_{NN/NS}$ first increases faster than in the benchmark case, and then more slowly. To see this, note that whether we consider $X_{NN/NS}$ from the export side (eq.15) or from the import side (eq.16), it is increasing in R. This is because colonial extraction shifts income from the colonies to the imperial powers, who spend part of that income on manufactures of the other imperial powers. Then, as n first increases and σ first decreases, the export and import $X_{NN/NS}$ terms increase for two reasons: first, industrial locations become more numerous and allocate a greater share of expenditure to foreign varieties as in the benchmark case, and second, empires shift income from the colonies to the industrial locations. As n continues to increase and σ continues to decrease, however, colonial extraction decreases. This second force slows down the increase of the export and import $X_{NN/NS}$ terms compared to the benchmark case.

Empire formation has the same impact on the comparative statics of the GL index of an industrial location's manufacturing trade, which has the same comparative statics as $X^e_{NN/NS}$. As for the share of imports that imperial powers allocate to primary products, coinciding with $1/(1+X^i_{NN/NS})$, empire formation first accelerates its decline and then slows it down.

In the next section, we first discuss the relevance of these outcomes to actual historical trajectories and then plot them for a particular parameterisation of the model.

VI History versus Model

We start this subsection by elaborating on the fact that motivated our study in the very first page—that industrial empires grew in number and in size to dominate global governance until the post-WWII period, followed by a sharp increase in the number of sovereign countries. We then present two additional facts about the international economy of the last two centuries: first, the same period witnessed the initial widening of international per-capita income dispersion, followed by catch-up growth by late industrialisers. Second, intra-industry trade in manufacturing between industrialized countries displayed a secular increase while the import share of primary goods declined. All the details about the data and compilation procedures are in Appendix B.

Fact 1: Industrialisation and size of empires

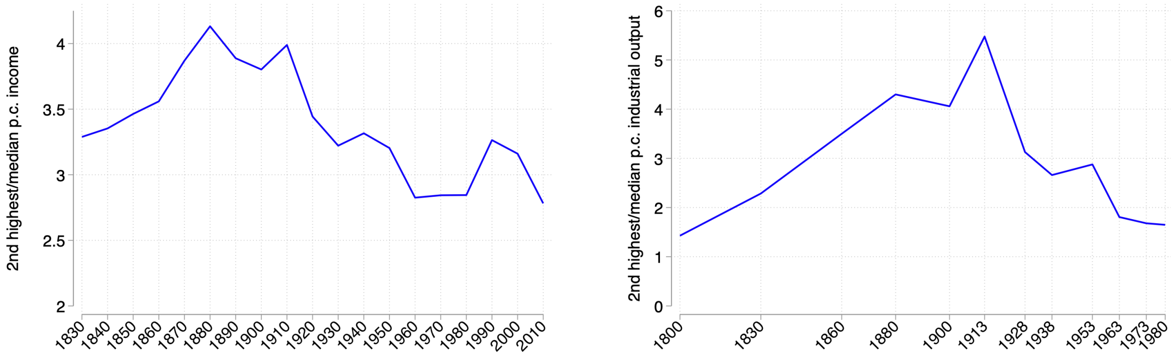
Drastic changes in global political boundaries since the early $19th$ century make it an inherently hard task to count the number of sovereign polities over time and measure the size of empires. Prior literature follows two distinct approaches: Wimmer and Min (2006), which we used in Figures I-II above, and Gokmen, Vermeulen and Vézina (2020) take the boundaries of present-day nation states and consider whether in a given year in the past, an imperial state exerted political power in a substantial part of their territory. Dedinger and Girard (2021), on the other hand, track polities as they existed in the past, informing whether in a given year, they were fully sovereign or under the political hegemony of an imperial state. In Appendix Figures B.1 and B.2a, we show the robustness of our motivating facts to using the two alternative political history datasets cited above. Similarly, the correlation between imperial growth and industrialisation is robust to using 1913 per capita income as an alternative measure of development (Appendix Figure B.2b). We plot individual empires' size and industrialisation trajectories in Appendix Figures B.3 and B.4.

Looking at the territorial evolution of the international political order in Figure II, we separated the sub-Saharan Africa (SSA) region to highlight the fact that imperial growth was not just driven by the "Scramble for Africa," the precipitous partition of the continent by European colonial powers after 1880 with adverse long-run implications for its development (Michalopoulos and Papaioannou, 2016). When we look at this trajectory based on population (Appendix Figure B.5), regions outside of SSA dominate both before and after 1880: between 1880-1910, the seven expanding empires brought under their administration an additional 123 mn people outside of SSA, compared to the 62 mn people in that region.

To sum our key findings here: there is a robust relationship between industrialisation and empire building before the World Wars which was followed by rapid devolution, leading to a U-shape in the global number of sovereign entities that mirrors the inverse U-shape in the size of modern empires.

Figure III: **Evolution of Income and Industrial Output Dispersion**

(a) Income (Maddison) (b) Industrial Output (Bairoch)



Notes: The left panel is the ratio of the second highest to the median of per capita real income across a balanced sample of 57 countries, constructed by the authors using data from Bolt and van Zanden (2020). The right panel plots the same statistic for per capita industrial output across a balanced sample of 29 countries, constructed by the authors using data from Bairoch (1982). See Appendix B for further details about the data.

Fact 2: Global income dispersion

The industrial revolution and its diffusion had a first-order effect on the evolution of the international per capita income distribution. Using data from the Maddison Project Database (Bolt and van Zanden, 2020), Figure IIIa in the left panel plots a per capita income dispersion statistic, the ratio of the second highest to the median value (rather than the max/median ratio which is prone to outlier bias), for a balanced sample of 57 countries (listed in Appendix Table B.1) from 1830 until 2010. Figure IIIb in the right panel plots the same statistic for per capita industrial output across a balanced panel of 29 countries (listed in Appendix Table B.2) from Bairoch (1982), which reports data until 1980 only. The evident inverse U-shape pattern in these trajectories is driven by the initial concentration of modern industrial production in early industrializers followed by diffusion to other countries. Appendix Figure B.6a showcases the robustness of this pattern when an alternative measure of dispersion, the coefficient of variation, is used.

We finish the presentation of this fact with a note of caution and a clarification. While the "great divergence" of living standards is an unequivocal fact, the growth literature has documented the importance of the sample used in assessing the degree of income convergence, e.g., De Long (1988) and Pritchett (1997). According to this critique, prior studies focused on biased *ex post* samples of countries that eventually industrialised and caught up—the so-called "convergence club"—and there is no discernible income convergence during the 20*th* century when least developed countries (LDCs) are accounted for. While our sample excludes many current LDCs due to their lack of historical income data, it goes beyond high-income countries and includes many that were colonized during the 19*th* century. Appendix Table

B.1 indicates with a star the 23 of the 57 countries in the income dispersion panel that were part of the expanding empires at some point, which alleviates concerns about how representative our sample is. To better demonstrate how the entire distribution evolves over time, Appendix Figure B.6b plots non-parametric densities of de-meaned per capita incomes of the 57 countries in the Maddison panel at three points in time: at the beginning (1830), during the peak of imperialism (1910) and after decolonisation (2000). Comparing 1830 to 1910, increased dispersion clearly manifests itself. Comparing 1910 to 2000, we see a set of countries converging to higher incomes while the rest stagnates, leading to the bimodal distribution described by Quah (1996).

Fact 3: Patterns of trade for the UK

The final historical pattern we document is the increasing importance of intra-industry trade (IIT) in industrial products for developed countries and the declining share of primary products in their imports. Two-way exchange within industries, a well-known stylized fact of international trade today, was first documented after World War II between European countries. Evidence from earlier time periods is sparse to nonexistent, challenged by lack of consistent product-level trade records.[25] The left panel of Figure IV plots the Grubel-Llyod (GL) intra-industry trade index in manufacturing for the United Kingdom since 1830. To our knowledge, ours is the first paper to document this using data that we have digitised from Mitchell (1988). As the birthplace of modern industry, the UK was initially a net exporter of manufactured goods, resulting in a rather low level of IIT until the second half of the 19*th* century. The diffusion of industrialization, however, led to a steady rise in the GL index except the interruption brought by the world wars. As showcased on the right panel of Figure IV, this evolution is mirrored by the declining share of primary products in UK imports since 1850.

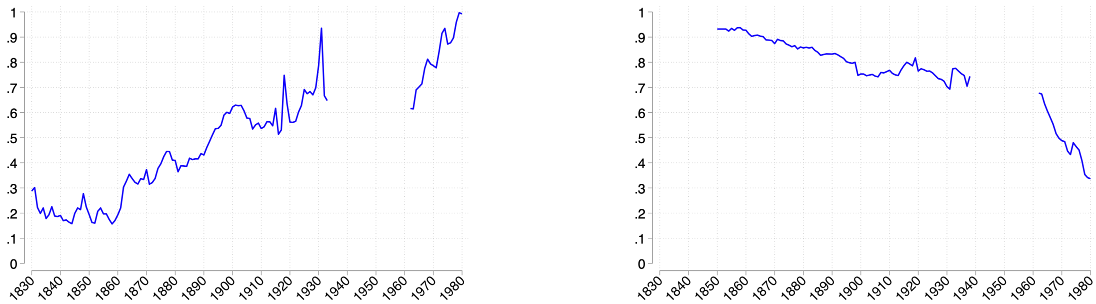
To further analyze the drivers of increasing IIT, Appendix Figure B.7 shows separate IIT indices for six main manufacturing industries along with their share in the UK's foreign trade. These trajectories help understand the margins of increasing aggregate manufacturing IIT: important sectors such as iron & steel and machinery not only retain or gain importance in overall trade but also display increasing IIT themselves. The trade share of textiles, which has a low level of IIT, diminishes steadily. Over time, new industries with high levels of IIT emerge and expand, such as chemicals and motorized vehicles.

There are two channels that are consistent with these trends: First, manufacturing goods

[25] Exceptions are recent work by Hungerland and Wolf (2021) and Becuwe, Blancheton and Meissner (2021) who document the prevalence of IIT in German and French foreign trade during the last decades of the 19*th* century. Jacks (2011) provides evidence on Canadian IIT for the inter-war period.

Figure IV: **Intra-industry Trade and Composition of British Imports**

(a) Intra-industry trade (b) Primary share of imports



Notes: The left panel uses UK aggregate manufacturing export (X) and import (M) data until 1933 to plot the Grubel-Lloyd index of intra-industry trade, defined as $GL = \min(X, M)/((X + M)/2)$. The right panel shows the UK's import share of primary products. Data after 1962 in both figures is from Feenstra et al. (2005), from Mitchell (1988) and Federico and Tena Junguito (2019) up to 1933 in the left and right panels, respectively. See Appendix B for further details.

being more differentiated than primary products, industrial diffusion implies increasing IIT for the first industrialiser due to a composition effect. As new trade partners arise in industrial products, there is an extensive margin increase in manufacturing trade, driving up its share in overall trade. Second, there could be increased differentiation within manufacturing itself, through the rise of inherently more differentiated sectors such as chemicals and motorized vehicles. In the model simulation, which we turn to next, we represent these channels through two processes: an increasing number of countries capable of producing industrial products, and an increasing degree of differentiation between them.

VI.A Numerical Comparative Statics

We now present numerical results from a parameterization of our model that rationalize the long-run patterns in international politics and economics presented above. While the objective of this exercise is qualitative rather than quantitative, our parameter choices are guided by salient empirical moments.

We specify the *marginal* cost of an empire with size E as $c(E) = \gamma_1 + \gamma_2 E$ where $\gamma_1, \gamma_2 > 0$. By equation (17), the equilibrium empire size is given by

$$E^*(\mu, n, \sigma) = \begin{cases} \left[\tilde{\gamma}_1 - \left(\dfrac{n}{\tau^{\sigma-1} + n - 1}\right)^{\frac{\beta}{\sigma-1}}\right] \Big/ \tilde{\gamma}_2 & \text{if } \tilde{\gamma}_1 > \left(\dfrac{n}{\tau^{\sigma-1} + n - 1}\right)^{\frac{\beta}{\sigma-1}}, \\ 0 & \text{otherwise,} \end{cases} \tag{21}$$

where $\tilde{\gamma}_1 = (1 - \gamma_1)/(1 - \mu)$ and $\tilde{\gamma}_2 = \gamma_2/(1 - \mu)$. Substituting this into equation (20) yields the equilibrium number of independent locations $N^*(\mu, n, \sigma)$ along with total size of

Table I: **Parameter Values**

Parameter	Value
N	200
β	0.1
δ	1.46

Parameter	Value
τ	1.32
σ	11 (baseline)
α	22

Parameter	Value
γ_1	0.0142
γ_2	$4.32 \cdot 10^{-4}$
μ	$8.69 \cdot 10^{-3}$

n empires $n\underline{E}^*(\mu, n, \sigma)$.

