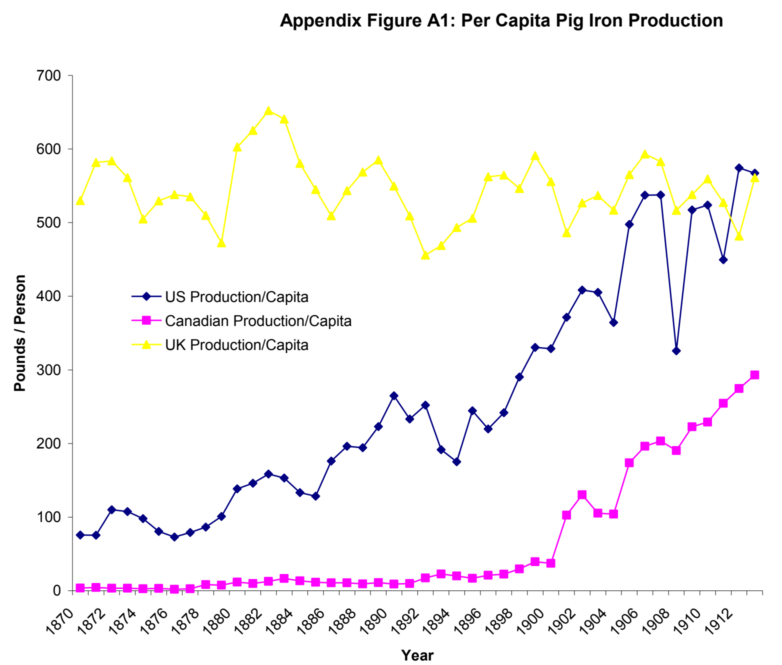
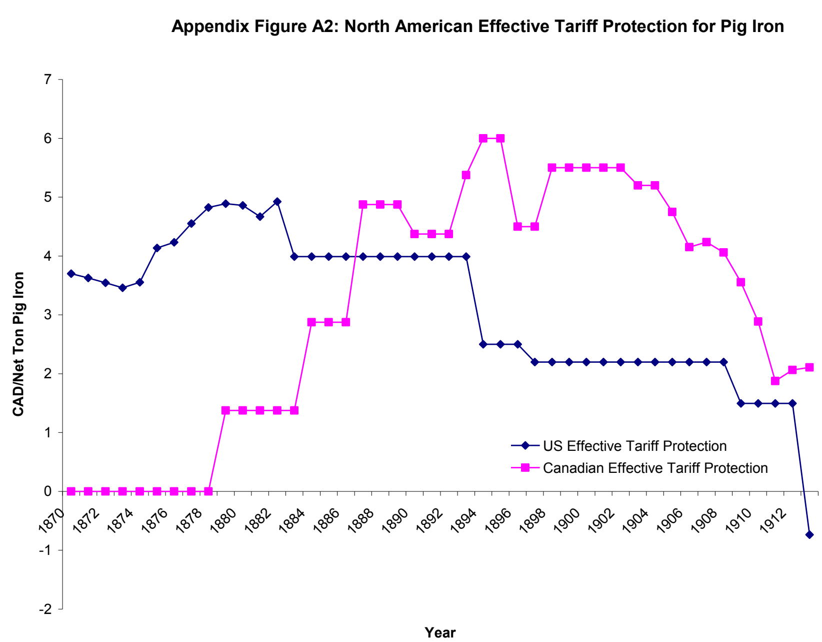
# *Online Appendix*

