**Appendix A: Technical appendix**

1. Baseline model

Our model estimates the effects of an exogenous change in trade costs (*t*). Following the standard approach in the partial equilibrium analysis of the welfare consequences of protectionism (e.g. Feenstra 1995), we measure the value of transfers to consumers and producers which are needed to sustain 1913 levels of welfare with pre-globalization trade costs, given 1913 endowments and technology. Under these conditions, we can model supply (*S*) and demand (*D*) in the producing country (subscript *P*) and in the consuming one (subscript *C*) as functions of prices (*P*) only. We assume linear functions:

*DC=a+αPC* A1)

*SC=b+γCPC* A2)

*ΔP=c+βPP* A3)

*SP=d+γPPP* A4)

Where *a*, *b*, *c* and *d* are stochastic stationary intercepts and *α<0*, *β<0*, *γC>0* and *γP>0 (*Steinwender 2014).[[1]](#footnote-1) The two markets are related by arbitrage by representative traders, who choose the profit-maximizing level of exports *xP*:

*π=(PC-PP-t)xP* A5)

Neither (*PC-PP)<t* nor (*PC-PP)>t* can be equilibrium solutions, as traders would lose money in the former and would want to export an infinite amount in the latter. Hence, the only equilibrium with positive trade is (*PC-PP)=t*. In this case, traders are indifferent with respect to the quantity exported, which is thus determined by the market clearing conditions (Steinwender 2014). We therefore substitute *PC=PP+t* and simplify the notation by writing *PP=P*. This approach assumes perfect market integration within both producing and consuming countries (though estimates would arguably be reliable also under the weaker condition that changes in border prices are passed through to domestic prices) and ‘specific’ rather than ‘iceberg’ trade costs. This latter assumption, although convenient in modelling is highly unrealistic. Many duties, including the British Corn Laws, were proportional to the traded weight and not to the value of the good and freights depended on the volume per unit of weight (Thomas 1930: 230). Nevertheless, as seen in the section below, it is straightforward to adopt the ‘iceberg’ assumption, with almost identical results. The market clears when the total demand equals the total supply:

*γPP+γC(P+t)=α(P+t)+βP* A6)

or:

*γPP+γCP-αP-βP=αt-γPt* A7)

Re-arranging yields an expression for the effect of changes in trade costs on prices in the producing country:

*ΔP=[(α-γC)/(γP+γC-α-β)]Δt* A8)

While the parallel condition for the change in prices in the consuming country is:

*Δ(P+t)/Δt=ΔP/Δt+1* A9)

or:

*Δ(P+t)=[(γP-β)/(γP+γC-α-β)]Δt* A10)

We express the unknown coefficients *α*, *β* and *γ* in terms of elasticities of demand (*ηC* and *ηP*) and supply (*εC* and *εP*). To this aim, we select the units of measurement so that in the baseline year *P=1* and *SP=1*. Furthermore, we express consumption in the producing country and supply in the consuming country as proportions *x* and *z* of production in the producing country (*ΔP=xSP=x* and *SC=zSP=z*). Of course, for tropical products (including cotton) *SC=z=0*. In this notation, the demand in the consuming country is equal to imports from the producer (*XP*) plus local supply *DC=XP+SC=SP-ΔP+SC=(1-x+z)*. Substituting in the standard definition of elasticity and re-arranging, we obtain *α=ηC[(1-x+z)/(1+t)]*, *β=ηP\*x*, *γC=εC [z/(1+t)]* and *γP=εP*. We thus can re-write A8) and A10) as functions of the elasticities and of the parameters *x*, *t* and *z*:

*ΔP=[(ηC\*(1-x+z)/(1+t)- z\*εC/(1+t))]/ [(εP+ z\*εC /(1+t) – ηC \*(1-x+z)/(1+t)- ηP\*x)]Δt* A11)

*Δ(P+t) =(εP-ηP\*x)/[(εP+z\*εC/(1+t)-ηC\*(1-x+z)/(1+t)-ηP\*x)]Δt* A12)

These two formulae allow us to estimate how changes in trade costs are allocated and thus affect prices in exporting and importing countries. We can also estimate the effects of the changes in trade costs on trade (*ΔXP*) as the difference between changes in demand (*ΔDC*) and supply (*ΔSC*) in the importing country:

*ΔXP=αΔ(P+t)-γCΔ(P+t)=[ηC(1-x+z)/(1+t)-z\*εC/(1+t)]\*[(εC-ηP\*x)/[(εP+z\*εC/(1+t)-ηC(1-x+z)/(1+t)-ηP\*x)]]Δt* A13)

Note that, given *η<0 and ε>0,* the first term in the numerator is negative, the second is positive and the denominator is positive: a decline in trade costs (*Δt*<0) causes trade to rise.

We estimate the effect of price convergence on welfare as the differences between changes in producers’ and consumers’ surpluses (Figure A1). Following Hufbauer et al. (2002), we assume costs to remain positive rather than becoming nil as in the standard partial-equilibrium analysis of trade liberalization (the Haberger triangles).