Table I summarizes all parameters. Without loss of generality, we set the number of locations to a large number ($N = 200$), and report all size-related results in terms of fractions with respect to that scale. The choice of $\beta = 0.1$ reflects the low shares of modern industry and urban population in the early to mid-19*th* century. We calibrate τ, alongside with δ, to match the estimates of trade costs during the first wave of globalization by Jacks, Meissner and Novy (2010). Using the trade flows of the UK, the US and France with 15 other countries between 1870-1913 in a gravity framework, they estimate iceberg trade costs for these three countries over time. Assuming an elasticity of substitution equal to 11, their estimate for the US in 1870 implies that 48% of a unit good shipped from the origin melts in transit (Figure 1 in their paper). Since the US was not part of an empire, we take this cost level as a measure of $\delta\tau$. In our setup, $\delta\tau$ units are shipped for one unit to arrive, so $(\delta\tau - 1)/(\delta\tau) = 0.48$, which yields $\delta\tau = 1.92$. To separate this into its components, we use the result that being within the British Empire reduces trade costs by 50% (Table 2 in their paper). Applying this to the 48% extra-empire trade cost level implies that 24% of a unit good shipped between metropoles and colonies melts in transit. Solving $(\tau - 1)/\tau = 0.24$ yields $\tau = 1.32$, from which we back out $\delta = 1.92/1.32 = 1.46$. For consistency, we set $\sigma = 11$ as our starting baseline value, the same value for which Jacks, Meissner and Novy (2010) imputed trade costs. In the numerical comparative statics that mimic changes in exogenous parameters over time, we progressively lower this elasticity to its average estimate of $\sigma = 5$ from modern-day trade data (Soderbery, 2015).

Note that in equation (21), the cost of rebellion μ simply scales (γ_1, γ_2), the two parameters specifying the marginal cost of empire. To present the comparative statics with respect to the size of empires and the number of independent countries (Fact 1), we only need to pin down $(\tilde{\gamma}_1, \tilde{\gamma}_2)$. We discipline $\tilde{\gamma}_1$ by bounding it from below and above through the constraint in the first line of equation (21). First, for an empire to emerge in the first place when $n = 1$, it needs to satisfy $\tilde{\gamma}_1 > \tau^{-\beta}$. Second, we set a threshold for the fraction of the world $\tilde{n}/N$ that needs to industrialise so that empires cease to exist. That is, for $E^* = 0$ to be the outcome at some $\tilde{n}$, it needs to satisfy $\tilde{\gamma}_1 \leq [\tilde{n}/(\tau^{\sigma-1} + \tilde{n} - 1)]^{\beta/(\sigma-1)}$. We set $\tilde{n} = 20$ so that when 10% of the world population is industrialised ($\tilde{n}/N = 20/200$), empires cease to exist. The choice of $\tilde{\gamma}_1 = 0.994$ satisfies both the lower and the upper bound (with equality) at the given $(\tau, \beta, \sigma, \tilde{n})$ values. Finally, with this value at hand, we set $\tilde{\gamma}_2 = 4.47 \cdot 10^{-4}$ so that the first empire has a size of $E^*(\mu, 1, \sigma)/N = 0.25$, roughly corresponding to the share of world population controlled by the British empire at its peak.

In what follows, we still have to pick values for the productivity parameter α and the cost of rebellion μ in order to simulate the dynamics of global income dispersion (Fact 2) and trade patterns (Fact 3). The parameter values set so far, however, suffice to present the comparative statics with respect to the size of empires and the number of independent countries (Fact 1), which we next turn to.

Simulating Fact 1: Size of empires and number of independent locations

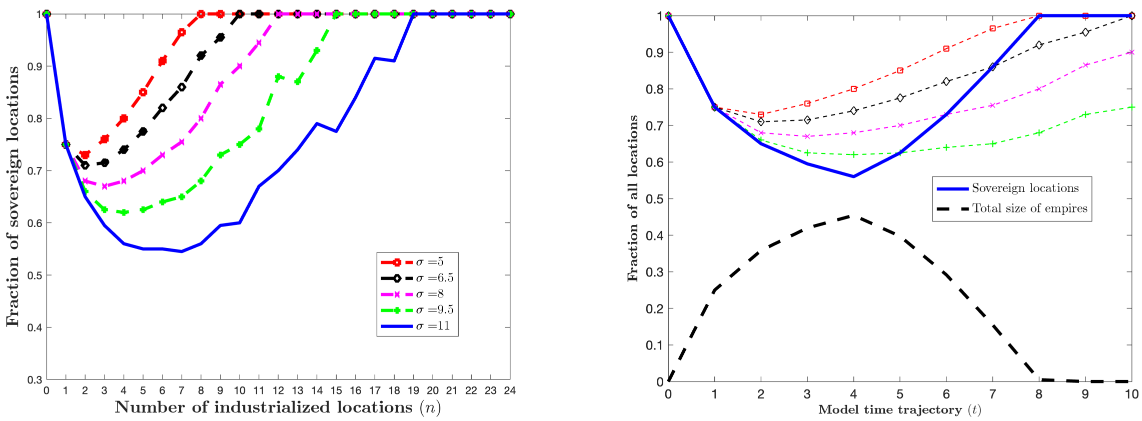
The left-hand side of Figure Va presents the fraction of independent locations N^*/N as a function of n from equation (20), along with level curves for various values of σ between 5 and 11. Note that for $n = 1$, the number of countries is invariant to σ because E^* is independent of it—see equation (21). Intuitively, if there is only one variety, the elasticity of substitution between varieties is inconsequential for gains from trade. For a fixed $n > 1$, however, a lower σ implies more sovereign polities. Most importantly, holding any value of σ constant, the number of independent entities N^* displays a global U-shaped pattern with some local non-monotonicity due to the integer constraints.[26] Reiterating from Section V, the comparative statics of the number of independent locations with respect to n is governed by two counteracting forces. On the one hand, the equilibrium number of countries shrinks as more empires are formed with increasing n. On the other, the value of empires—and thus their size $\underline{E}^*$—decreases, increasing the number of countries. The first force is stronger for low values of n since large empires are formed at this stage. In contrast, the second force dominates as more locations have industrialised, since at this stage the reduction in size involves the largest number of empires. Driven by these two forces, N^* displays an approximate U-shape as n increases from 0 to N.

Our main goal in this subsection is to show how the historical evolution of the two exogenous forces in our model, diffusion of industrialisation and increased product differentiation, combine to rationalize the empirical patterns showcased in the sub-panels of Figure II. We do so in the right-hand side of Figure Vb, which plots the trajectory of N^*/N when both n and σ may vary progressively. We thus consider its horizontal axis

[26] Note that in our parameterization, we set parameter values such that optimal empire size E^* drops to 0 when $n/N = 0.1$ (which corresponds to $n = 20$) for $\sigma = 11$, with the level curve of the latter represented by the blue line in Figure Va. However, since E^* drops below 1 for $n \geq 19$, and we allow parts of locations to be independent, N^* reaches its maximum value of N at $n \geq 19$.

Figure V: **Numerical Comparative Statics of Independent Locations**

(a) with respect to n (b) with respect to $n(t)$ and $\sigma(t)$

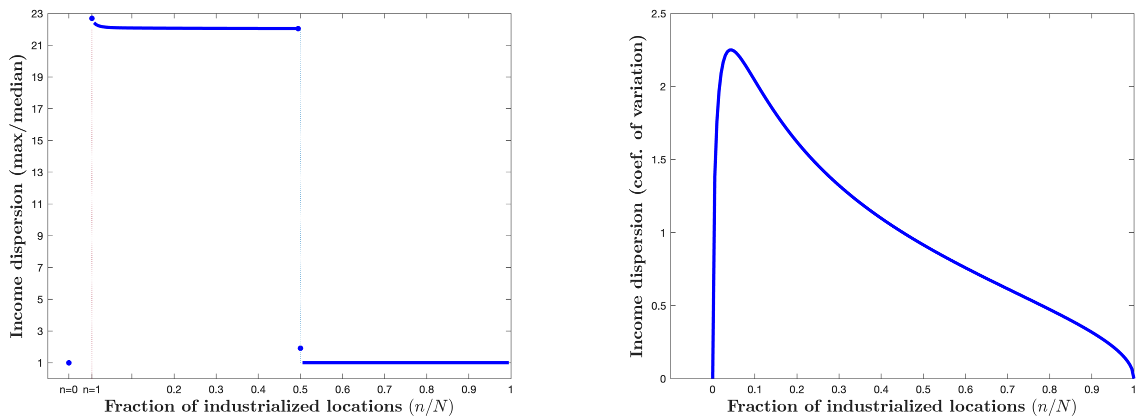


representing sub-periods of the era since 1830 when these discrete industrial diffusion and increased differentiation events happened. To better convey the connection with the left-hand side Figure Va, the dashed U-shaped lines correspond to the same color-coded lines with different σ levels. For them, the horizontal axis is simply the number of industrial locations n. For $n \leq 4$, the solid blue line corresponds to the one with the same color in the left panel, that is we let industrialisation to diffuse initially, keeping $\sigma = 11$ at its baseline level. Up until that point, the horizontal axis coincides with n. After that, each unit increase in n is contemporaneous with a corresponding decrease in σ so as to make the solid blue line move across the dashed level curves. For example, when the horizontal axis equals $t = 5$, we let $n = 5$ and $\sigma = 9.5$. The inverse U-shaped dashed black line plots nE^*/N, the total size of empires relative to the scale parameter. The fact that both the increase in n and the decrease in σ happen contemporaneously speeds up its decline (the decreasing segment of the dashed black line). As a result, when there are eight industrialised locations and the elasticity of substitution reaches its lower bound of $\sigma = 5$, empires shrink to size less than one so that there are N sovereign entities again.

During this process, each emergent empire monotonically shrinks, following the comparative statics of size with respect to n and σ in Appendix Figure B.9. This may strike the reader as ahistorical given that the separate trajectories of modern empires themselves tend to display an inverse-U shape (Appendix Figure B.3). While not central to our story, this empirical pattern could be captured by introducing dynamics to the model in the form of capital deepening during the transition path to the steady state, or further manufacturing TFP increases after industrialisation.

Figure VI: **Numerical Comparative Statics of Global Income Dispersion**

(a) with respect to n (b) with respect to n



Simulating Fact 2: Global income dispersion

To see how the distribution of global incomes evolves with industrial diffusion and increased product differentiation, we use the after-tax real incomes of the three type of locations: independent agricultural locations (eq.3), metropoles of empires (eq.19) and their colonies (eq.9). To do so, we need to parameterize the productivity parameter α and cost of rebellion parameter μ. Given (β, N, τ) and the baseline $\sigma = 11$, the right hand side of the imperfect specialisation condition (Assumption 2) equals 21.97. We let $\alpha = 22$ and make two remarks about the magnitude of this parameter. First, a high sectoral TFP gap between industrialised countries and the agricultural periphery in early to mid-19th century is realistic. In the Maddison data (Bolt and van Zanden, 2020), the ratio of the highest to lowest income in 1865 is about 18. Since the poorest countries of the era are underrepresented in the Maddison data, this is likely to be a lower bound for the actual gap between the frontier and locations living on subsistence agriculture. Even today, after decades of technology diffusion, calibrated TFP gaps to rationalize per capita income differences are in this order of magnitude (Klenow and Rodriguez-Clare, 1997). Second, Assumption 2 is derived for symmetric locations with equal populations. The case of $n = 2$ and $N = 200$ implies a world population share of 1% in the metropoles of the first two empires in the model. In reality, the world population share of the first two industrial imperial powers, England and France, was consistently about 5% throughout the 19th century (Joerg et al., 2014). Accounting for this would have made them even more capable in satisfying the demand for industrial goods from the rest of world without perfectly specialising in manufacturing, therefore relaxing the minimum bound on α under the sufficient condition of Assumption 2.

To calibrate the cost of rebellion parameter μ, we use the equilibrium tax given in expression (12). As an empirical counterpart to this extractive tax rate, we take the calculation by Tadei (2020) who estimates the ad-valorem cost equivalent of monopsonist trade practices and labor coercion in French Africa between 1898-1959 as 2% of local GDP. Taking $n = 7$ for the time period (corresponding to the number of industrial empires plotted in Figure II) we solve for $\mu = 0.0087$ from equation (12) at the given parameter values.

Calculating incomes from the fully parameterised model, we plot two measures of income dispersion in Figures VIa-VIb as they vary with the number of industrialised locations n: the highest-to-median income ratio (left panel) and the coefficient of variation (right panel). Both statistics capture the inverse U-shaped pattern displayed by their empirical counterparts in Figure IIIa-IIIb and Appendix Figure B.6a.

Simulating Fact 3: Patterns of trade

In Figure IV above, we presented evidence from UK data on the long-run secular rise of its intra-industry trade in manufacturing and the secular decline of its import share of primary products. Our model is compatible with both of these trends. To demonstrate this, we calculate the GL index for an industrialised empire at any level of n using equation (15) in expression (7), and plot it in Figure VIIa with level curves for various values of σ.