## *Transport Costs and Trade Volumes: Evidence from the Trans-Atlantic Iron Trade, 1870–1913*

FIGURES, ALTERNATE MODELS, SENSITIVITY TESTING, IV ESTIMATION, DATA

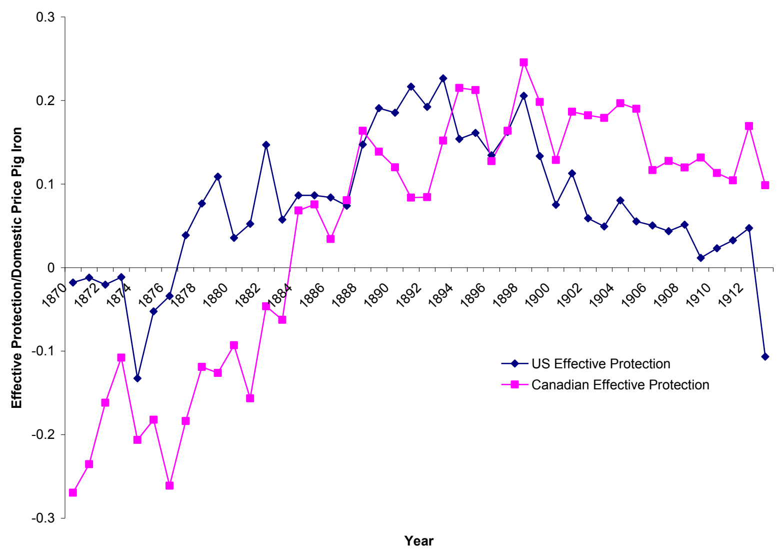



*Sources*: See Data Appendix.



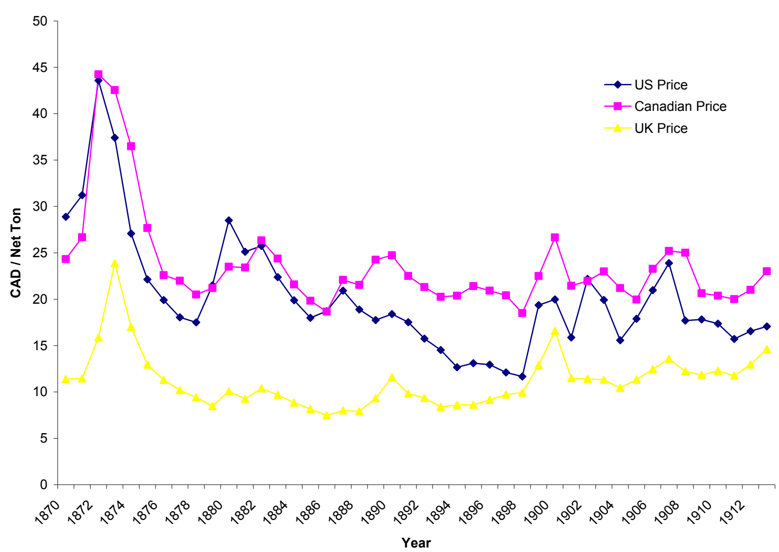

*Sources*: See Data Appendix.

**Appendix Figure A3: North American Ad Valorem Effective Protection for Pig Iron**




*Sources*: See Data Appendix.

**Appendix Figure A4: Trans-Atlantic Pig Iron Prices**




*Sources*: See Data Appendix.