Figure A1: Welfare gains from integration, producing country



A fall in trade costs implies that in the producing country (Figure A1) the price of the exported good rises by *ΔP* causing domestic demand to fall by *–ΔDP*, domestic supply to rise by *ΔSP* and exports to increase by *ΔXP*. The consumer surplus decreases by *YBAZ*, the producers’ surplus increases by *YCDZ* – so that net gains are equivalent to the area of the trapezoid *ABCD*. The area can be decomposed in two triangles *ABF* and *CED*, the area of which increase with the responsiveness of consumers and producers to change in prices, respectively, and in a rectangle *BCEF*, the area of which depends on both consumers and producers. The respective areas can be measured as:

a) rectangle *BCEF*: *DWGi=ΔP\*(SP-DP)* A14)

b) triangle *ABF*: *DWGii=-0.5\*ΔP\*dDP=-0.5\*ΔP2\*ηP\*ΔP/P*A15)

c) triangle *CED*: *DWGiii=0.5\*ΔP\*dSP=0.5\*ΔP2\*εP\*SP/P* A16)

The total gains are obtained as a sum of the three:

*DWGC=DWi+DWGii+DWGiii=ΔP\*(SP-ΔP) -0.5\*ΔP2\*ηP\*ΔP/P+0.5\*ΔP2\*εP\*SP/P*  A17)

Multiplying by *P/P*, dividing by *GDPP*and re-arranging yields:

*DWGP/GDPP= ΔP/P\*[(SP-ΔP)\*P/GDPP]-0.5\*(ΔP/P)2\*(ηP\*ΔP\*P/GDPP-εP\*SP\* P/GDPP)*  A18)

Defining *δP= (DP\* P)/GDPP* and *θP= (SP\* P)/GDPP*as the ratio of total consumption and production on *GDPP* yields the final formula:

*DWGP/GDPP = ΔPP/PP\*(θP-δP)-0.5\*(ΔPP/PP)2\*[ηP\* δP- εP\*θP]* A19)

The second term is positive by definition as *ηP<0* and *εP>0*. The first term is positive for net exporters, too, because market integration causes prices to rise (*ΔP/P*) and production exceeds consumption (*θP-δP>0*). Note that gains can be substantial for minor products if all production is exported (i.e. if *θP* and *δP* are both very low) and for products mostly consumed at home (high *δP*), if the surplus is large enough.

The reasoning is symmetric for the importing country, yielding:

*DWGC/GDPC=-ΔPC/PC\*(δC- θC)+0.5\*(ΔPC/PC)2\*[εC\*θC- ηC\* δC]* A20)

The gains are positive in net importing countries because integration causes prices to fall (*ΔPC/PC <0*) and consumption exceeds production (*δC-θC>0*).

Summing up, we can derive the expressions to estimate the changes in prices for producers (A11) and for consumers (A12) and consequently the changes in welfare (A19 and A20) for each product given changes in price gaps (*Δt*) relative to a baseline year, with four parameters (the elasticities of supply and demand in producing and consuming countries) and as many figures from national accounts (the ratios of production in the consuming country and consumption in the producing country to production in the producing country, and the shares of production and consumption on national income).

Our next step is the distribution of the aggregate gains (separately) between regions and social classes. We assume that benefits are proportional to the shares of regions or social class on total production. Formally, for each product *i*, we compute the region’s *j* gains as a proportion of regional *GDP* thus:

*DWGPij/GDPPj= (DWGPi/GDPP)\*(**SPji/SPi)/(GDPP/GDPPj)* A21)

Where *SPij/SPi* and *GDPP/GDPPj* are theshares of the total production of product *i* and total *GDP* respectively of region *j*. Since all gains are expressed as a share of regional *GDP*, they can be added up to obtain total gains from the products covered for each producer *P*. Likewise, we estimate the social distribution of gains in producer *P* caused by the integration of product *i* as:

*DWGPij/GDPPk= (DWGPi/GDPP)\*(πPik/πPi)/(GDPP/GDPPk)* A22)

Where *πPik/πPi* denotes our estimate of the share of total gains enjoyed by the k-th social class and otherwise the notation is as before. Again, since the gains are all expressed as a share of the total income of class *k* they can be added up across products.

The impact on overall regional and social inequality is measured by comparing actual and counterfactual level of inequality in 1913. We estimate the counterfactual GDP by region or social class by subtracting the market integration gains. Following standard approaches in the literature, we measure regional inequality with the population-weighted coefficient of variation of the income per capita (e.g. Rosés and Wolf 2021) and social inequality with the Gini coefficient and the top 1% income share or the (agricultural) labor income share (e.g. Milanovic 2016; Piketty 2014), depending on data availability.

1. Iceberg assumption

Following the ‘iceberg assumption’ the price ratio between the producing and the consuming country, in efficient trading markets, is equal to *t*. Thus, we substitute *PC=PPt* and, as before, simplify notation by writing *PP=P*. By definition total demand equals total supply:

*DC+DP = SC +SP* A23)

We start by substituting A1)-A2) in the equation

*γAP+ γEPt= αPt + βP* A24)

or:

*P= Pt(α- γC)/(γP-β)* A25)

Re-arranging yields an expression for the effect of changes in iceberg costs on the prices of the producer:

*ΔP/Δt =ΔP/Δt\* t(α- γC)/(γP-β)+ P(α- γC)/(γP-β)* A26)

or:

*ΔP = P(α- γC)/[γP-β-t(α- γC)]\*Δt* A27)

while the parallel condition for the change in prices of the consumer is:

*Δ(Pt)/Δt= tΔP/Δt+P* A28)

*Δ(Pt) ={tP(α- γC)/[γP-β-t(α- γC)]+P}\*Δt* A29)

As before, we express the unknown coefficients *α*, *β* and *γ* in terms of elasticities of demand (*ηC* and *ηP*) and supply (*εC* and *εP*) and select unit of measurement so that at time zero *P=1* and *SP=1*. Furthermore we express European supply and Asian consumption as proportions *z* and *x* of Asian production (*SC=zSP=z* and *ΔP=xSP=x*). In this notation, the consumer’s demand is equal to imports from the producer (*XP*) plus local supply *DC= XP + SC =SP-ΔP+SC=(1-x+z)*. Substituting in the standard definition of elasticity and re-arranging, we obtain *α=ηC(1-x+z)/t*, *β=ηP\*x*, *γC = εC\*z/t* and *γP= εP*. We thus can re-write A26) and A27) as functions of the elasticities and of the parameters *x*,*t* and *z*:

*ΔP = [ηC(1-x+z)/t - εC\*z/t)/[εP - ηP\*x-ηC(1-x+z)+εC\*z)]\*Δt* A30)

*Δ(Pt) ={(ηC(1-x+z) - εC\*z)/[εP - ηP\*x-ηC(1-x+z)+εC\*z)]+1}\*Δt* A31)

Substituting A3) and A4) in the identity *Δt=Δ(Pt)-tΔP*, we allocate *Δt*.