Evidently, as n increases, the GL index for intra-industry trade increases monotonically. Such a pattern is reinforced by a simultaneous decrease in σ, as shown by the fact that the trajectory of the GL index is higher, the lower is σ. In Figure VIIb, we plot the implied import share of primary goods for an empire. To be precise, this corresponds to $1/(1 + X^i_{NN/NS})$ where $X^i_{NN/NS}$ is given by equation (16). Consistent with its empirical counterpart, the simulated share of primary goods imports decreases as industrialisation diffuses. In Appendix Figure B.10, we plot the comparative statics of the GL index and primary import share with respect to σ, confirming the patterns described above.

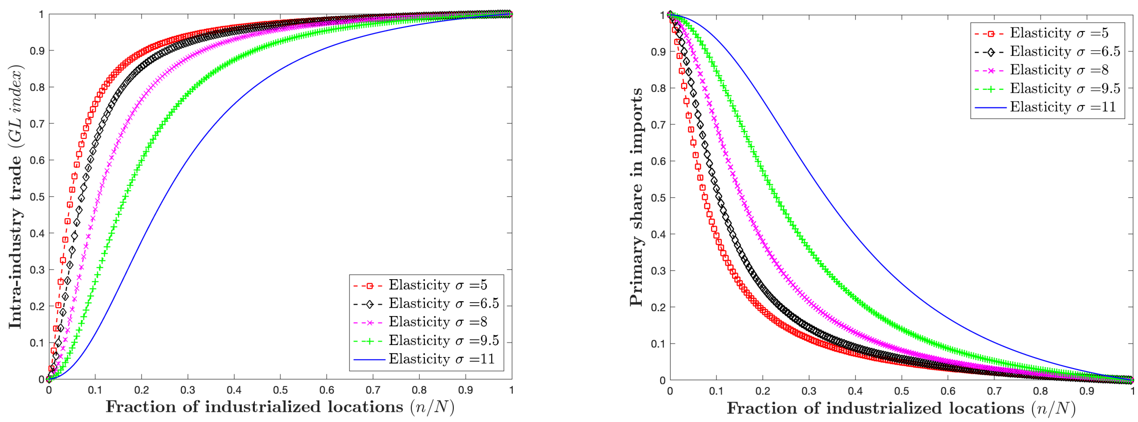
VII Conclusion

We conclude with a discussion of how to interpret the model in light of the historically relevant factors that we abstracted from in the baseline.

This paper focuses on international trade, but one can imagine a similar story for international investment. If empires reduce the cost of foreign direct investment and lending, then the emergence of industrialisation will increase the value of empires as it increases the value of investing in the agricultural periphery. Frieden (1994) argues that investments in resource-based primary production for exports were more likely to take place within empires which enforced property rights against appropriation. The diffusion of industrialisation,

Figure VII: **Numerical Comparative Statics of Trade Patterns**

(a) with respect to n (b) with respect to n



however, will generate new manufacturing investment opportunities in emerging centers, hence reducing the value of empire.

Our framework abstracts from the role of geography and the physical environment in determining the equilibrium size of empires. A related literature demonstrates theoretically, empirically and quantitatively how certain geographical features affect the shape and size of sovereign states. Bates (1983) and Fenske (2014) emphasize the role of ecological diversity on state formation, where a state is needed to fully realise the gains from trade generated by such diversity. Kitamura and Lagerlof (2020) show that geographical features such as mountains, rivers and coastlines have played a key role in shaping the borders between sovereign states. Through simulations, Fernández-Villaverde et al. (2023) demonstrate that topographical differences between Europe's ragged coastline and China's landmass are sufficient to explain historical political fragmentation in the former and centralised unification in the latter. Allen (2023) characterizes the existence, uniqueness, and efficiency of equilibrium borders given the locations of political capitals. We note that all these contributions emphasize the role of geography in the emergence of *contiguous* states. Our choice to abstract from geography not only ensures tractability, but is also supported by the observation that, unlike contiguous nation states, colonial empires were mostly overseas and were thus able to overcome geographical hurdles such as distance.

While our model features rent extraction through coercion—a key factor in the emergence of empires old or new—it abstracts from the role of improving political and/or military technology in the periphery. The populations under imperial control were by no means equally restive during the colonisation period. Instead, they became more assertive over time, increasingly campaigning for concessions and/or independence, and eventually negotiating decolonisation with the metropoles. Our model focuses on the economic forces which led to this change, leading to the fall in equilibrium rent extraction, which eventually made empires unprofitable for the imperial powers. Although this trajectory may have been in part explained by a diffusion of political and military technologies from the imperial powers to the periphery–a decrease in μ in our model–we deliberately abstracted from this, to demonstrate that the political evolution which led to decolonisation were also grounded in the fundamental economic changes at play in that period.

In the baseline model, the combined assumptions of imperfect specialisation and a spacious world shut off potential negative terms-of-trade externalities that an expanding industrial center would inflict on others. If a combination of these assumptions was relaxed, then enlarging one's empire would improve an industrial center's terms of trade—vs its colonies, and/or vs the other imperial powers—at the expense of the others. An additional source of interaction between the industrial centers would derive from strategic trade policy. We assumed that industrial centers neither engage in trade wars with each other, nor strategically raise trade barriers to discriminate against other industrial countries in accessing their colonial markets. While this is clearly a simplification, it is important to point out that it is not wholly insensible for much of the period that we are looking at. Average import duties were no higher in 1928 than they were in 1865—see Figures 1 and 2 in Clemens and Williamson (2004), reporting tariff levels for a panel of 26 independent countries and 9 colonies, and our Appendix Figure B.8. Several empires—most notably the British, but also the Dutch and German—maintained an "open door," non-discriminatory trade policy until the 1920s (see Mitchener and Weidenmier 2008, Table 3). In the French empire, the most important colonies were in a customs union with the metropole, which meant that they had the same, rather low tariffs adopted by France until the Great Depression (see Appendix Figure B.8). Even in the 1930s, many African colonies maintained an open door policy, in force of a 1885 Berlin Conference agreement on maintaining free trade in a vast swathe of Central Africa known as the Conventional Basin of the Congo, and free navigation in the Niger and Congo rivers.

Nevertheless, the strategic interactions described in the previous paragraph were clearly at play in the real world, particularly if one takes into account that *expectations* about future access to markets and trade routes may also have played a role in driving imperial expansion (Copeland, 1996). Future model extensions may thus want to incorporate them, perhaps by also allowing for the possibility of conflict between the imperial powers. What is important, for the purposes of the current paper, is that it is reasonable to conjecture that a model enriched in that direction would generate similar comparative statics to the ones we presented above. The intuition is that as bilateral trade flows between the colonies and the imperial powers become less important relative to the multilateral trade of both parties, institutions designed to magnify only the former flows—or to protect them from the imperial expansion of others—ought to become less valuable as a share of GDP, independently on whether or not they generate negative externalities.

When we turn to the newly independent developing countries, we see highly protectionist trade policies in the post-imperial second half of the 20*th* century. The reader may naturally wonder how to reconcile this fact with the mechanism in the model according to which rising trade opportunities with other industrial countries incentivise agricultural locations to break free. The answer lies in the fact that these post-colonial tariffs—motivated by import-substituting industrialisation policies—were typically non-discriminatory and uniformly high against all source countries, rather than being discriminatory towards any trade partner, including the past metropoles.

Finally, the increasing political and economic involvement of China in developing countries in recent years, most notably in Africa, has been interpreted as the formation of a sphere of influence seeking to secure primary products, and to deepen economic and political links—see Kumar (2022) for a discussion of the "Belt and Road Initiative" in the context of Chinese imperial history. Coupled with the ongoing paralysis of the multilateral trade system, these developments suggest that the framework and the mechanisms laid out in this paper may not only be relevant for the past but also for the present.

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ONLINE APPENDIX

A Theory Appendix

A.1 Technology Choice

The environment can be reformulated in the following manner. Utility is linear in the consumption of a non-tradable composite good Q, which can be produced in all locations using the primary input z and the manufactured input X in a Cobb-Douglas fashion:

$$Q = z^{1-\beta} X^{\beta},$$

where $\beta \in (0, 1)$. The primary input is the numeraire.

Before the industrial revolution ($n = 0$), the manufactured input X consists of a homogeneous, traditional manufactured input x_T (i.e. $X = x_T$), which can be produced everywhere and traded at the costs described in Section III. Technologies are the same everywhere, and are equal to

$$z = L_z \quad \text{and} \quad x_T = \alpha_T L_x, \tag{22}$$

where $\alpha_T < 1$. In equilibrium, the producer price of x_T is $1/\alpha^T$ everywhere. Thus, since x_T is homogeneous, all locations are autarkic.

With the industrial revolution ($n > 0$), two changes occur. First, in all locations, the manufactured input X can now be produced using technology

$$X = \Big(\sum_{i=1}^{n} x_i^{\frac{\sigma-1}{\sigma}}\Big)^{\frac{\sigma}{\sigma-1}} + x_T,$$

where differentiated varieties x_i produced by n industrial locations (on which more below) are bundled with an elasticity of substitution $\sigma > 1$. This bundle is perfectly substitutable with the traditional input x_T.

Second, in addition to the traditional technologies in (22), n locations now also have access to the modern technologies

$$z = \alpha L_z \quad \text{and} \quad x = \alpha L_x, \tag{23}$$

where x is production of the domestic variety and $\alpha > 1$. Featuring a higher TFP $\alpha > \alpha_T$, the modern technologies in (23) replace the traditional ones in the n locations who have access to them. Such locations thus become "industrial."

While the $N - n$ locations who do not have access to the technologies in (23) could still produce X using the traditional technologies in (22), we assume that $\alpha_T < 1$ is low enough to make it attractive to import differentiated varieties from the industrial locations. Thus, these locations endogenously abandon traditional manufacturing, and instead specialize in the production of the primary input. We call these locations "agricultural" in our model. This result corresponds to the de-industrialisation result discussed in Section III.

More in detail, an independent location who does not have access to the technologies in (23) becomes agricultural if the price of the bundle of differentiated varieties is lower than the price of the traditional input x_T. This leads to condition

$$n^{\frac{1}{1-\sigma}} \delta\tau < \frac{1}{\alpha_T}.$$

We assume that this condition holds even when $n = 1$, i.e. when the industrial revolution has just started. Re-arranging the above yields

$$\alpha_T < \frac{1}{\delta\tau}. \tag{24}$$

Condition (24) is sufficient for all locations who do not have access to the technologies in (23) to become agricultural. This also applies to those who are part of an empire, since the price of the bundle of differentiated varieties is even lower for them. Under condition (24), which we assume, the framework described here is isomorphic to the model in Section III.

To capture the idea that some agricultural locations may make the technological switch while some others may not, one can introduce heterogeneity in trade costs due to geography. For example, remote locations with high enough trade costs (for which condition 24 would not be satisfied) would endogenously continue using the traditional technology and remain autarkic in the aftermath of the industrial revolution, while those with better market access would specialize in the primary commodity and start using the modern technology with imported inputs. Similarly, to capture the effect of empires on de-industrialisation, one can assume a higher $\alpha_T \in [1/(\delta\tau), 1/\tau)$, so that only when a location becomes part of an empire—thus trading at a lower cost—does it find it optimal to replace the traditional input x_T with imported varieties.

A.2 General Trade Costs

Let the cost of trading primary products and manufactures be, respectively, $\delta^{1-\phi}\tau^{1-\xi}$ and $\delta^{\phi}\tau^{\xi}$ (where $0 \leq \phi, \xi \leq 1$), decreasing to $\delta^{1-\phi}$ and δ^{ϕ} within empires. This model contains the baseline model as a special case ($\phi = \xi = 1$). We take as numeraire the price of z in a specific independent agricultural location, which we call the numeraire location.

If $\xi < 1$, empire formation now leads to the cost of trading in z being asymmetric: colonies find it cheaper to export it to their imperial power than to other industrial locations. We do not require balanced bilateral trade, which implies that the colonies are allowed to export to their imperial power more than they import from it, and use the trade surplus they so acquire to purchase manufactures from other industrial locations. Since transshipment is never optimal, however,[27] there must be a mechanism through which industrial locations

[27] To see this, note that for agricultural location i to transship z bound for industrial location k through its imperial power j costs $\delta^{2(1-\phi)}\tau^{1-\xi}$, as compared to only $\delta^{1-\phi}\tau^{1-\xi}$ for direct shipping.

clear their colonies' trade surpluses amongst themselves.[28] The limit to this is that no imperial power can import from its colonies more than its total import demand for z.[29]

We now need to find $N + n - 1$ equilibrium prices: the producer price of z in all $N - 1$ locations other than the numeraire location, and the producer price of all n varieties. Let p_i^z denote the producer price of z in location i, and p_j the producer price of variety j. We continue to assume that industrial locations are imperfectly specialised. That implies $p_j = p_j^z$. Moreover, since all locations produce z, we can refer to p_i^z as to the price of z in location i.