APPENDIX TABLE A1
ALTERNATE NORTH AMERICAN IMPORT DEMAND FUNCTIONS

| | IV | | | |
|---|---|---|---|---|
| | Model 4 | Model 5 | Model 6 | Model 7 |
| *Transport:* | | | | |
| Ocean + Other Freight | –2.563*** | –2.627*** | — | –1.108* |
| | (0.691) | (0.770) | — | (0.612) |
| Input Transport | 2.017* | — | — | — |
| | (1.071) | — | — | — |
| Ore Transport | — | 1.182** | — | — |
| | — | (0.571) | — | — |
| Coke Transport | — | 1.635* | — | — |
| | — | (0.974) | — | — |
| *Tariff:* | | | | |
| Pig Iron Tariff | –1.044*** | –0.796*** | — | –1.074*** |
| | (0.203) | (0.172) | — | (0.187) |
| Input Tariff | 1.041*** | — | — | 0.932*** |
| | (0.350) | — | — | (0.323) |
| Ore Tariff | — | 0.278 | — | — |
| | — | (0.204) | — | — |
| Coke Tariff | — | 0.551*** | — | — |
| | — | (0.191) | — | — |
| *Protection:* | | | | |
| Net Transport and Tariff | — | — | –2.890*** | — |
| | — | — | (0.457) | — |
| *Exchange Rate:* | | | | |
| Gold Standard | –0.565* | –0.269 | –0.162 | –0.861*** |
| | (0.337) | (0.348) | (0.223) | (0.286) |
| *Import Demand:* | | | | |
| Own Price | 3.795*** | 3.087*** | 3.626*** | 4.472*** |
| | (0.925) | (0.640) | (0.617) | (0.555) |
| U.K. Price | –1.476** | –1.248** | –1.672*** | –2.058*** |
| | (0.674) | (0.617) | (0.513) | (0.484) |
| Other N. Amer. Price | –1.744*** | –1.673*** | –2.173*** | –1.309* |
| | (0.584) | (0.546) | (0.451) | (0.696) |
| Gross Investment | 1.407*** | 1.517*** | 1.199*** | 1.057*** |
| | (0.237) | (0.254) | (0.163) | (0.164) |
| Lagged Trade Volume | 0.373*** | 0.385*** | 0.446*** | 0.422*** |
| | (0.069) | (0.068) | (0.077) | (0.064) |
| *Technology:* | | | | |
| Charcoal-to-Coke | –1.265*** | –1.273*** | –1.708*** | –0.896*** |
| | (0.282) | (0.294) | (0.399) | (0.281) |
| Cold-to-Hot Metal | –0.957*** | –1.051*** | –0.694*** | –0.815*** |
| | (0.253) | (0.235) | (0.192) | (0.272) |
| *Fixed Effects:* | | | | |
| Canada | 1.281** | 0.780 | 0.109 | 0.621 |
| | (0.542) | (0.620) | (0.331) | (0.589) |
| Constant | 1.183 | 3.430 | 4.732*** | –1.571 |
| | (2.914) | (2.973) | (1.159) | (2.027) |
| N | 86 | 86 | 86 | 86 |
| $R^2$ | 0.842 | 0.771 | 0.755 | 0.766 |

*Note*: See Table 2; Model 5 disaggregates iron ore and coke transport costs and tariffs; Model 6 aggregates all transport costs and tariffs into protection / net ton pig iron = (pig iron transport cost + tariff) – (raw material transport cost and tariff); Model 7 IV Model 2 (all pig iron transport costs, without controls for raw material transport costs).
*Sources*: See discussion in text and Data Appendix.