Bilateral vs. multilateral model In the multilateral model, too, welfare changes are estimated with (minus) the compensating variation: the transfer that would ensure the maintenance of 1913’s levels of welfare with 1815’s or 1870’s trade costs. However, in the multilateral model markets clearing involves multiple exporters and importers. The downside is that the mathematics becomes more complex than with the bilateral model. The system of equations does not have an explicit solution and one needs to rely on a Mixed Complementarity Programme solver, a Newton-type algorithm, usually implemented with the software GAMS. The upside is that the multilateral model considers that the effect of a decline of bilateral trade costs on prices depend also on contemporaneous changes in trade costs between other exporters and importers. For instance, relative to the bilateral model, the effect of a decline in the costs of exporting cotton from British India to Europe on its export price and hence on its welfare gains is expected to decrease if there are contemporaneous declines in trade costs from other exporting countries (e.g. the United States) and increase if there are contemporaneous declines in trade costs to other importing countries (e.g. Japan). Moreover, the welfare effects of a change in the price of an imported good (e.g. American wheat in Britain) also depend on contemporaneous changes in prices of the same good supplied by other producers (including, in the American wheat example, Britain itself). The formula of the per capita compensating variation (cf. Chilosi and Federico 2021 for details on its derivation) in country *j*:

*CVj=-Σi(Dij/Lj)ΔPij-)-0.5ΣiΣk(βjk+Dkjδij/Lj)ΔPijΔPkj+(ΔPjjSj+0.5ΔPjjΔPjjΔSj)/Lj* A32)

Where *Dij* is the demand for the good in country j produced by country *i*, *Lj* is the population of country *j*, *ΔPij* and *ΔPkj* are the changes in the prices in country *j* of the goods produced in countries *i* and *k* respectively (so that when i=j the term is the change price of the locally produced and consumed good), *βjk* is the marginal effect on the demand for a good produced in country *i* and consumed in country *j* of the price of the good produced in country *k* and consumed in country *j* (expected to be negative for own-price demand and negative for substitutes), *δij* is the marginal effect on the demand for a good produced in country *i* and consumed in country *j* of the income in country *j* (expected to be positive) and *Sj* and *ΔSj* are the size and changes in the supply of the good produced in country *j*. The first and third terms on the right-hand side imply that, similarly to the bilateral setup, the welfare effects of price changes are proportional to the local demand and supply of each type of good. Hence, benefits of market integration for importing countries decrease with domestic production and increase with consumption of imported goods, while in exporting countries benefits increase with exports. In addition, the second term shows that for each price decline, the consumer’s benefit decreases (increases) if the price of a substitute (complement) decreases at the same time, in proportion to the associated substitution effect. Therefore, the less substitutable imported goods are, the greater the benefits from their falling prices, as standard in welfare analyses of trade.

In practice, it looks as if negative and positive biases in the bilateral model relative to the more realistic multi-lateral model tend to cancel each other out. Figure 4 compares a set of multilateral estimates of welfare gains for producers and consumers of wheat and cotton from Chilosi and Federico (2021) with newly computed analogous bilateral estimates. Estimates with the bilateral approach tend to be only a little higher and are highly correlated with multi-market estimates, discounting for one obvious outlier: Indian cotton over the long-run. The world cotton market was dominated by the United States, which also saw a marked decline in their export costs in 1816-1913. Hence, for Indian cotton in the long-run, there is an obvious violation of the bilateral assumption that the export costs of competitors were not changing at the same time.

Figure A2: Comparison of multi-market and bilateral welfare estimates (% GDP in 1913)

Notes: the dotted line is the fitted OLS line disregarding the outlier.

Source: Table A1 in Appendix B.

In the case of the Indian gains from exporting cotton, the gap between the two approaches is so wide because the world cotton market was strongly dominated by the United States, which also saw a marked increase in integration with Europe over the long run, implying an obvious violation of the bilateral assumption that there were no competing producers. Anyway, for Indian cotton, given that the multilateral estimates are available, we do not use the bilateral figure in the subsequent analysis. In all other cases the bilateral estimates emerge as rather robust approximations of the multilateral ones.

**Appendix B: statistical appendix**

Table A1: Comparison of multi-market and bilateral welfare estimates (% GDP in 1913)

|  |  |  |
| --- | --- | --- |
|  | Bilateral model | Multi-market model |
|  | 1815-1913 | 1870-1913 | 1815-1913 | 1870-1913 |
| Wheat |  |  |  |  |
| UK | 0.551 | 0.218 | 0.400 | 0.200 |
| North America | 0.006 | 0.002 | 0.018 | 0.004 |
|  |  |  |  |  |
| Cotton |  |  |  |  |
| Europe | 0.917 | 0.021 | 0.500 | -0.009 |
| India | 1.961 | 0.312 | 0.400 | 0.300 |
| US | 0.345 | 0.004 | 0.400 | 0.042 |

Sources: see the text and Appendix C.