The following lemma provides a useful starting point:

Lemma 1. *For given empires, suppose that markets are in equilibrium. Let k index any independent agricultural location other than the numeraire location, and r, l and q index any industrial locations who, after taking extraction into account, import respectively a greater amount of z than exported by their own empire, the same amount of z as exported by their own empire, and a smaller amount of z than exported by their own empire (the first category including any industrial locations who do not have an empire). Then, prices must be as*

[28] Suppose we start from a situation in which bilateral trade is balanced. Keeping prices constant, if imperial power j increases its imports from colony i by Δ, it must reduce imports from some other agricultural location(s) q by the same amount. At the same time, some other industrial locations must decrease their imports from i by Δ, and increase their imports from q by Δ. Since consumption of varieties has not changed, i must now have a trade surplus of Δ vs j, and a trade deficit of Δ vs some other industrial locations. Symmetrically, q must have a trade deficit of Δ vs j, and a trade surplus of Δ vs some other industrial locations. Rather than j transferring i's trade surplus to the other industrial locations, and the other industrial locations transferring q's trade surplus to j, the two can clear these surpluses, so that no z is actually transshipped.

[29] If $\xi = 1$, that is if empires do not reduce the cost of trading in primary products, then unbalanced bilateral trade remains a theoretical possibility, but one without implications for the cost of trade as it isn't any cheaper for colonies to export z to their metropole, as compared to other industrial locations. If $\xi = \phi = 1$, that is if primary products are freely traded (as in our baseline model), then unbalanced bilateral trade does not even require a clearing mechanism to be in place, since z can be transshipped through the imperial power at zero cost.

follows:

$$\begin{aligned}
&p_k^z = 1 && \forall k \\
&p_{E_r}^z = \tau^{1-\xi} \quad p_r^z = \delta^{1-\phi}\tau^{1-\xi} && \forall r \\
&p_{E_l}^z \in [1, \tau^{1-\xi}] \quad p_l^z = \delta^{1-\phi} p_{E_l}^z && \forall l \\
&p_{E_q}^z = 1 \quad p_l^z = \delta^{1-\phi} && \forall q.
\end{aligned}$$

where $p_{E_j}^z$ *denote the (common) price of* z *in all colonies of industrial power* j*.*

Proof. Note first that all agricultural locations must export z and all industrial locations must import it, since the former all import varieties, and the latter all export varieties to agricultural locations. Then, all independent agricultural locations must have the same price, and so do all colonies who belong to the same empire, or else the location with the highest price within each group of locations would not be able to export. It immediately follows that $p_k^z = 1$ for any non-numeraire independent agricultural location k. Moreover, letting $p_{E_j}^z$ denote the common price of z in colonies of imperial power j, it must be $p_{E_j}^z \in [1, \tau^{1-\xi}]$ $\forall j$, or else either E_j would not be able to export (if $p_{E_j}^z > \tau^{1-\xi}$), or independent agricultural locations would not be able to export (if $p_{E_j}^z < 1$). It follows that, for any r who imports more than exported by E_r, it must be $p_{E_r}^z = \tau^{1-\xi}$ (or else r would only import from E_r), and for any q that imports less than exported by E_q, it must be $p_{E_q}^z = 1$ (or else E_q would only be able to export to q). Since the cheapest import price available to r (q) is $\delta^{1-\phi}\tau^{1-\xi}$ ($\delta^{1-\phi}$), it must be $p_r^z = \delta^{1-\phi}\tau^{1-\xi}$ ($p_q^z = \delta^{1-\phi}$). Finally, note that, for each $p_{E_l}^z \in [1, \tau^{1-\xi}]$, the cheapest import price available to l is $\delta^{1-\phi} p_{E_l}^z$: it must then be $p_l^z = \delta^{1-\phi} p_{E_l}^z$. □

Using backward induction, we now show that a symmetric equilibrium such as the one described in Proposition 1 also exists in this general model, and has qualitatively similar comparative statics.

We start from stage III. Suppose that, in stage I, symmetric empires of size E have formed, not extending to all agricultural locations (that is, $nE < N - n$). Since imperial powers are identical, they must all import more z then exported by their own empire, or else the independent agricultural locations would not be able to export. From Lemma 1, it follows that the price of z must be equal to one in all independent agricultural locations, to $\tau^{1-\xi}$ in all colonies, and to $\delta^{1-\phi}\tau^{1-\xi}$ in all industrial locations. Then, the price of industrial varieties is $\delta^{1-\phi}\tau^{1-\xi}$ in the industrial locations where they are produced, $\delta\tau^{1-\xi}$ in their colonies, and $\delta\tau$ elsewhere.

The real income of independent agricultural locations is thus as in the baseline model,

$$U_I = \frac{1}{P_I} = \frac{1}{[n(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}}.$$

The real income of colonies is instead

$$U_C = \frac{\tau^{1-\xi}}{P_C} = \frac{\tau^{1-\xi}}{\tau^{(1-\xi)(1-\beta)}\left[\left(\delta\tau^{1-\xi}\right)^{1-\sigma} + (n-1)\left(\delta\tau\right)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}} = \frac{1}{\left[\delta^{1-\sigma} + (n-1)\left(\delta\tau^{\xi}\right)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}}.$$

In period II, the equilibrium tax is found by equating post-tax real income within the empire, $U_C(1-t)$, to the colony's outside option, $U_I(1-\mu)$. Doing so and rearranging, the equilibrium tax can be written as

$$\begin{aligned} t^*(\mu, n, \sigma, \xi) = 1 - (1-\mu)\frac{U_I}{U_C} &= 1 - (1-\mu)\left(\frac{n\tau^{(1-\xi)(1-\sigma)}}{\tau^{\xi(\sigma-1)} + n - 1}\right)^{\frac{\beta}{\sigma-1}} \\ &= 1 - (1-\mu)\left(\frac{n}{\tau^{\xi(\sigma-1)} + n - 1}\right)^{\frac{\beta}{\sigma-1}} \frac{1}{\tau^{(1-\xi)\beta}}. \end{aligned} \quad (25)$$

The real income of industrial location i is

$$U_i = \frac{\left(\alpha + \frac{R_i}{\delta^{1-\phi}}\right)\delta^{1-\phi}\tau^{1-\xi}}{\left(\delta^{1-\phi}\tau^{1-\xi}\right)^{1-\beta}\left[\left(\delta^{1-\phi}\tau^{1-\xi}\right)^{1-\sigma} + (n-1)(\delta\tau)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}} = \frac{\alpha + \frac{R_i}{\delta^{1-\phi}}}{[1 + (n-1)(\delta^{\phi}\tau^{\xi})^{1-\sigma}]^{\frac{\beta}{1-\sigma}}},$$

where $R_i = t^*(\mu, n, \sigma, \xi)E_i - \int_0^{E_i} c(x)dx$ is extraction in terms of units of z extracted in the colonies. Extraction in terms of colonial income is then $\tau^{1-\xi}R_i$.

Moving back to stage I, we prove the following:

Proposition 3. *If the industrial locations simultaneously and non-cooperatively form empires to maximise their real incomes, then if ξ is large enough, there exists a Nash equilibrium in which they form empires if and only if $t^*(\mu,n,\sigma,\xi) > c(0)$, where $t^*(\mu,n,\sigma,\xi)$ is described in equation (25). In such a case, they form equally-sized empires of size*

$$\begin{aligned} E^*(\mu,n,\sigma,\xi) &= \arg_E\left[t^*(\mu,n,\sigma,\xi) = c(E)\right] \\ &= \arg_E\left[1-(1-\mu)\left(\frac{n}{\tau^{\xi(\sigma-1)}+n-1}\right)^{\frac{\beta}{\sigma-1}}\frac{1}{\tau^{(1-\xi)\beta}} = c(E)\right]. \end{aligned}$$

Proof. Let r index the imperial powers, and let M_r^z and M_{r,E_r}^z denote, respectively, imports of z by r, and the joint imports of z by r and its empire (in short, r's "extra-empire imports"). We can write

$$M_r^z = EXP_r^z - (INC_r - EXP_W^r) \tag{26}$$

$$M_{r,E_r}^z = M_r^z - X_{E_r}^z \tag{27}$$

where EXP_r^z is expenditure by r on z, INC_r is income by r (net of extraction), EXP_W^r is world expenditure on variety r, and $X_{E_r}^z$ is exports of z by E_r. Note that $INC_r - EXP_W^r$ is nominal production of z in r. Given symmetry, in the proposed equilibrium, it must be $M_{r,E_r}^z = \beta(N-n-nE^*)/n > 0\ \forall r$.

Suppose that imperial power j deviates from the proposed equilibrium, by selecting $E_j = E^* + \Delta E_j$ (where $\Delta E_j \gtrless 0$). Let Δ in front of a variable denote changes following j's deviation, and superscript $'$ denote the new value the variable. Moreover, let notation $-j$ identify variables referring to industrial locations other than j (which, by symmetry, must take the same value for all other industrial locations). The proof is articulated in two steps. In the first step, we show that, if ξ is large enough, then there exists $\overline{\Delta} \in (0, N-n-nE)$ such that, if $\Delta E_j \in [-E^*, \overline{\Delta}]$, then it is $\left(M_{j,E_j}^z\right)', \left(M_{-j,E_{-j}}^z\right)' > 0$, so that, by Lemma 1, prices do not change following j's deviation. If instead $\Delta E_j \in (\overline{\Delta}, N-n-nE^*)$, then it is $\left(M^z_{j,E_j}\right)' \leq 0 < \left(M^z_{-j,E_{-j}}\right)'$, so that, by Lemma 1, the only change which occurs to prices is $\Delta p^z_{E_j} < 0$ (and hence $\Delta p^z_j = \Delta p^z_{E_j}\delta^{1-\phi} < 0$). In the second step, we show that the proposed deviation does not increase j's real income.

First step. Suppose $\left(M^z_{j,E_j}\right)', \left(M^z_{-j,E_{-j}}\right)' > 0$, so that, by Lemma 1, prices do not change following j's deviation. Then, $\Delta U_I = \Delta U_C = \Delta\tau^* = 0$, which implies $\Delta R_j < 0$.[30] It is:

$$\Delta EXP^z_j = (1-\beta)\Delta R_j \tau^{1-\xi} \tag{28}$$

$$\Delta INC_j = 0 \tag{29}$$

$$\begin{aligned}\Delta EXP^j_W &= \beta\left\{\Delta R_j \tau^{1-\xi} s_{j,j} + (\Delta E_j - \Delta R_j)\tau^{1-\xi} s_{j,E_j} - \frac{\Delta E_j}{n}\right\} \\ &= \beta\left\{\Delta E_j\left(\tau^{1-\xi} s_{j,E_j} - \frac{1}{n}\right) + \Delta R_j \tau^{1-\xi}\left(s_{j,j} - s_{j,E_j}\right)\right\}\end{aligned} \tag{30}$$

$$\Delta X^z_{E_j} = \beta\Delta E_j \tau^{1-\xi} + (1-\beta)\Delta R_j \tau^{1-\xi}, \tag{31}$$

where $s_{j,j}$ and s_{j,E_j} denote the expenditure shares of variety j, respectively in j and E_j. Note that, due to the fact that prices not changing, expenditure shares do not change following j's deviation. From (26) and (27), it follows that $\Delta M^z_{j,E_j} = \Delta EXP^z_j - (\Delta INC_j - \Delta EXP^j_W) - \Delta X^z_{E_j}$. Substituting (29-31) into such an equation, we obtain

$$\Delta M^z_{j,E_j} = \beta\left\{-\Delta E_j \Gamma(\xi) + \Delta R_j \tau^{1-\xi}\left(s_{j,j} - s_{j,E_j}\right)\right\}, \tag{32}$$

where

$$\Gamma(\xi) \equiv \left[\tau^{1-\xi} - \left(\tau^{1-\xi} s_{j,E_j} - \frac{1}{n}\right)\right] = \left[\tau^{1-\xi} - \frac{\tau^{1-\xi}}{1+(n-1)\tau^{\xi(1-\sigma)}} + \frac{1}{n}\right]. \tag{33}$$

It is easy to see that $\Gamma(\xi)$ is decreasing in ξ. Moreover, there exists $\hat{\xi} \in (0,1)$ such that, if $\xi \in [0,\hat{\xi})$, it is $\Gamma(\xi) > 1$, and for $\xi \in [\hat{\xi}, 1]$, it is $\Gamma(\xi) \in \left(\frac{1}{n}, 1\right]$.

[30] In contrast, $\Delta R_{-j} = 0$.

Since $\Gamma(\xi) > 0$, an expansion in j's empire ($\Delta E_j > 0$) always corresponds to a decline in j's extra-empire imports. To gain intuition, note that, in the limit case $\Delta R_j = 0$ (which is relevant for $c(.)$ close enough to $t(\mu, n, \sigma, \xi)$), j's extra-empire imports drop by a factor $\tau^{1-\xi}$ for every colony added, corresponding to the additional exports of z by the empire. Since only a factor $\tau^{1-\xi} s_{j,E_j} - \frac{1}{n}$ of these new exports replace z which was initially produced in j (and whose production is now abandoned, to allow for increased production of manufactures), this must result in a decline in j's extra-empire imports.