APPENDIX TABLE A2
SENSITIVITY TESTING

| | Panel A: IV | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 4 | Test 1: Drop U.S. Input Tariffs | Test 2: Additional Controls | Test 3: Alt. Cold-to-Hot Metal | Test 4: Levels | Test 5: First Differences | Test 6: No Interpolation | Test 7: Industrial Output |
| *Transport:* | | | | | | | | |
| Ocean + Other Freight | –2.563*** | –2.020*** | –2.204*** | –1.870*** | –4.138*** | –3.228* | –3.890** | –1.370** |
| | (0.691) | (0.611) | (0.809) | (0.684) | (1.568) | (1.923) | (1.562) | (0.664) |
| Input Transport | 2.017* | 2.488*** | 1.847* | 1.771* | 0.180 | 1.759* | 0.656 | 1.478* |
| | (1.071) | (0.923) | (1.054) | (0.912) | (1.259) | (0.904) | (1.045) | (0.880) |
| *Tariff:* | | | | | | | | |
| Pig Iron Tariff | –1.044*** | –0.705*** | –0.900*** | –0.795*** | –4.119* | –1.047* | –1.850*** | –0.787*** |
| | (0.203) | (0.149) | (0.304) | (0.173) | (2.459) | (0.605) | (0.506) | (0.235) |
| Input Tariff | 1.041*** | 0.568*** | 0.886*** | 0.769** | 4.672 | 0.771* | 2.273*** | 0.582* |
| | (0.350) | (0.177) | (0.313) | (0.323) | (5.431) | (0.412) | (0.832) | (0.325) |
| *Exchange Rate:* | | | | | | | | |
| Gold Standard | –0.565* | –0.108 | –0.405 | –0.489* | –4.143 | –0.078 | –1.079** | –0.675 |
| | (0.337) | (0.278) | (0.373) | (0.279) | (4.600) | (0.165) | (0.417) | (0.417) |
| Exch. Rate Volatility | — | — | 0.045 | — | — | — | — | — |
| | — | — | (0.164) | — | — | — | — | — |
| *Import Demand:* | | | | | | | | |
| Own Price | 3.795*** | 2.926*** | 3.346*** | 3.089*** | 3.851*** | 1.253 | 7.138*** | 2.846*** |
| | (0.925) | (0.720) | (1.069) | (0.722) | (1.068) | (1.803) | (1.935) | (1.034) |
| U.K. Price | –1.476** | –1.040* | –1.319* | –1.168** | –3.051*** | –0.180 | –1.700** | –1.328* |
| | (0.674) | (0.617) | (0.684) | (0.526) | (0.987) | (0.867) | (0.762) | (0.780) |
| Other N.A. Price | –1.744*** | –1.734*** | –1.498*** | –1.462*** | –1.216*** | –1.295* | –2.155* | –1.317** |
| | (0.584) | (0.501) | (0.507) | (0.526) | (0.356) | (0.737) | (1.147) | (0.654) |
| Domestic Demand | 1.407*** | 1.429*** | 1.329*** | 1.470*** | 12.624* | 2.113** | 1.046*** | 1.549*** |
| | (0.237) | (0.218) | (0.289) | (0.205) | (6.790) | (0.940) | (0.287) | (0.372) |
| Lagged Trade Volume | 0.373*** | 0.405*** | 0.421*** | 0.353*** | 0.256** | — | 0.293*** | 0.506*** |
| | (0.069) | (0.070) | (0.076) | (0.071) | (0.123) | — | (0.093) | (0.073) |
| GDP Similarity | — | — | –0.050 | — | — | — | — | — |
| | — | — | (0.719) | — | — | — | — | — |
| *Technology:* | | | | | | | | |
| Charcoal-to-Coke | –1.265*** | –1.233*** | –1.155*** | –1.159*** | –8.384* | 0.113 | –1.806** | –0.807*** |
| | (0.282) | (0.295) | (0.292) | (0.247) | (4.453) | (0.132) | (0.753) | (0.259) |
| Cold-to-Hot Metal | –0.957*** | –0.975*** | –0.892*** | –1.250*** | –6.014** | –0.099 | –1.283*** | –0.768*** |
| | (0.253) | (0.211) | (0.265) | (0.191) | (2.836) | (0.135) | (0.346) | (0.236) |
| United States—Early | — | — | — | –0.224 | — | — | — | — |
| | — | — | — | (0.215) | — | — | — | — |
| United States—Late | — | — | — | –0.602** | — | — | — | — |
| | — | — | — | (0.243) | — | — | — | — |
| *Fixed Effects:* | | | | | | | | |
| Canada | 1.281** | –0.153 | 1.136 | 1.298*** | 15.620 | 0.189 | 1.605* | –0.429 |
| | (0.542) | (0.415) | (0.786) | (0.445) | (11.132) | (0.115) | (0.904) | (0.456) |
| Constant | 1.183 | 4.041* | 1.315 | 1.937 | –21.484 | –0.100 | –8.830*** | –0.122 |
| | (2.914) | (2.345) | (2.908) | (2.523) | (17.324) | (0.211) | (3.171) | (3.136) |
| N | 86 | 86 | 86 | 86 | 86 | 86 | 58 | 86 |
| $R^2$ | 0.842 | 0.861 | 0.854 | 0.867 | 0.658 | 0.197 | 0.813 | 0.729 |