Table A2: Share of the eleven products on total exports (%)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 1830 | 1850 | 1870 | 1890 | 1900 | 1912 |
| British India |  |  |  |  |  |  |
| Cotton | 15.0 | 19.1 | 35.2 | 16.5 | 9.4 | 17.2 |
| Indigo | 27.0 | 10.9 | 5.8 | 3.1 | 2 | 0.2 |
| Foodgrains | 0.0 | 4.1 | 8.1 | 19.5 | 13.1 | 18.4 |
| Jute | 0.0 | 1.1 | 4.7 | 7.6 | 10.1 | 7.4 |
| Seeds | 0.0 | 0.9 | 0.6 | 2.5 | 7.3 | 8.1 |
| Sugar | 0.0 | 1.8 | 3.7 | 4.7 | 10.7 | 6.2 |
| Tea | 17.0 | 30.1 | 19.5 | 9.2 | 8.8 | 6.1 |
| Total | 59.0 | 68.0 | 77.6 | 63.1 | 61.4 | 63.6 |
| Colonial Indonesia |  |  |  |  |  |
| Coffee | 41.0 | 52.6 | 36.8 | 35.7 | 20.2 | 11.2 |
| Sugar | 12.8 | 16.5 | 37.1 | 41.2 | 51.1 | 48.2 |
| Tin | 8.4 | 10.7 | 8.8 | 7.9 | 9.4 | 14.6 |
| Total | 62.2 | 79.8 | 82.6 | 84.8 | 80.7 | 74.0 |
| United States |  |  |  |  |  |  |
| Cotton | 47.0 | 54.1 | 50.1 | 29.3 | 18.6 | 25.2 |
| Wheat |  | 0.9 | 9.4 | 5.2 | 6.7 | 2.0 |
| Total | 47.0 | 55.0 | 59.5 | 34.5 | 25.3 | 27.2 |

Sources: Colonial Indonesia: Korthals Altes (1991) (three years averages); British India: Chauduri (1982: Tables 10.10, 10.11) (1850, 1870, 1890, 1900 and 1910); United States: Carter et al. (2006: Tables Ee571 and Ee 575) (three years averages).

Table A3: Shares on world exports (%)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | British India | Colonial Indonesia | Asia | United States | World (millions 1913 $) |
| 1831 | 5.1 | 0.6 | 12.5 | 6.5 | 916 |
| 1851 | 5.0 | 1.4 | 14.2 | 8.9 | 2045 |
| 1870 | 5.4 | 0.9 | 12.5 | 7.9 | 4690 |
| 1890 | 5.9 | 1.0 | 12.3 | 11.3 | 8901 |
| 1900 | 4.0 | 1.1 | 11.0 | 14.4 | 11437 |
| 1912 | 4.5 | 1.4 | 12.2 | 12.9 | 17688 |

Notes: The column ‘World’ is at constant (1913) prices, while the shares are computed on three-year moving averages with data at current prices. Trends of shares at 1913 prices are similar, but the decline of India is much steeper.

Source: Federico and Tena-Junguito (2019).

Table A4: Welfare gains as share of national GDP (%), 1815–1913

|  |  |  |
| --- | --- | --- |
|  | 1815-1913 | 1870-1913 |
| a) British India |  |  |
| Wheat | 0.522 | 0.126 |
|  | (0.423,0.671) | (0.112,0.147) |
| Cotton | 0.400 | 0.300 |
|  | (0.3,0.5) | (0.2,0.5) |
| Tea | 0.112 | 0.112 |
|  | (0.111,0.113) | (0.111,0.113) |
| Indigo | 0.001 | 0.000 |
|  | (0.001,0.001) | (0,0) |
| Jute | 0.263 | 0.177 |
|  | (0.255,0.275) | (0.174,0.183) |
| Lineseed | 0.196 | 0.059 |
|  | (0.187,0.21) | (0.058,0.06) |
| Rapeseed | 0.029 | 0.029 |
|  | (0.027,0.032) | (0.027,0.032) |
| Rice | 0.070 | 0.070 |
|  | (0.051,0.063) | (0.012,0.081) |
| Total | 1.593 | 0.873 |
|  | (1.355,1.865) | (0.693,1.116) |
| b) Colonial Indonesia |  |
| Sugar | 1.866 | 0.931 |
|  | (1.777,2) | (0.906,0.97) |
| Coffee | 0.104 | 0.037 |
|  | (0.100,0.109) | (0.037,0.038) |
| Tin | 0.132 | 0.162 |
|  | (0.131,0.135) | (0.16,0.166) |
| Total | 2.102 | 1.131 |
|  | (2.008,2.243) | (1.131,1.173) |
| c) United States |  |  |
| Wheat | 0.018 | 0.004 |
|  | (0.015,0.02) | (0.003,0.005) |
| Cotton | 0.400 | 0.042 |
|  | (0.3,0.5) | (0.031,0.057) |
| Total | 0.418 | 0.045 |
|  | (0.315,0.52) | (0.034,0.062) |

Notes: the figures in parentheses report the results of a sensitivity analysis, assuming demand and supply elasticities to range between 66% and 150% of their baseline values.

Sources: see the text and Appendix C.