Since $M^z_{j,E_j} = \beta(N - n - nE^*)/n$, a necessary and sufficient condition for $\left(M^z_{j,E_j}\right)' > 0$ is $\Delta M^z_{j,E_j} > -\beta(N - n - nE^*)/n$. Using (32), such a condition can be written as

$$\Delta E_j < \frac{1}{\Gamma(\xi)} \frac{N - n - nE^*}{n} + \Delta R_j \left(\frac{s_{j,j} - s_{j,E_j}}{1 - s_{j,E_j} + \frac{1}{n\tau^{1-\xi}}} \right). \tag{34}$$

For $\Delta E_j < 0$, (34) always holds, given that $\Delta E_j < \Delta R_j$[31], and that ΔR_j multiplies a term that is less than one. For $\Delta E_j \geq 0$, the right-hand side of (34) is decreasing in ΔE_j. Moreover, the condition holds for $\Delta E_j = 0$, but not for $\Delta E_j = N - n - nE^*$. Then, there exists $\overline{\Delta} \in (0, N - n - nE^*)$ such that, if $\Delta E_j \in [-E^*, \overline{\Delta})$, it is $\left(M^z_{j,E_j}\right)' > 0$, and if $\Delta E_j \in [\overline{\Delta}, N - n - nE^*)$ it is instead $\left(M^z_{j,E_j}\right)' \leq 0$.

Next, consider $\left(M^z_{-j,E_{-j}}\right)'$. Since $M^z_{-j,E_{-j}} = \beta(N - n - nE^*)/n$, a necessary and sufficient condition for $\left(M^z_{-j,E_{-j}}\right)' > 0$ is $\Delta M^z_{-j,E_{-j}} > -\beta(N - n - nE^*)/n$. Market clearing requires

$$\begin{aligned} \Delta M^z_{j,E_j} + (n-1)\Delta M^z_{-j,E-j} &= -\beta \Delta E_j \\ \Delta M^z_{-j,E_{-j}} &= -\frac{\beta \Delta E_j + \Delta M^z_{j,E_j}}{n-1}. \end{aligned} \tag{35}$$

In words, the sum of extra-empire imports of the imperial powers must change by as much

[31] In turn, this follows from the fact that $\Delta R_j = -\int_{E^*+\Delta E_j}^{E^*} [t^* - c(x)]dx > -\int_{E^*+\Delta E_j}^{E^*} [1 - 0]dx = \Delta E_j$.

as the exports of independent agricultural locations. Using (32), we can write

$$\frac{-\beta\Delta E_j + \beta\left[\Delta E_j\Gamma(\xi) - \Delta R_j\tau^{1-\xi}\left(s_{j,j} - s_{j,E_j}\right)\right]}{n-1} \quad > \quad -\beta\frac{(N-n-nE^*)}{n} \tag{36}$$

Since $\Delta R_j < 0$, a sufficient condition for (36) is

$$-\frac{\Delta E_j\left[1-\Gamma(\xi)\right]}{n-1} \quad > \quad -\frac{(N-n-nE^*)}{n},$$

or

$$\Delta E_j\left[1-\Gamma(\xi)\right] \quad < \quad \frac{(n-1)(N-n-nE^*)}{n}. \tag{37}$$

An expansion in j's empire (ΔE_j) corresponds to a decline in $-j$'s extra-empire imports if and only if $\Gamma(\xi) < 1$, that is if and only if the decrease in j's extra-empire imports less than offsets the decrease in exports of independent agricultural locations. Condition $\Gamma(\xi) < 1$, or equivalently $\xi \in \left(\hat{\xi}, 1\right]$, is also sufficient for (37) to hold, since the latter condition can then be re-written as

$$\Delta E_j \quad < \quad \frac{(n-1)(N-n-nE^*)}{n - n\tau^{1-\xi}(1-s_{j,E_j}) - 1}$$

which holds for any $\Delta E_j \in [-E^*, N-n-nE^*]$.

In summary, we have shown that, if $\xi \in \left(\hat{\xi}, 1\right]$, then for $\Delta E_j \in [-E^*, \overline{\Delta}]$, it is indeed true that $\left(M^z_{j,E_j}\right)', \left(M^z_{-j,E_{-j}}\right)' > 0$, so that, by Lemma 1, prices do not change following j's deviation.

For $\Delta E_j \in (\overline{\Delta}, N-n-nE^*)$, since there are still some independent agricultural locations, it must be either $\left(M^z_{j,E_j}\right)' \leq 0 < \left(M^z_{-j,E_{-j}}\right)'$, or $\left(M^z_{-j,E_{-j}}\right)' \leq 0 < \left(M^z_{j,E_j}\right)'$. Since for $\Delta E_j = \overline{\Delta}$ it is $\left(M^z_{j,E_j}\right)' = 0 < \left(M^z_{-j,E_{-j}}\right)'$, however, by continuity, it must be $\left(M^z_{j,E_j}\right)' \leq 0 < \left(M^z_{-j,E_{-j}}\right)'$ for $\Delta E_j \in (\overline{\Delta}, N-n-nE^*)$. By Lemma 1, it then follows that the only change which occurs to prices in this range of deviations is $\Delta p^z_{E_j} < 0$ (and hence $\Delta p^z_j = \Delta p^z_{E_j}\delta^{1-\phi} < 0$)

Second step. j's real income can be written as

$$\frac{\left(\alpha + \frac{R_j}{\delta^{1-\phi}}\right) p^z_{E_j}\delta^{1-\phi}}{(p^z_{E_j}\delta^{1-\phi})^{1-\beta}\left[(p^z_{E_j}\delta^{1-\phi})^{1-\sigma} + (n-1)(\delta^{\phi}\tau^{\xi})^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}},$$

which is increasing in $p^z_{E_j}$. Since $\left(p^z_{E_j}\right)' \leq p^z_{E_j}$, to show that j has no profitable deviation, it is enough to show that $(R_j)' < R_j$. To do that, note that the equilibrium tax can be written as

$$t_j(p^z_{E_j}) = 1-(1-\mu)\frac{U_I}{U_C} = 1-(1-\mu)\frac{\frac{1}{\left[(p^z_{E_j}\delta\tau^{\xi})^{1-\sigma}+(n-1)(\delta\tau)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}}}{\frac{p^z_{E_j}}{(p^z_{E_j})^{1-\beta}\left[(p^z_{E_j}\delta)^{1-\sigma}+(n-1)(\delta\tau)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}}}$$

$$= 1-(1-\mu)\left(\frac{\delta^{1-\sigma}+(n-1)\left(\frac{\delta\tau}{p^z_{E_j}}\right)^{1-\sigma}}{(p^z_{E_j}\delta\tau^{\xi})^{1-\sigma}+(n-1)(\delta\tau)^{1-\sigma}}\right)^{\frac{\beta}{1-\sigma}},$$

which is increasing in $p^z_{E_j}$. Extraction is then

$$R_j = t_j(p^z_{E_j})(E^* + \Delta E_j) - \int_0^{E^*+\Delta E_j} c(x)dx.$$

For $\Delta E_j \in [-E^*, \overline{\Delta}]$, it is $t_j(p^z_{E_j}) = t^*(\mu, n, \sigma, \xi)$. Then, $(R_j)' < R_j$ follows by definition of E^*. For $\Delta E_j \in (\overline{\Delta}, N-n-nE^*)$, $t_j(p^z_{E_j}) < t^*(\mu, n, \sigma, \xi)$. Again, $(R_j)' < R_j$ follows by definition of E^*. □

We have thus shown that, in this general model, if ξ is large enough, there still exists an equilibrium with symmetric empires, and these have size $E^*(\mu, n, \sigma, \xi)$. Note that $E^*(\mu, n, \sigma, \xi)$ has the same comparative statics as $t^*(\mu, n, \sigma, \xi)$, following equation (25):

$$t^*(\mu, n, \sigma, \xi) \;=\; 1 - (1-\mu)\left(\frac{n}{\tau^{\xi(\sigma-1)} + n - 1}\right)^{\frac{\beta}{\sigma-1}} \frac{1}{\tau^{(1-\xi)\beta}}$$

The term in parenthesis depends on n and σ in the same way for any $\xi \in (0,1]$, while it does not depend on them for $\xi = 0$. The term $1/\tau^{(1-\xi)\beta}$ does not depend on n and σ. Thus, the comparative statics of empire formation (and hence of the number of countries) is qualitatively the same in the general model as in the baseline case, provided $\xi \in (0,1]$ (the case considered in the baseline being $\xi = 1$). Such comparative statics is instead different if $\xi = 0$. In this case, empires only reduce the cost of exporting z, and their attractiveness does not depend on the number nor differentiation of varieties of manufactures.

A.3 Alternative Taxation Tool

Suppose that the income tax t is replaced by the following arrangement. In order to export, colonial producers within each empire must sell z to a monopsonist buyer from the imperial power, such as a cartel of private companies, or a marketing board. In contrast, amongst the imperial power, z continues to be traded freely, and competitively. Let the price of z in the imperial powers be the numeraire. The monopsonist from imperial power i makes a take-it-or-leave-it offer to producers in each colony j, whereby it offers to buy any amount of z at a price $1 - t_{ij}^e$, where $t_{ij}^e \in [0,1]$. It then uses the revenues thus generated to pay for the cost of administering the colony, and brings whatever is left back home.[32]

Let p_{ij} be the price of z in colony j. Given that the colony's production of z is equal to one, and its demand is equal to $[(1-\beta)p_{ij}]/p_{ij} = 1 - \beta$, the colony's export supply is perfectly inelastic and equal to β. Then, it must be $p_{ij} = 1 - t_{ij}^e$ in equilibrium.

Since the empire's export supply is perfectly inelastic, the monopsonist would ideally like to set $t_{ij}^e = 1$. It is, however, constrained by the colony's capacity to rebel. Post-tax real

[32] Equivalently, we could assume that the imperial power imposes an export tax t_{ij}^e on the colony.

income in the colony is now

$$\frac{1-t_{ij}^e}{(1-t_{ij}^e)^\beta[\delta^{1-\sigma}+(n-1(\delta\tau)^{1-\sigma})]^{\frac{\beta}{1-\sigma}}}=U_C(1-t_{ij}^e)^{1-\beta}.$$

The optimal tax is found by solving $U_C(1-t_{ij}^e)^{1-\beta}=U_I(1-\mu)$, and is equal to

$$\begin{aligned} t_{ij}^e=(t^e)^* &= 1-\left[(1-\mu)\frac{U_I}{U_C}\right]^{\frac{1}{1-\beta}} \\ &= 1-\left[(1-\mu)\left(\frac{n}{\tau^{\sigma-1}+n-1}\right)^{\frac{\beta}{\sigma-1}}\right]^{\frac{1}{1-\beta}}. \end{aligned}$$

The real income of industrial location i is

$$U_i = \frac{\alpha+R_i}{[1+(n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}},$$

where

$$R_i=(t^e)^*\beta E_i-\int_0^{E_i}c(x)dx$$

is the net revenues of the monopsonist from industrial location i, who appropriates $(t^e)^*\beta E_i$ units of z from producers, and uses $\int_0^E c(x)dx$ of them to pay for the administrative cost of empire. Since the comparative statics of R_i is qualitatively the same in this model as in the baseline model, results are also qualitatively unchanged.

A.4 Condition for Imperfect Specialisation

Aggregate demand for variety i at the location of production (inclusive of iceberg trade costs) is

$$\beta\left(\frac{\alpha+R_i+[(n-1)\alpha+R_{-i}](\delta\tau)^{1-\sigma}}{1+(n-1)(\delta\tau)^{1-\sigma}}+\frac{E_i-R_i+(E_{-i}-R_{-i})\tau^{1-\sigma}}{1+(n-1)\,\tau^{1-\sigma}}+\frac{N-n-E_i-E_{-i}}{n}\right), \tag{38}$$

where R_i is extraction in empire i (see Section IV.C) and $R_{-i} = \sum_{j \neq i} R_j$. Since (38) is increasing in E_i and R_i, and decreasing in E_{-i} and R_{-i}, to find the maximum possible demand for variety i, we first set the former (latter) two variables at their maximum (minimum) possible value, that is $E_i = R_i = N - n$ ($E_{-i} = R_{-i} = 0$). Aggregate demand for variety i thus becomes

$$\beta \left(\frac{\alpha + N - n + (n-1)\alpha(\delta\tau)^{1-\sigma}}{1 + (n-1)(\delta\tau)^{1-\sigma}} \right). \tag{39}$$

Since (39) is decreasing in n, to find the maximum possible demand for variety i given $n > 1$, we set $n = 2$. Aggregate demand for variety i becomes

$$\beta \left(\frac{\alpha + N - 2 + \alpha(\delta\tau)^{1-\sigma}}{1 + (\delta\tau)^{1-\sigma}} \right) = \beta \left(\alpha + \frac{N-2}{1 + (\delta\tau)^{1-\sigma}} \right).$$

A sufficient condition for industrial location i to be imperfectly specialised is that perfect specialisation in the industrial good (i.e., an output of α) results in excess supply, even when aggregate demand for variety i is the maximum possible:

$$\beta \left(\alpha + \frac{N-2}{1 + (\delta\tau)^{1-\sigma}} \right) < \alpha,$$
$$\frac{\beta}{1-\beta} \frac{N-2}{1 + (\delta\tau)^{1-\sigma}} < \alpha.$$

The last inequality coincides with Assumption 2.