*Note*: See Table 2; Test 1 drops U.S. input tariffs; Test 2 controls for early (1892) and late (1902) U.S. move to hot-metal; Test 3 drops log-log specification; Test 4 uses first differenced data; Test 5 drops interpolated freight rates; Test 6 uses industrial output for domestic demand; Test 7 includes exchange rate volatility and GDP similarity.
*Sources*: See discussion in text and Data Appendix.

| | Panel B: IV | | | | | |
|---|---|---|---|---|---|---|
| | Model 4 | Test 8: Endogenous U.K. Price | Test 9: Endog. Input Transport and Tariff | Test 10: Additional Instruments | Test 11: Decompose Price | Test 12: Include U.S.→ Cda Exports |
| *Transport:* | | | | | | |
| Ocean + Other Freight | –2.563*** | –3.037*** | –3.666*** | –2.500*** | –3.481*** | –1.901** |
| | (0.691) | (0.700) | (1.007) | (0.701) | (0.652) | (0.847) |
| Input Transport | 2.017* | 2.461** | 3.431* | 1.842* | 2.829*** | 0.308 |
| | (1.071) | (1.013) | (1.811) | (1.032) | (0.749) | (0.971) |
| *Tariff:* | | | | | | |
| Pig Iron Tariff | –1.044*** | –1.031*** | –1.195*** | –1.103*** | –1.033*** | –0.630*** |
| | (0.203) | (0.165) | (0.254) | (0.190) | (0.217) | (0.185) |
| Input Tariff | 1.041*** | 0.969*** | 1.523** | 1.038*** | 1.003*** | 0.527** |
| | (0.350) | (0.345) | (0.598) | (0.343) | (0.303) | (0.260) |
| *Exchange Rate:* | | | | | | |
| Gold Standard | –0.565* | –0.579* | –0.454 | –0.663** | –0.681** | –0.921*** |
| | (0.337) | (0.318) | (0.559) | (0.314) | (0.331) | (0.306) |
| *Import Demand:* | | | | | | |
| Own Price | 3.795*** | 3.627*** | 3.720*** | 3.964*** | — | 3.815*** |
| | (0.925) | (0.726) | (0.834) | (0.867) | — | (1.076) |
| Own Price | — | — | — | — | 4.845*** | — |
| (Protection Removed) | — | — | — | — | (1.087) | — |
| U.K. Price | –1.476** | –1.552** | –1.265* | –1.603** | –1.554** | –2.189*** |
| | (0.674) | (0.629) | (0.686) | (0.659) | (0.624) | (0.502) |
| Other N.A. Price | 1.744*** | –1.533*** | –2.171*** | –1.634*** | — | –0.439 |
| | (0.584) | (0.564) | (0.796) | (0.578) | — | (0.484) |
| Other N.A. Price | — | — | — | | –2.084*** | — |
| (Protection Removed) | — | — | — | | (0.606) | — |
| Domestic Demand | 1.407*** | 1.543*** | 1.781*** | 1.445*** | 1.336*** | 0.895*** |
| | (0.237) | (0.254) | (0.374) | (0.233) | (0.223) | (0.248) |
| Lagged Trade | 0.373*** | 0.357*** | 0.282*** | 0.381*** | 0.367*** | 0.450*** |
| Volume | (0.069) | (0.073) | (0.103) | (0.067) | (0.066) | (0.063) |
| *Technology:* | | | | | | |
| Charcoal-to-Coke | –1.265*** | –1.356*** | –1.569*** | –1.249*** | –1.288*** | –0.474* |
| | (0.282) | (0.273) | (0.459) | (0.282) | (0.313) | (0.282) |
| Cold-to-Hot Metal | –0.957*** | –1.077*** | –1.033*** | –1.011*** | –0.898*** | –0.517** |
| | (0.253) | (0.238) | (0.285) | (0.259) | (0.574) | (0.235) |
| *Fixed Effects:* | | | | | | |
| United Kingdom | 1.281** | 1.516*** | 2.183*** | 1.310** | 0.894 | 0.718 |
| →Canada | (0.542) | (0.487) | (0.684) | (0.549) | (0.574) | (0.558) |
| United Kingdom | — | — | — | — | — | –1.290* |
| →United States | — | — | — | — | — | (0.761) |
| Constant | 1.183 | 1.423 | 2.934 | 0.683 | –1.127 | –2.863 |
| | (2.914) | (2.839) | (4.015) | (2.728) | (3.002) | (3.095) |
| N | 86 | 86 | 86 | 86 | 86 | 132 |
| $R^2$ | 0.842 | 0.830 | 0.797 | 0.840 | 0.841 | 0.820 |