Table A5: Welfare gains in other places as share of GDP (%), 1815–1913

|  |  |  |
| --- | --- | --- |
|  | 1815-1913 | 1870-1913 |
| a) United Kingdom |  |  |
| Wheat | 0.4 | 0.2 |
| Cotton | 0.5 | -0.009 |
| Tea | 0.025 | 0.025 |
| Indigo | 0.004 | 0.000 |
| Jute | 0.094 | 0.062 |
| Linseed | 0.054 | 0.017 |
| Rapeseed | 0.007 | 0.007 |
| Rice | 0.087 | 0.039 |
| Coffee | 0.005 | 0.002 |
| Sugar | 0.108 | 0.056 |
| Total | 1.285 | 0.649 |
|  |  |  |
| b) Eastern Europe |  |  |
| Wheat | 0.1 | 0.006 |
|  |  |  |
| c) Western Europe |  |  |
| Wheat | 0.2 | -0.1 |
|  |  |  |
| d) Egypt |  |  |
| Cotton | 5 | 1 |
|  |  |  |
| e) Japan |  |  |
| Cotton | 4.2 | 4.2 |

Notes: whenever available a multi-market estimate (wheat and cotton for the UK and the other places) has been preferred to a corresponding bilateral estimate. For cotton, we assume that the gains in the UK were the same as in Europe as a whole (Austria-Hungary, Belgium, France, Germany, Italy, Netherlands, Russia, Spain, Switzerland and the United Kingdom). ‘Eastern Europe’ refers to Austria-Hungary, Bulgaria, Romania, Russia and Serbia. ‘Western Europe’ refers to Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain and Sweden.

Sources: see the text and Appendix C.

Table A6: Welfare gains as share of regional GDP (%), 1815–1913

1. British India

|  |  |  |
| --- | --- | --- |
| Provinces | 1815-1913 | 1870-1913 |
| Bengal, Bihar and Orissa | 4.300 | 2.733 |
| Madras | 0.389 | 0.327 |
| Burma | 0.141 | 0.130 |
| United Provinces | 2.007 | 0.700 |
| Central Provinces and Berar | 3.185 | 1.574 |
| Assam | 2.672 | 2.597 |
| Bombay and Sind (including native states) | 0.951 | 0.599 |
| Punjab | 2.392 | 0.837 |
| Central India States | 1.511 | 0.636 |
| North-west Frontier Province | 0.999 | 0.305 |
| Rajputana States | 0.481 | 0.236 |
| Ajmel-Merwara | 0.931 | 0.686 |
| Mysore State | 0.085 | 0.062 |

1. Colonial Indonesia

|  |  |  |
| --- | --- | --- |
| Region | 1815-1913 | 1870-1913 |
| West Java | 0.73% | 0.36% |
| Central Java | 2.64% | 1.32% |
| East Java | 5.30% | 2.61% |
| Sumatra's West Coast | 0.53% | 0.19% |
| South Sumatra | 0.24% | 0.09% |
| North Sumatra | 1.91% | 2.26% |
| Kalimantan | 0.00% | 0.00% |
| Sulawesi | 0.00% | 0.00% |
| Moluccas | 0.12% | 0.04% |
| Other | 0.00% | 0.00% |

1. United States

|  |  |  |
| --- | --- | --- |
| State | 1815-1913 | 1870-1913 |
| Maine | 0.000 | 0.000 |
| New Hampshire | 0.000 | 0.000 |
| Vermont | 0.000 | 0.000 |
| Massachusetts | 0.000 | 0.000 |
| Rhode Island | 0.000 | 0.000 |
| Connecticut | 0.000 | 0.000 |
| New York | 0.001 | 0.000 |
| New Jersey | 0.000 | 0.000 |
| Pennsylvania | 0.007 | 0.001 |
| Delaware | 0.000 | 0.000 |
| Maryland | 0.016 | 0.003 |
| Ohio | 0.017 | 0.003 |
| Indiana | 0.039 | 0.008 |
| Illinois | 0.013 | 0.003 |
| Michigan | 0.012 | 0.002 |
| Wisconsin | 0.004 | 0.001 |
| Minnesota | 0.063 | 0.013 |
| Iowa | 0.014 | 0.003 |
| Missouri | 0.114 | 0.015 |
| Dakota | 0.198 | 0.040 |
| Nebraska | 0.093 | 0.019 |
| Kansas | 0.107 | 0.021 |
| Virginia | 0.075 | 0.010 |
| West Virginia | 0.010 | 0.002 |
| North Carolina | 2.390 | 0.250 |
| South Carolina | 5.861 | 0.608 |
| Georgia | 4.985 | 0.518 |
| Florida | 0.350 | 0.036 |
| Kentucky | 0.019 | 0.004 |
| Tennessee | 0.882 | 0.093 |
| Alabama | 3.760 | 0.390 |
| Mississipi | 4.151 | 0.431 |
| Arkansas | 3.356 | 0.349 |
| Louisiana | 0.969 | 0.101 |
| Oklahoma | 1.694 | 0.179 |
| Texas | 3.248 | 0.338 |
| Montana | 0.069 | 0.014 |
| Idaho | 0.077 | 0.015 |
| Wyoming | 0.000 | 0.000 |
| Colorado | 0.020 | 0.004 |
| New Mexico | 0.015 | 0.003 |
| Arizona | 0.000 | 0.000 |
| Utah | 0.035 | 0.007 |
| Nevada | 0.000 | 0.000 |
| Washington | 0.065 | 0.013 |
| Oregon | 0.036 | 0.007 |
| California | 0.003 | 0.001 |

Sources: see the text and Appendix C.

Table A7: Changes in regional dispersion of GDP (%)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Counterfactual 1815-1913 | Counterfactual 1870-1913 | Actual |
| British India | 40.432 | 40.010 | 39.605 |
| Colonial Indonesia | 35.711 | 34.740 | 34.321 |
| United States | 36.374 | 35.802 | 35.737 |

Notes: regional dispersion is measured by the population-weighted coefficient of variation.

Sources: see the text and Appendix C.