By definition, imperfect specialisation means that the labor share in manufacturing (equation 8) is less than one. Since equation (8) is decreasing in n, it suffices to show that it is less than one for $n = 2$:

$$\beta \left(1 + \frac{N-2}{2\alpha} \right) < 1.$$

Starting with the sufficient condition derived above,

$$\begin{aligned}
\frac{\beta}{1-\beta}\cdot\frac{N-2}{1+(\delta\tau)^{1-\sigma}} &< \alpha \\
\beta\frac{N-2}{\alpha} &< (1-\beta)[1+(\delta\tau)^{1-\sigma}], \\
\beta\frac{N-2}{\alpha} &< 1+(1-\beta)(\delta\tau)^{1-\sigma}-\beta, \\
\beta\frac{N-2}{2\alpha} &< \frac{1}{2}+\frac{1-\beta}{2(\delta\tau)^{\sigma-1}}-\frac{\beta}{2}, \\
\beta\left(1+\frac{N-2}{2\alpha}\right) &< \frac{1}{2}+\frac{1-\beta}{2(\delta\tau)^{\sigma-1}}+\frac{\beta}{2}.
\end{aligned}$$

We need to show that the RHS is less than or equal than one:

$$\begin{aligned}
\frac{1}{2}+\frac{1-\beta}{2(\delta\tau)^{\sigma-1}}+\frac{\beta}{2} &\leq 1, \\
1+\frac{1-\beta}{(\delta\tau)^{\sigma-1}}+\beta &\leq 2, \\
\frac{1-\beta}{(\delta\tau)^{\sigma-1}}+\beta &\leq 1, \\
\frac{1-\beta}{(\delta\tau)^{\sigma-1}} &\leq 1-\beta, \\
1 &\leq (\delta\tau)^{\sigma-1},
\end{aligned}$$

which is the case since iceberg trade costs satisfy $\delta > 1$ and $\tau > 1$, and the elasticity of substitution satisfies $\sigma > 1$.

A.5 Proof that the Equilibrium Tax is Increasing in σ for $n > 1$

The equilibrium tax calculated in (12) is increasing in $[(\tau^{\sigma-1}-1+n)/n]^{\frac{\beta}{\sigma-1}}$, or equivalently $\beta/(\sigma-1)\log[(\tau^{\sigma-1}-1+n)/n]$. We show that this is increasing in σ. A sufficient condition for this is that the first derivative of the latter with respect to σ be greater than zero, or

$$-\frac{\beta}{(\sigma-1)^2}\left[\log\left(\tau^{\sigma-1}+n-1\right)-\log(n)\right]+\frac{\beta}{\sigma-1}\frac{\tau^{\sigma-1}\log\tau}{\tau^{\sigma-1}+n-1}>0$$

$$-\left[\log\left(\tau^{\sigma-1}+n-1\right)-\log(n)\right]+\frac{\tau^{\sigma-1}\log\tau^{\sigma-1}}{\tau^{\sigma-1}+n-1}>0 \tag{40}$$

But condition (40) holds for any $\sigma > 1$. To see this, note that, for $\sigma = 1$, it is $\tau^{\sigma-1} = 1$, and the left-hand size is equal to zero. At the same time, for $\sigma > 1$, $\tau^{\sigma-1}$ is increasing in σ, and the left-hand side is increasing in $\tau^{\sigma-1}$. A sufficient condition for the latter is, using the simplified notation $a \equiv \tau^{\sigma-1}$,

$$\begin{aligned}\frac{d\left[-\log(a+n-1)+\frac{a\log a}{a+n-1}\right]}{da} &= -\frac{1}{a+n-1}+\frac{(\log a+1)(a+n-1)-a\log a}{(a+n-1)^2}\\ &= \frac{\log a\,(a+n-1)-a\log a}{(a+n-1)^2}\\ &= \frac{\log a\,(n-1)}{(a+n-1)^2}>0\end{aligned}$$

which is true given $n > 1$ and $a > 1$. □

A.6 Constrained utilitarian Social Planner

We consider a Social Planner (SP) who solves the following problem:

$$\max_{t_I^P,t_{E_i}^P(x),t_i^P,E_i} W \tag{41}$$

$$\text{s.t.}\quad E_i \geq 0 \tag{42}$$

$$t_I^P \leq 0 \tag{43}$$

$$U_C[1-t_{E_i}^P(x)-c(x)] \geq U_I \tag{44}$$

$$t_i^P \leq 0 \tag{45}$$

$$(N-n-\sum_{i=1}^{n}E_i)t_I^P+\sum_{i=1}^{n}\left[\int_0^{E_i}t_{E_i}^P(x)dx+t_i^P\right]=0, \tag{46}$$

where

$$W = (N - n - \sum_{i=1}^{n} E_i)U_I(1 - t_I^P) + \sum_{i=1}^{n} \left\{ \int_0^{E_i} \{U_C[1 - t_{E_i}^P(x) - c(x)]\} \, dx + \frac{\alpha - t_i^P}{[1 + (n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}} \right\},$$

$t_I^P \gtreqless 0$ is a transfer imposed on independent agricultural locations, and $t_i^P \gtreqless 0$ and $t_{E_i}^P(x) \gtreqless 0$ are transfers imposed on, respectively, industrial location i, and the x-th worker added to the empire of industrial location i.[33] Then, the following holds:

Proposition 4. *A Social Planner (SP) solving the problem in (41)–(46) forms empires if and only if $0 < n < N$ and $t^*(0, n, \sigma) > c(0)$, where $t^*(\mu, n, \sigma)$ is described in equation (12). In such a case, it forms equally-sized empires of size*

$$E^*(0, n, \sigma) = \arg_E [t^*(0, n, \sigma) = c(E)] = \arg_E \left[1 - \left(\frac{n}{\tau^{\sigma-1} + n - 1} \right)^{\frac{\beta}{\sigma-1}} = c(E) \right].$$

Proof. The first part of the proposition follows by definition, since empires must contain one industrial location, and a positive measure of workers from agricultural locations. Suppose then $0 < n < N$. Problem (41)–(46) can be solved in two stages, by first identifying the optimal transfers for given E_i, and then solve for the optimal E_i. To identify the optimal transfers, note that the price index is highest in independent agricultural locations, intermediate in colonies, and lowest in industrial locations, i.e. $P_I > P_C > [1 + (n-1)(\delta\tau)^{1-\sigma}]^{\frac{\beta}{1-\sigma}}$. Together with the constraints in (43)–(46), this implies that the

[33] We focus for simplicity on a utilitarian Social Planner with equal Pareto weights on all locations, but results are robust to adopting any set of weights. Intuitively, the choice of weights does not change the fact that the SP form empires which maximise efficiency gains, but only the way in which those gains are distributed across locations.

optimal transfers are:

$$
\begin{aligned}
t_I^P &= 0 \\
t_{E_i}^P(x) = t_E^P(x) = 1 - \frac{U_I}{U_C} - c(x) &= t^*(0,n,\sigma) - c(x) \\
\sum_{i=1}^n t_i^P &= \sum_{i=1}^n \int_0^{E_i} t_E^P(x)dx.
\end{aligned}
$$

It follows that W after the transfers can be written as

$$
\widehat{W} = (N-n)U_I + \frac{\alpha + \sum_{i=1}^n \left[E_i t^*(0,n,\sigma) - \int_0^{E_i} c(x)dx\right]}{\left[1+(n-1)(\delta\tau)^{1-\sigma}\right]^{\frac{\beta}{1-\sigma}}},
$$

The Planner's problem can then be re-written as

$$
\max_{E_i} \widehat{W}
$$
$$
\text{s.t.} \quad E_i \geq 0.
$$

Given that $c(\cdot)$ is continuous and increasing, the maximand is strictly concave in E_i. Then, the necessary conditions for a maximum,

$$
\begin{aligned}
t^*(0,n,\sigma) - c(E_i) + \lambda_i &= 0 \\
E_i\lambda_i &= 0,
\end{aligned}
$$

where λ_i is the Lagrange multiplier, are also sufficient. If

$$
t^*(0,n,\sigma) \leq c(0),
$$

then the necessary conditions require $\lambda_i \geq 0$ and $E_i = 0$. Otherwise, they require $\lambda_i = 0$ and

$$E_i = \arg_y \left[t^*(0, n, \sigma) = c\,(y)\right]$$
$$= \arg_y \left[1 - \left(\frac{n}{\tau^{\sigma-1} + n - 1}\right)^{\frac{\beta}{\sigma-1}} = c\,(E)\right].$$

□

B Empirical and Quantitative Appendix

Size of Empires and Number of Independent Countries: As our baseline political history data source, Wimmer and Min (2006) provides a panel data of political status (sovereign vs. under the dependency of an enlisted empire) for countries that existed as of year 2001 starting from 1816. It considers the 13 empires plotted in Figure I. Large empires such as the British, French and Russian, are separately tracked, while several others, such as Belgium and China which only accounted for a few dependencies, are accounted jointly as 'Other empires.' We separate this group into individual empires. Countries such as Czechia, Slovakia, and Yugoslav Republics that were once unified with a constitutional right to secede are counted separately. If a modern country was not formed yet in the past, the data reports the status of its existing main constituent part (e.g., India before independence or Germany before unification are counted as one). For robustness, we use data from Gokmen, Vermeulen and Vézina (2020) and Dedinger and Girard (2021) (see Figure B.2). The former follows a similar methodology in projecting back the status of modern-day countries, while the latter tracks polities as they exist at any point in time.[34] See text for additional details.

[34] For example, Malaysia appears as a single entity throughout in our dataset. In reality, two current states of the Federation of Malaysia, Pahang and Perak, were separate sovereign entities before British colonization in 1888 and 1874, respectively. The British administration created the Federated Malay States in 1895. Our approach counts both of these pre-colonial entities as "Malaysia," purging out administrative reorganizations by colonizers and highlighting changes in political status of continuous territorial units. The alternative approach counts them as separate polities until 1895, falling under British administration in different years. After 1895, they appear as a single entity, first within the British Empire and then as a sovereign country after the Malaysian independence in 1957.

Income Dispersion and Industrialisation Levels: To generate Figure IIIa, we use the Maddison dataset (Bolt and van Zanden, 2020), which reports per capita real income for a balanced sample of 57 countries (based on their modern-day political boundaries) since 1830. Table B.1 lists these countries. To construct the panel, we first compute decadal average per capita income for each country. Whenever a country's income is missing for a decade, we interpolate it by the previous and following reported decadal incomes. In Figures I and IIIb, we use Tables 9, 12, 15 and 16 in Bairoch (1982) which report industrialisation levels of 29 countries. Table B.2 below lists these countries. In this dataset, industrialisation data for Turkey is not reported. For Figure I, we impute Turkey's level of per capita industrialisation by multiplying China's reported level with the ratio of Turkey's per capita GDP to that of China's from the Maddison dataset, which we also use in the robustness Figure B.2b for metropole's per capita GDP in 1913 in the x-axis. The Maddison dataset does not report p.c. income for Russia until after WWII. To impute Russia's 1913 income in that figure, we use Table A37 in Markevich and Harrison (2011).

UK intra-industry trade index and import share of primary products: Both series plotted in Figure IV use the NBER-UN world trade data (Feenstra et al., 2005) after 1962. Aggregate manufacturing imports and exports until 1933 are digitized from Mitchell (1988) by the authors, and the share of primary products in UK imports between 1850-1938 is based on the Federico and Tena Junguito (2019) dataset. Both the pre-1938 and post-1962 data define primary products as SITC sections 0-4. For the manufacturing IIT index after 1962, we use aggregate UK imports and exports of SITC sections 5-8. Manufacturing trade data before 1938 is from Table 19 (total finished manufactures) in Mitchell (1988).

Table B.1: **List of Countries in the Income Dispersion Panel**

Algeria*	Czechia*	Italy	Norway	Taiwan*
Argentina	Denmark	Jamaica*	Peru	Thailand
Australia*	Egypt*	Japan	Philippines	Tunisia*
Austria	Finland*	Jordan*	Poland*	Turkey
Belgium	France	Lebanon*	Portugal	United Kingdom
Brazil	Germany	Malaysia	South Korea*	United States
Canada*	Greece	Mexico	Saudi Arabia	Uruguay
Chile	India*	Morocco	South Africa*	Venezuela
China	Indonesia	Myanmar*	Spain	Viet Nam*
Hong Kong*	Iran	Nepal	Sri Lanka*	
Colombia	Iraq*	Netherlands	Sweden	
Cuba	Ireland*	New Zealand*	Syria*	

Notes: Balanced sample of 57 countries in the Maddison project data Bolt and van Zanden (2020) with per capita income reported since 1830, used in generating the income dispersion time series plotted in Figure IIIa. The Maddison project data does not report per capita income for Russia prior to 1960. See notes to Table B.2 below where Russia is included. Countries labeled with an asterisk * were within an industrial empire (defined in Appendix B) at some point after 1830, excluding the metropoles themselves.