*Note*: See Panel A; Test 8 includes British rail TFP from Crafts, Mills and Mulatu (2005) as an additional excluded instrument for *Transport,* and labor productivity in domestic iron ore mining as an additional excluded instrument for *Own Price*; Test 9 allows for potential endogeneity in U.K. prices; Test 10 allows for potential endogeneity in input transport costs and tariffs; Test 11 removes tariff and transport costs from prices; Test 12 expands panel to include U.S. exports into Canada.
*Sources*: See discussion in text and Data Appendix.

APPENDIX TABLE A3
FIRST STAGE IV ESTIMATION RESULTS AND DIAGNOSTIC TESTING

| | Endogenous Explanatory Variables: OLS | | |
|---|---|---|---|
| | Own Price | Transport Costs | Tariffs |
| *Excluded Instruments:* | | | |
| Domestic Coal Price | 0.460*** | — | — |
| | (0.150) | — | — |
| Manufacturing TFP | –0.486*** | — | — |
| | (0.180) | — | — |
| Harley (1989) Freight Rate Index | — | 0.468** | — |
| | — | (0.221) | — |
| Domestic RR TFP | — | –0.405*** | — |
| | — | (0.086) | — |
| Domestic Fish Price | — | 0.885*** | — |
| | — | (0.215) | — |
| Electoral Support for Protectionist Party | — | — | 0.636*** |
| | — | — | (0.212) |
| Canadian National Policy Dummy | — | — | 0.742*** |
| | — | — | (0.162) |
| N | 86 | 86 | 86 |
| Centered $R^2$ | 0.869 | 0.910 | 0.909 |
| *Diagnostic Testing:* | | | |
| Shea Partial $R^2$ | 0.255 | 0.347 | 0.475 |
| Partial *F-Statistic* | 6.03*** | 11.25*** | 41.45*** |
| | (0.000) | (0.000) | (0.000) |
| Hausman (*t-test*) | –1.69* | 2.84*** | 2.29** |
| | (0.096) | (0.006) | (0.025) |
| Durbin-Wu-Hausman (*F-Statistic*) | | 4.565*** | |
| | | (0.006) | |
| Under-ID (*LM Statistic*) | | 10.832* | |
| | | (0.055) | |
| Kleibergen-Paap (*F-Statistic*) | | 5.601 | |
| (Stock-Yogo 20 /10 percent Relative Bias) | | (5.56 / 8.50) | |
| Hansen (*J-Statistic*) | | 1.960 | |
| | | (0.743) | |

*Note*: For *Excluded Instruments* robust standard errors reported in parentheses. For *Diagnostic Tests* p-values reported in parentheses (unless otherwise noted). All continuous variables measured as natural logarithms.

(i) Shea Partial $R^2$: [0,1] measure of statistical relevance of excluded instruments for each potentially endogenous regressor.

(ii) Partial F-Statistic $H_o$: Jointly insignificant excluded instruments in first stage. Rejection indicates strong instruments for each endogenous regressor.

(iii) Hausman Specification Test $H_o$: Exogenous second stage regressor. Rejection indicates presence of endogeneity for each regressor.

(iv) Durbin-Wu-Hausman Specification Test $H_o$: Jointly exogenous second stage regressors. Rejection indicates presence of endogeneity among regressors.

(v) Under-Identification Test $H_o$: Jointly insignificant instruments in first stage (with multiple endogenous regressors). Rejection indicates strong instruments for endogenous regressors.