Table A8: Changes in the labor income share of agricultural GDP in Southern states in the US (%)

|  |  |  |
| --- | --- | --- |
| State | Actual | Counterfactual 1815-1913 |
| North Carolina | 34.5 | 36.530 |
| South Carolina | 27.3 | 31.076 |
| Georgia | 41.2 | 47.829 |
| Florida | 37.1 | 37.932 |
| Tennessee | 29.7 | 30.581 |
| Alabama | 35.5 | 39.441 |
| Mississipi | 22.9 | 24.801 |
| Arkansas | 30.7 | 33.451 |
| Louisiana | 29 | 30.040 |
| Texas | 21 | 23.306 |
|  |  |  |
| Southern US | 29.098 | 31.862 |

Sources: see the text and Appendix C.

Table A9: Changes in the social distribution of GDP in Java (%)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Counterfactual 1815-1913 | Counterfactual 1870-1913 | Actual |
| Gini | 29.8 | 30.8 | 31.8 |
| Top 1% | 8.550 | 10.098 | 12.523 |

Sources: see the text and Appendix C.

Figure A3: The growth of total exports at constant prices (1913=100)



Source: Federico and Tena-Junguito (2019).

Figure A4: Shares of world exports in the three countries

Source: Federico and Tena-Junguito (2019).

Figure A5: Shares pf primary products on total exports from the three countries (%)

Notes: we plot two series for Colonial Indonesia because Federico and Tena-Junguito’s (2019) source (Korthal Altes 1991) reports data for selected goods only and no data in 1874-1879. The series ‘Colonial Indonesia, max’ assumes that these goods are representative of the whole export trade, while the series ‘Colonial Indonesia, min’ assumes that all missing goods were industrial products. This latter assumption is in contrast with the anecdotal evidence. The actual share is likely to be close to 100 and to be fairly stable in time.

Source: Federico and Tena-Junguito (2019).

Figure A6: Price of Java sugar in Indonesia and in the UK (£/long ton)

Notes: HP stands for Hodrick-Prescott filter (smoothing parameter=6.25, as customary with annual data).

Source: Chilosi and Federico (2015).

**Appendix C: sources of the aggregate welfare gains**

The multi-lateral estimates of the welfare gains from cotton (from both India and the United States) and American wheat are from Chilosi and Federico (2021). What follows presents the sources used for the values of the variables and parameters needed to compute the new bilateral estimates. To begin with, Table A8 presents trade costs in 1913, their changes in the previous decades, as well as the elasticities.

Table A10: Trade costs, their changes (relative to the export price in 1913) and elasticities used for the new bilateral welfare estimates

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | Changes in trade costs | Elasticities |  |  |  |
|  |  |  |  | Demand |  | Supply |  |
| Good | Origin | Destination | Trade costs in 1913 | 1815-1913 | 1870-1913 | Producer | Consumer | Producer | Consumer |
| Cotton | India | UK | 0.019 | -1.089 | -0.253 | -0.65 | -0.8 | 1 | 0.5 |
| Indigo | India | UK | 0.124 | -2.283 | -0.156 | -1.5 | -1 | 0.5 | 0.5 |
| Jute | India | UK | 0.056 | -0.502 | -0.348 | -1 | -1 | 0.5 | 0.5 |
| Linseed | India | UK | 0.108 | -0.667 | -0.221 | -1.2 | -0.5 | 0.5 | 0.5 |
| Rapeseed | India | UK | 0.122 | -0.426 | -0.426 | -1.2 | -0.5 | 0.5 | 0.5 |
| Rice | India | UK | 0.251 | -0.561 | -0.561 | -1 | -0.5 | 0.5 | 0.5 |
| Tea | India | UK | 0.223 | -0.211 | -0.211 | -1 | -1 | 0.5 | 0.5 |
| Wheat | India | UK | 0.189 | -0.839 | -0.314 | -0.5 | -0.5 | 0.75 | 0.5 |
| Coffee | Indonesia | UK⸸ | 0.104 | -0.299 | -0.114 | -1 | -1 | 0.5 | 0.5 |
| Sugar | Indonesia | UK | 0.108 | -0.713 | -0.382 | -1 | -0.3 | 0.5 | 0.5 |
| Tin | Indonesia | Netherlands | 0.011 | -0.095 | -0.115 | -0.9 | -1 | 1 | 1 |
| Cotton | US | UK | 0.088 | -0.824 | -0.012 | -0.65 | -0.65 | 0.5 | 1 |
| Wheat | US | UK | 0.006 | -0.560 | -0.250 | -0.5 | -0.5 | 0.75 | 0.75 |

Notes: ⸸Here we assume that trade costs to the UK are the same as to the Netherlands.

Sources: see the text of Appendix C.

Our source for trade costs is Chilosi and Federico’s (2015) database. We estimate trade costs, relative to export prices in 1913, in three steps. First, we compute yearly series of predicted price ratios by combining relevant coefficients from the route-specific regressions from Chilosi and Federico (2015: Table 6) with the values of the explicative variables (freights, duties etc.). These series are strictly correlated with the actual price gaps, but fluctuations are only half as wide as the original series. We then convert the ratios into nominal specific (i.e. per unit of weight) trade costs by taking the average of the specific cost implied by the expected (HP-filtered, with 6.25 smoothing factor) import and export prices. Finally, we deflate the nominal values with the (HP-filtered) export price in the producing country in 1913. The changes in trade costs are then simply the trade cost in 1913 minus the trade cost at the beginning (eg. 1815 or 1870).