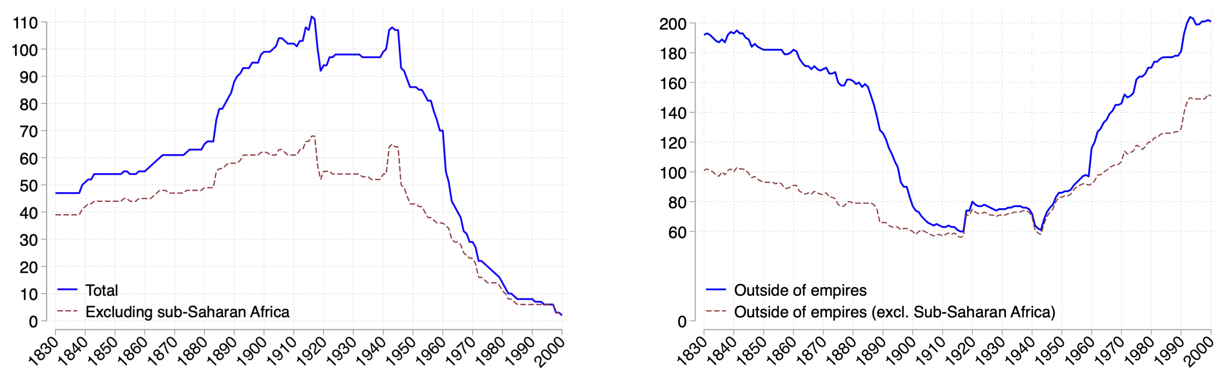
Table B.2: **List of Countries in the Industrial Output Dispersion Panel**

Australia	China	India	Norway	Spain
Austria	Denmark	Italy	Portugal	Sweden
Belgium	Finland	Japan	Romania	Switzerland
Brazil	France	Mexico	Russia	United Kingdom
Bulgaria	Germany	Netherlands	Serbia	Unites States
Canada	Greece	New Zealand	South Africa	

Notes: Balanced panel of 29 countries from Bairoch (1982) with per capita industrial output measures reported after 1800.

Figure B.1: **Alternative Political History Datasets**

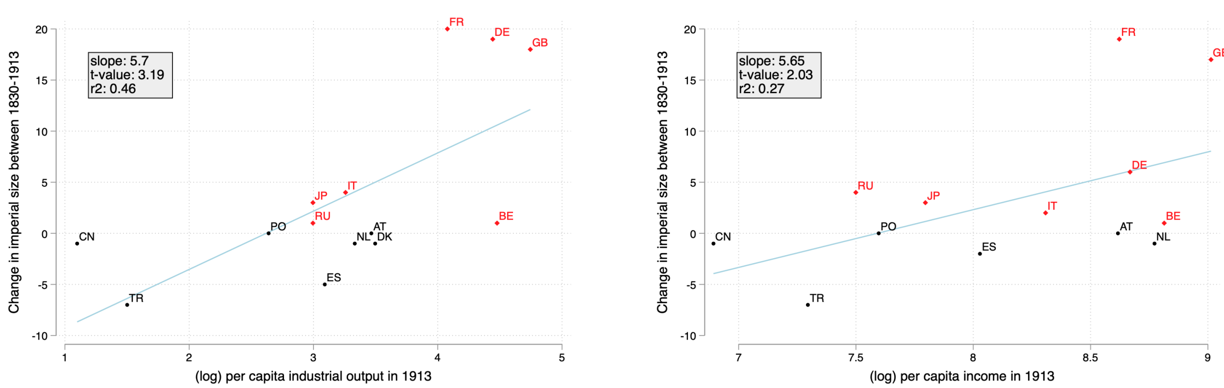
(a) Size of Expanding Empires (b) Number of Independent Countries



Notes: The left panel uses imperial political history data from Gokmen, Vermeulen and Vézina (2020). As in Figure IIa, it plots the number of territories within the jurisdiction of the following empires, excluding the imperial metropoles themselves: Belgian, British, French, German, Italian, Japanese and Russian. Unlike Figure IIa, it does not track the USSR as the continuation of the Russian Empire. The right panel uses data from the GeoPolHist database (Dedinger and Girard, 2021). It treats once-independent constituent parts of yet-to-be-united Germany and Italy (e.g., pre-unification German and Italian states) as single entities (e.g., Germany and Italy). In both panels totals are depicted in solid blue lines, while the dashed-red lines exclude the sub-Saharan region. See Appendix B for details.

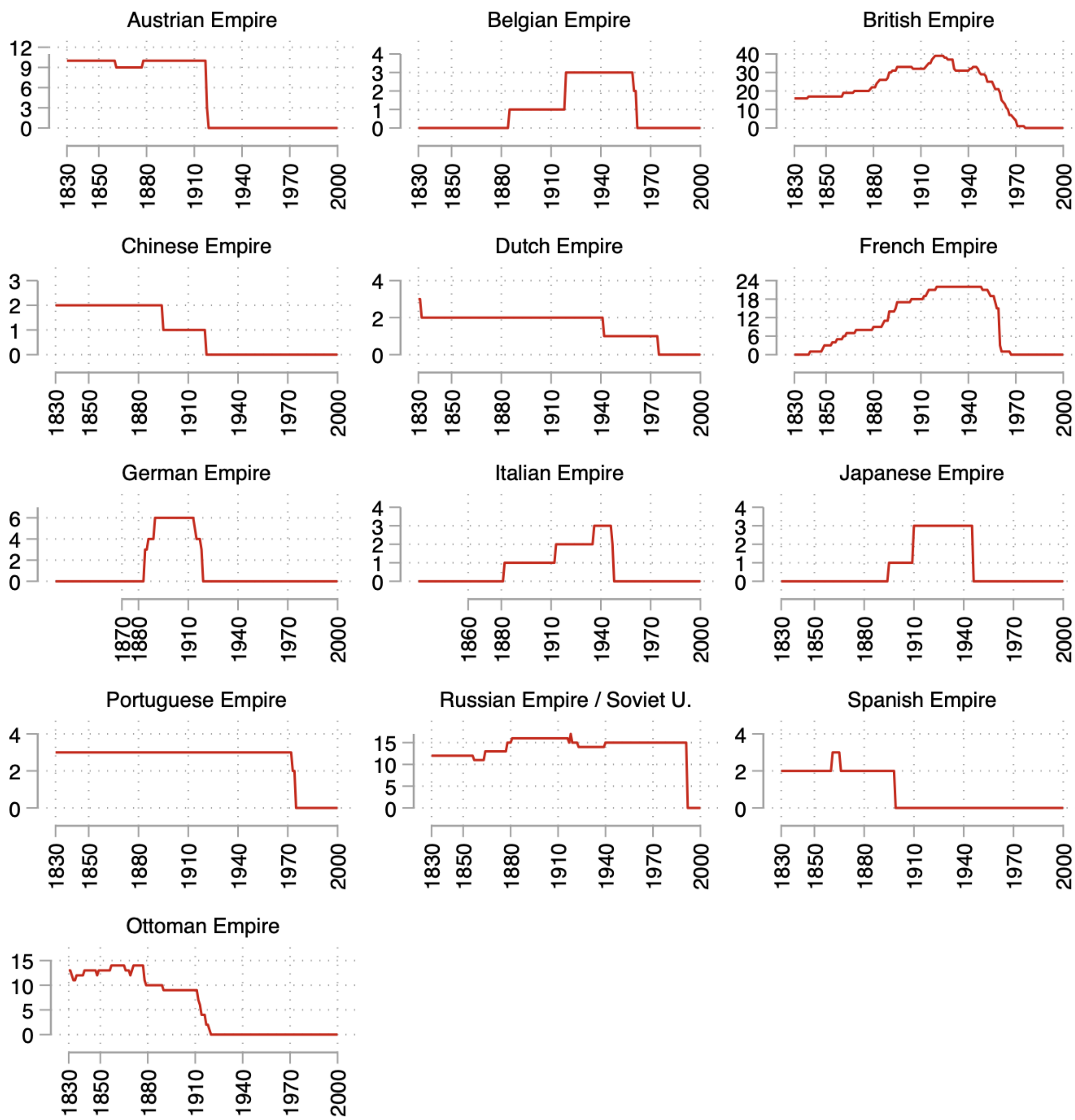
Figure B.2: **Alternative Measures for Imperial Growth and p.c. Output**

(a) Robustness 1 (b) Robustness 2



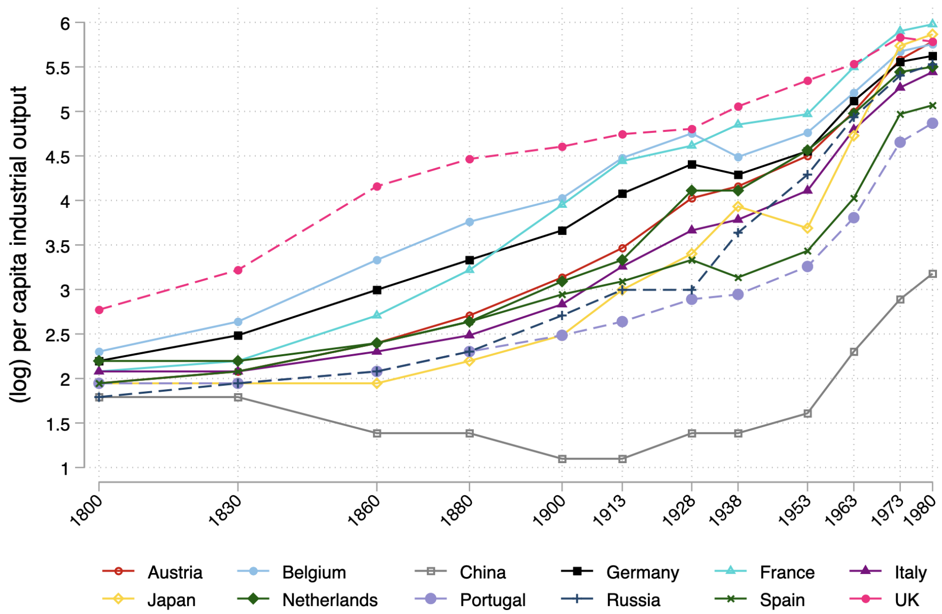
Notes: Both figures replicate Figure I with alternative datasets in the x- and y-axes. The left figure replaces the y-axis with imperial political history data from Gokmen, Vermeulen and Vézina (2020). The right figure replaces the x-axis with per capita income from Bolt and van Zanden (2020).

Figure B.3: **Separate Imperial Trajectories**



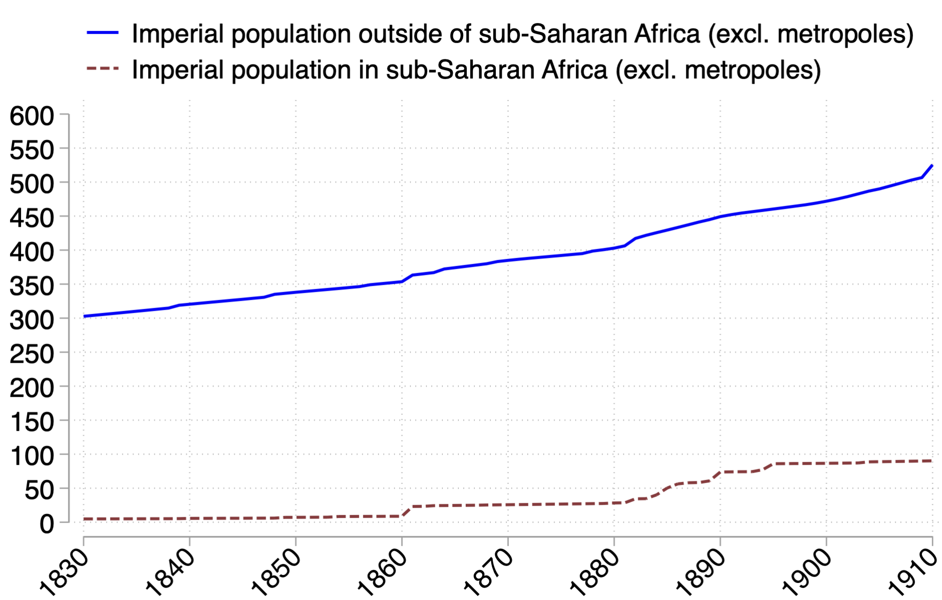
Notes: Separate size trajectories for the 13 empires in the Wimmer and Min (2006) dataset.

Figure B.4: **Industrialisation Levels of Imperial Metropoles**



Notes: The plot shows (log) per-capita manufacturing output of imperialist countries in each year for which data is reported in Bairoch (1982), also used in Figure IIIb in the text. The data is indexed to the level of the UK in 1900, set as 100. We label only the years for which data is reported.