(vi) Kleibergen-Paap F-Stat (used in Stock-Yogo Relative Bias Test with robust standard errors): Critical values reported in parentheses for multiple endogenous regressors (assumed IID errors) reflect potential bias in small-sample IV estimates relative to potential bias in OLS with endogenous regressors.

(vii) Hansen Over-Identification Test $H_o$: Excluded instruments jointly exogenous. Inability to reject indicates that instruments are valid.

*Sources*: See discussion in text, IV Appendix and Data Appendix.

# *IV Appendix*

## ESTIMATION, ENDOGENEITY, INSTRUMENT SELECTION AND DIAGNOSTIC TESTING

- GMM, 2SLS, control function and panel 2SLS estimation approaches all generate identical IV parameter estimates, but because each method makes different assumptions about the underlying error structure, the reported standard errors can vary slightly. Fixed effects-two stage-generalized method of moments estimation (Stata command *xtivreg2, fe gmm robust bw small*) is appropriate for use with small sample panel data and linear estimation models. Because some instruments are common across panels, the independence assumption required for random effects estimation is inappropriate. A small sample degrees of freedom correction has been made for reported first and second stage test statistics. Standard errors are consistent in the presence of arbitrary autocorrelation and heteroskedasticity. Bandwidth for the autocorrelation correction has been selected on the basis of the rule-of-thumb: $bw \approx N^{1/3}$. None of our qualitative conclusions are affected by the use of appropriate control function or 2SLS approaches.

- Conditional on the endogeneity of trans-Atlantic transport costs, pig iron tariffs and domestic pig iron prices, Hausman exogeneity tests cannot reject the exogeneity of: British pig iron prices (*p value* = 0.462); pig iron prices in the neighboring North American market (*p value* = 0.857); input transport costs (*p value* = 0.804); or input tariffs (*p value* = 0.488); with any standard levels of statistical confidence. Because under some specifications the exogeneity tests for British pig iron prices and iron ore transport costs approach marginal rejections, British prices, and input transport costs and tariffs are assumed to be endogenous in Test 9 and 10 (respectively), Appendix Table A2, Panel B.

- All excluded instruments are smoothed using a Hoddrick-Prescott filter to isolate longer run trend movements from highly volatile annual deviations from trend. The degree of smoothing is selected in an effort to maximize instrument strength. Other smoothing techniques, including higher order time trends or moving averages generate very similar first and second stage results. GMM-distance tests cannot reject exogeneity for any of the excluded instruments used in Model 4.

- Excluded instruments for *Own Price* are meant to capture plausibly exogenous marginal cost determinants for pig iron. Domestic manufacturing productivity is measured as total factor productivity for all manufacturing industries other than iron and steel. Coal prices are likely to be exogenous because short and medium run supply curves for natural resources, including coal, are typically considered to be inelastic, and there is no qualitative evidence that North American blast furnaces enjoyed any monopsonist power in domestic coal markets. Iron ore prices are less likely to be exogenous (GMM-distance test for exogeneity *p value* = 0.078), and productivity in iron ore mining (for Canada in particular) cannot be calculated on a consistent basis for our full period of study. The inclusion of additional excluded instruments similar to those employed by Irwin (2000)—domestic ore prices, domestic ore and coal mining productivity, foreign unskilled real wages, British corporate bond yields, or German coal and ore prices—does not affect our conclusions, although the diagnostic tests are sensitive to instrument choice. Productivity in domestic metallic mineral mining is included as an additional instrument in Test 8, Appendix Table A2, Panel B.