The elasticities are drawn from an extensive survey of the literature, cross-checking the different sources for consistency. We rely on estimates which match our products, period and areas as closely as possible. A close match in all three respects was possible for the European demand for wheat and jute, the American demand for cotton, the European and American supplies of wheat and the Indian and American supplies of cotton. While O’Rourke and Williamson (1994: 914), basing themselves on old estimates, assume that the elasticity of the UK’s demand for wheat in 1870-1913 was -0.3, a recent estimate by Barquín (2005: 264) for Europe in 1884-1913 implies a somewhat higher elasticity (-0.45). A correction in the same direction is also implied by the figure used by Allen (2000: 14) for the demand for agricultural products in pre-modern Europe (-0.6). We therefore use -0.5. The elasticity of the European demand for jute is estimated as -1, as done by the producers in India at the time (Chakrabarty, 2000: 43). The elasticity of demand for cotton in the US is based on Wright’s (1971: 119) estimate for the mid-nineteenth century. We use the same value for the corresponding parameter in the UK, which had a similar income and climate.

Turning to the supply elasticity of wheat, O’Rourke and Williamson (1994: 119) justify a value of 1 by citing Harley (1986), who, in turn, cites Fisher and Temin (1970) for the US and Olson and Harris (1959) for the UK. Fisher and Temin (1970) offer estimates by US state for the period 1867-1914 and their average is indeed very close to 1. However, after eliminating an obvious outlier (Iowa, where the figure is 10.76), the mean becomes 0.74. Olson and Harris’ (1959) estimate (greater than 1.6) would imply that the supply in the UK in 1873-1894 was much more elastic than in the US, which is hardly plausible. Ward’s (2004: 251) recent estimate for the UK 1864-1880 is 0.68, which is in line with expectations. The figure is also close to estimates reported by Askari and Cummings (1976) for the UK in the inter-war years (0.72) and the US in 1867-1914 (0.8). We therefore use 0.75 for the elasticity of the supply of wheat both in the UK and the US. Wright’s (1974: 617) estimates of the supply elasticity of Indian cotton in the mid-nineteenth century range from 0.32 and 0.75; the value of 0.5, which is also close to those found by Wright (1974: 617-618) for Brazil and Egypt at the same time and is chosen by Irwin (2003: 284), too, is used here. Estimates by Wright (1974) and Duffy et al. (1994) agree that the supply was more elastic in the mid-nineteenth century U.S., in the order of twice as much (Irwin, 2003: 286), justifying a value of 1 there.

All the remaining elasticities of demand in the UK, but that of indigo, are based on recent estimates for Italy in 1870-1913 taken from Federico and Vasta (2014). Specifically, we use their figures as follows (the name in parentheses refers to the group upon which our estimates are based): rice (cereals), tea and coffee (tea, coffee and spices), tin (metals), rapeseed and linseed (oil seeds). Given that by the early twentieth century Germany produced synthetic substitutes for indigo, we assume that the demand for this specific product was comparatively elastic, both in India (-1) and especially in Europe (-1.5). Like O’Rourke and Williamson (1994), we assume that the elasticity of demand for wheat in the US was the same as in the UK, where diet and incomes were very similar. For the Asian demand, there are pre-1914 estimates only for cotton and hardware. Desai’s (1971: 353) estimate of the demand elasticity for cotton in India between 1814 and 1904 (-0.80) is admittedly rough; nevertheless it is reassuringly close to Murti and Sastri’s (1951: 320) estimate for the inter-war years (-0.89). The elasticity is also close but somewhat higher to the value used for the US and the UK (-0.65), where it is reasonable to assume that income and climate made cotton relatively more necessary than in India. Murti and Sastri (1951: 320) also estimates that the elasticity of demand for hardware in inter-war India was close to -1; this vale is used for the demand elasticity of tin in the Dutch East Indies.

For the remaining goods the Asian demand elasticities rely on measures made in present-day India. For Swamy and Bisanwager (1983: 681-682), Indian demand is more inelastic for wheat (-0.23 to -0.32) than for rice (-0.58 to -0.70), which is odd. For Kumar et al. (2011: 11-12) for the very poor the demand elasticity for both wheat and rice is about -0.5, which matches those of the UK and the US before 1913; hence, we use this value for both wheat and rice in Asia. Kumar et al.’s (2011: 11-12) estimates for the very poor also suggest demand elasticities in Asia of -0.5 for rapeseed and lineseed (edible oils), -0.3 for sugar, and -1 for jute, tea, coffee and pepper (other food & non-food). These values imply equal or lower elasticities of demand for food in Asia than in Europe, which is consistent with inelastic demand for items of staple food in low-income economies with few available substitutes.

For the Asian supply elasticities, we mainly rely on Askarin and Cummins (1976) and Krishna (1963: 485) who report pre- ‘green revolution’ figures for rice, wheat, rape, cotton, jute, sugar and tea. Reassuringly the figures do not suggest major changes between the inter-war years and the post-1945 period. Indeed, for cotton they tend to be very close to the nineteenth-century estimates quoted earlier: discounting for an obvious outlier (American cotton in Punjab in 1900-19139 yields a figure of 9.74) the average (0.59) is very close to 0.5. In general, the production of agricultural commodities emerges as inelastic and the figures suggest that 0.5 is a reasonable approximation. For tin, too, we rely on present-day (1955-1975) estimates in Indonesia and other producing areas, which suggest that a value of 1 is appropriate (Chhabra et al., 1978: 13). Although mining technology obviously did change significantly since 1913, for Matthews (1990: 23) in the nineteenth-century, too, tin production was inelastic in the short-run, but more elastic in the long-run. With the only exceptions of wheat, whose supply elasticity has already been discussed, and Indian cotton, which was mainly substituted by American cotton, for Europe, in all cases the main alternative sources were other tropical countries. Hence, the Asian supply elasticities are used for the European elasticities for all the remaining goods. As implied earlier, at least for cotton, that this assumption is reasonable is borne out by the data. By the same token, the American elasticity is used for Europe when examining Indian cotton.