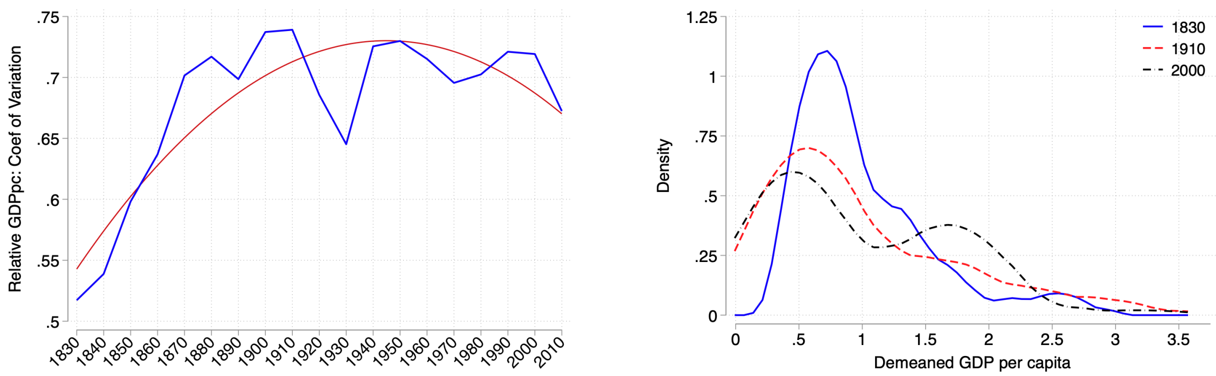
Figure B.5: **Population under the Rule of Expanding Empires**



Notes: Population data at the country-year level is downloaded from http://gapm.io/dpop (accessed on January 8, 2024) and merged with the political history dataset Wimmer and Min (2006) that is used to generate Figures I and II. It plots population within the jurisdiction of the following empires, excluding the imperial metropoles themselves: Belgian, British, French, German, Italian, Japanese and Russian.

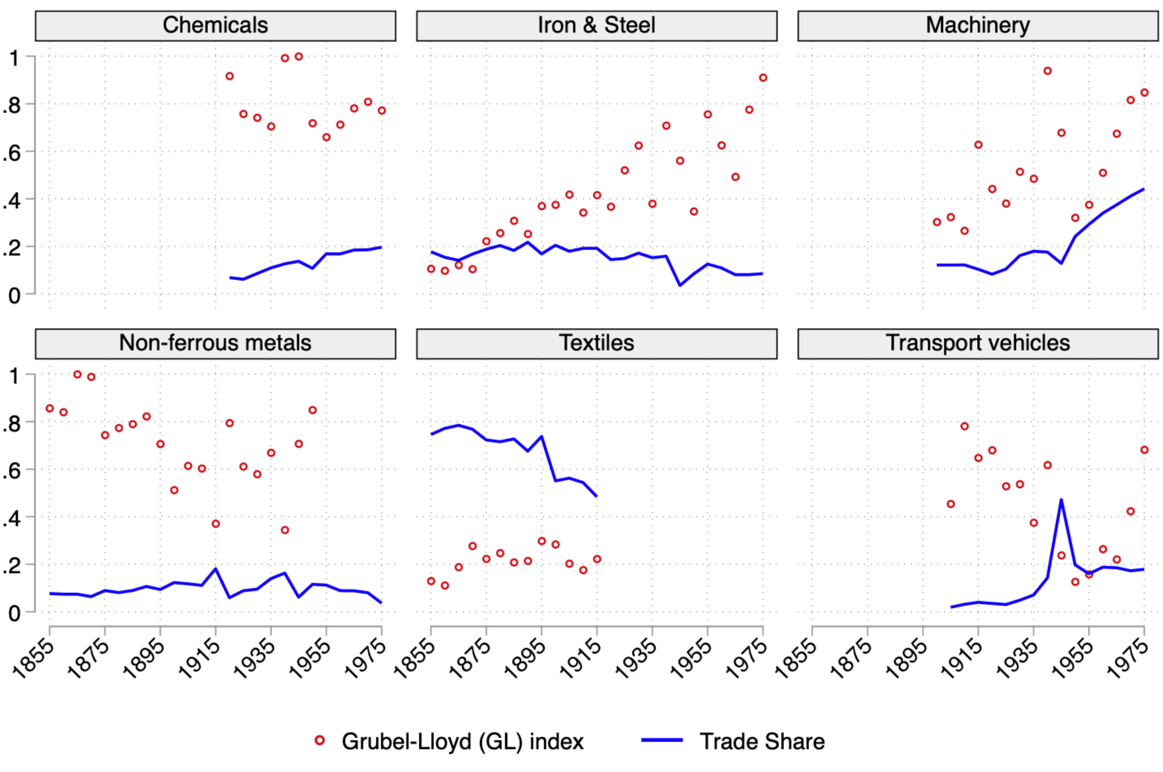
Figure B.6: **Additional Income Dispersion Plots**

(a) Coefficient of Variation of p.c. Incomes (b) Distribution of p.c. Incomes over Time



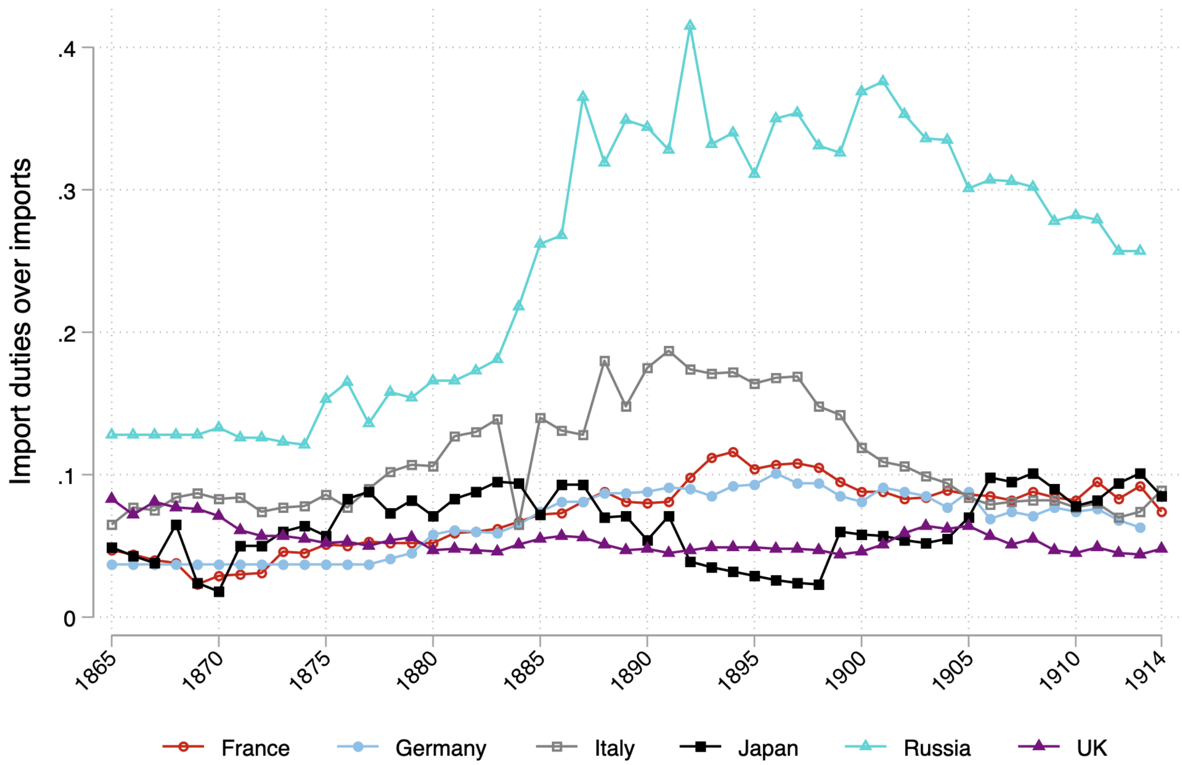
Notes: Both figures use the same balanced sample of 57 countries from the Maddison project as in Figure IIIa. The left panel plots the coefficient of variation in per capita incomes with a quadratic fit. The right panel demeans per capita incomes in three years and plots kernel densities.

Figure B.7: **Sectoral Trade Statistics for the United Kingdom**



Notes: Source is Mitchell (1988) data on British historical statistics digitized by the authors. GL index is defined in the text. Trade share is the share of each sector's exports and imports in the total trade in the six sectors plotted here.

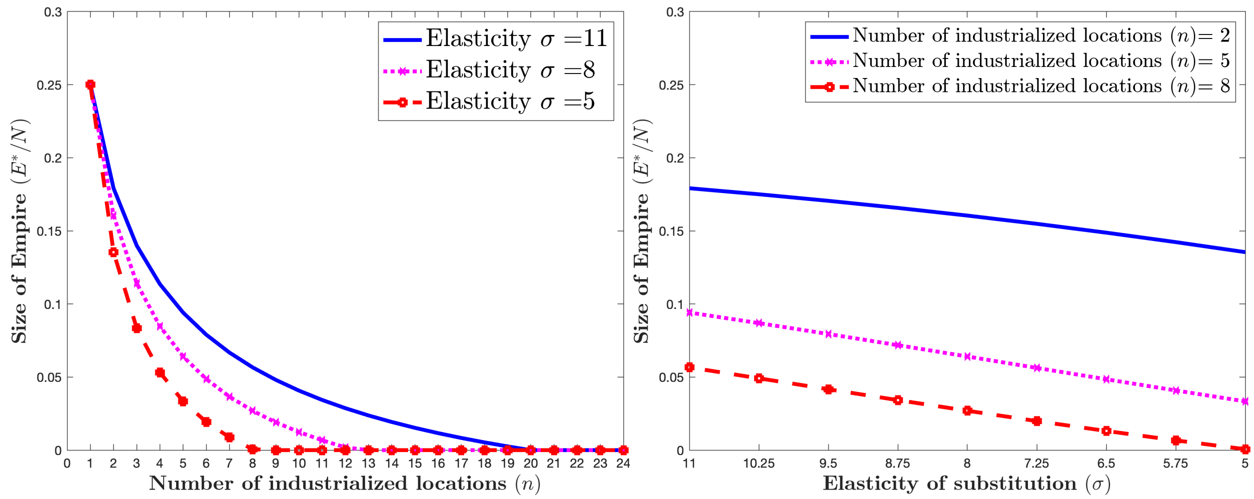
Figure B.8: **Effective Tariff Rates by Empire**



Notes: Source is Clemens and Williamson (2004). Y-axis is effective tariff rate defined as total import duties over imports. Data exists for all expanding empires except Belgium.

Figure B.9: **Numerical Comparative Statics of Empire Size**

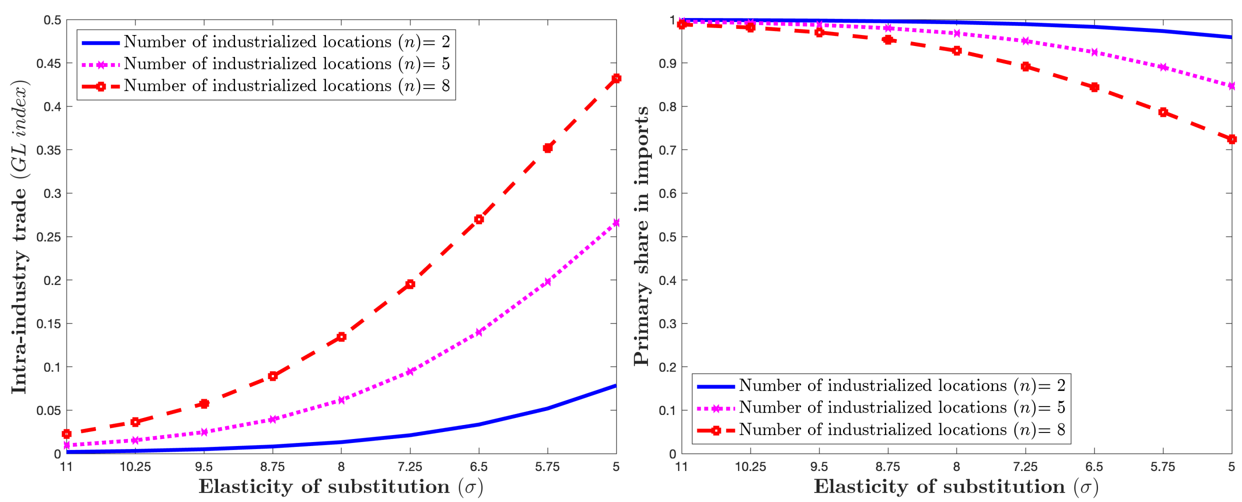
(a) with respect to n (b) with respect to σ



Notes: The figures normalize the y-axis E^*/N with respect to the total number of locations N, and feature level curves for σ (left) and n (right). In the right panel, the horizontal axis for σ is reversed to ease interpretation. See Subsection VI.A for details.

Figure B.10: **Numerical Comparative Statics of Trade Patterns**

(a) with respect to σ (b) with respect to σ



Notes: In both figures, the horizontal axis for σ is reversed to ease interpretation and level curves are plotted for n. See Subsection VI.A for details.

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