Table A11: National accounts’ figures

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Good | Origin | Destination | *w* | *Z* | *θP* | *δP* | *θC* | *δC* |
| Cotton | India | UK | 0.502 | 1.164 | 0.030 | 0.012 | 0 | 0.024 |
| Indigo | India | UK | 1.000 | 0.031 | 0.000 | 0.000 | 0 | 0.000 |
| Jute | India | UK | 0.490 | 0.002 | 0.021 | 0.006 | 0 | 0.002 |
| Linseed | India | UK | 0.144 | 0.445 | 0.004 | 0.001 | 0 | 0.003 |
| Rapeseed | India | UK | 0.692 | 0.015 | 0.008 | 0.006 | 0 | 0.003 |
| Rice | India | UK | 0.912 | 0.003 | 0.193 | 0.183 | 0 | 0.001 |
| Tea | India | UK | 0.049 | 0.572 | 0.007 | 0.001 | 0 | 0.004 |
| Wheat | India | UK | 0.854 | 0.620 | 0.048 | 0.042 | 0.002 | 0.021 |
| Coffee | Indonesia | Netherlands/UK | 0.197 | 2.429 | 0.005 | 0.001 | 0 | 0.001 |
| Sugar | Indonesia | UK | 0.080 | 1.201 | 0.030 | 0.002 | 0 | 0.008 |
| Tin | Indonesia | Netherlands | 0.089 | 0.405 | 0.025 | 0.002 |  |  |
| Cotton | US | UK | 0.300 | 0.086 | 0.019 | 0.008 | 0 | 0.024 |
| Wheat | US | UK | 0.910 | 0.255 | 0.011 | 0.011 | 0.002 | 0.021 |

Notes: *w*=quantity consumed in the producing country relative to the quantity supplied in the producing country; *z*=quantity supplied in the consuming country (including imports from third countries) relative to the quantity supplied in the producing country; *θP*=value of supply in producing country relative to GDP; *δP*=value of consumption in producing country relative to GDP; *θC*=value of supply in consuming country relative to GDP; *δC*=value of consumption in consuming country (excluding imports from third countries) relative to GDP. Due to data availability, for coffee we rely on Dutch data to estimate the effect of market integration on prices and then make the (rather undemanding) assumption that the changes in prices were the same as in the UK for the welfare calculations.

Sources: see the text of Appendix C.

Turning to the national accounts’ figures data (Table A9), quantities produced in British India are from Sivasubramonian (2000: table 3b), wheat production in the UK is from Mitchell (1988: 196-197), quantities produced in the Dutch East Indies and the United States are from the on-line version of Mitchell’s *Historical Statistics* (accessed on 7th February 2014). All production data are in thousands of tons and we use three-year averages centered in 1913. To compute *w* (consumption in producing countries relative to the supply in the producing country) and *z* (supply in the consuming country, including imports from third countries, relative to the supply in the producing country) the production data are combined with trade data (also three-year averages centered in 1913 in thousands of tons), from the following sources. Total imports and imports from our producers in the United Kingdom are from *Annual Statement of Trade* (1914), total exports from British India are from the *Statistical Abstract of British Colonies* (1914: 73-74), total exports from the United States are from Carter et al. (2006: Tables Ee 570 and Ee574), those from the Dutch East Indies are from Korthal Altes (1991: Table 6A), total imports and imports from the Dutch East Indies into the Netherlands are from *Statistiek van den In-, Uit-en Doorvoer* (1914).

The numerator of the share of the *i-th* product on total GDP (*θ*) should be the value added (VA), but all sources report the gross output, inclusive of expenditures. We thus estimate the VA by product by multiplying gross output by a country-specific ratio gross output/VA from Federico (2004). We estimate the shares of consumption on GDP *δ* under the assumption that consumers buy raw materials (cotton, wheat etc.) separately from processing and selling services. Thus, we compute the consumption as gross output less net exports, which is equivalent to imports for goods not produced in the country (e.g. tea in the United Kingdom).

In all cases, we compute the welfare gains separately by product. For the United States, we obtain data on gross output of wheat and cotton from Strauss and Bean (1940, Tables 13 and 25) and on GDP, consumption and net exports from Carter et al. (2006: Tables Ca188, Cd1, Ee571 and Ee575). The ratio VA/output is 0.84. We get data on gross output of wheat in the United Kingdom, from Ojala (1952: 208-209) and we use a VA/GDP ratio of 0.66. Imports are from *Annual Statement of Trade* (1913); total consumption and GDP are from Feinstein (1972: Table T9). For India, we assume a VA/output 0.95 and we take data on gross output by product and total GDP from Sivasubramonian (2000: Tables 3 (c) and 6.10), averaging two consecutive crop years and on value of trade from the *Statistical Abstract of British India* (1913 issue).[[2]](#footnote-2)

The Dutch Indies are an exception because the estimates of national accounts by van der Eng (1992, Table A4) divide total agricultural production in three categories, food crops, cash crops (from peasant farms) and estate crops. In line with 1913 production data, we assume that sugar and coffee accounted for 65 per cent and 10 per cent respectively of the sum of cash and estate crops, with an output/VA ratio of 0.95. Likewise, we assume that tin accounted for half of mining output and that VA accounted for 90 per cent of the value of production. Finally, we rely on the data on quantities to estimate shares of domestic consumption of coffee, sugar and tin (ie. we use the same sources as those used for *w*, the quantities consumed in the producing country).

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1. We cannot reproduce Steinwender’s (2014) approach to market efficiency because it needs high-frequency data which are not available. [↑](#footnote-ref-1)
2. The source does not report data on trade in linseed. We assume exports accounted for 15 per cent of gross output, as for rapeseed. [↑](#footnote-ref-2)