- Excluded instruments for *Transport* are meant to capture plausibly exogenous marginal cost determinants for trans-Atlantic pig iron shipments and intra-continental rail transport. Harley (1989) reports British freight rates for the west-bound trans-Atlantic shipment of coal. These rates reflect input costs and productivity for British shipping in general, and because they are product-specific, not multi-product averages that could include rates for iron ore and/or pig iron, they are more likely to be exogenous than the indexes reported in, for example, Isserlis (1938), Jacks and Pendakar (2010), or Mohammed and Williamson (2004). North American fisheries potentially compete with merchant shipping for local labor and capital. Marginal costs in the fishing industries are reflected in domestic fish prices, such that movements in these prices reflect changing input costs and/or productivity for the factors of production in merchant shipping. Domestic rail productivity is derived from information on ton-miles, employment, and investment among steam and electric railways reported in *U.S. Historical Statistics* (2006) and Urquhart (1993). Because the distance from British production points to British ports was short relative to the distance from North American ports to North American consumption points (Newcastle-to-Stockton = 60 km; New York-to-Pittsburgh = 600 km; Montreal-to-Hamilton = 610 km), British rail productivity is a relatively weak (but still statistically significant) instrument for pig iron transport costs. British rail productivity, reported in Crafts, Mills, and Mulatu (2007), is included as an additional instrument in Test 8, Appendix Table A2, Panel B. The inclusion of additional excluded instruments similar to those employed by Jacks and Pendakar (2010)—Norwegian sailors' wages, climate variables, fleet size, or the prevalence of steam power in the British fleet—does not affect our conclusions, although again diagnostic tests are sensitive to instrument choice. The authors thank David Jacks for providing data (and documentation) for some of our *Transport* instruments.

- Excluded instruments for *Tariffs* are meant to capture pre-emptive motives for trade policy and the presence of broader nation-building policy objectives. Political support for protectionist parties in the neighboring North American nation is measured as the share of Electoral College votes earned by Democrats in U.S. presidential elections, and the share of parliamentary seats won by Liberals in Canadian federal elections. Variants on this instrument, including total vote shares, election dummy variables, and electoral support for Republican and Conservative candidates, generate very similar first and second stage results. In Canada the National Policy was enacted in March 1879. This policy had broad nation-building objectives that included the construction of a trans-continental railway, the promotion of immigration, and protection for domestic manufacturers. The introduction of this policy is viewed as a regime change in the structure of Canadian trade policy that had no direct connection to trade flows for specific products or industries (see McDiarmid (1946) or Beaulieu and Cherniwchan (2014)). Political economy models that include trade policy determinants similar in spirit to our instruments can be found in Irwin (1994), or Beaulieu and Emery (2001). The inclusion of foreign duties, domestic pork exports, domestic wheat prices, or German and French pig iron output as additional excluded instruments does not affect our conclusions.

- In Appendix Table A3 we report that all excluded instruments have the expected sign and are strongly statistically significant: lower coal prices and improved manufacturing productivity are associated with falling domestic pig iron prices; falling freight rates for British coal exports, improvements in North American rail productivity, and falling North American fish prices are associated with falling transport costs; and support for protectionist political parties in the neighboring countries' national elections, and the introduction of a broad policy commitment to "nation building" in Canada are associated with rising tariffs.

- The rejection of the equation-specific Hausman specification tests (*t-stat*=–1.69, p-value=0.096 for *Own Price*; *t-stat*=2.84, p-value=0.006 for *Transport Costs*; and *t-stat*=2.29, p-value=0.025 for *Tariffs*) confirms that *Own Price, Transport,* and *Tariffs* should be considered endogenous in our import demand functions. High first stage $R^2$ and Shea partial $R^2$, and the strong rejection of the first stage partial F-tests (Partial *F-stat*=6.03, p-value=0.000 for *Own Price*; Partial *F-stat*=11.25, p-value=0.000 for *Transport Costs*; and Partial *F-stat*=41.45, p-value=0.000 for *Tariffs*) confirms the statistical significance of the excluded instruments in each first stage equation.

- The Durbin-Wu-Hausman joint specification test (*F-stat*=4.57, p-value=0.006), confirms that as a group *Own Price, Transport,* and *Tariffs* should be considered endogenous in our import demand functions. The (marginal) rejection of the second stage under-identification test (*LM-stat*=10.83, p-value=0.055) confirms the joint statistical significance of the excluded instruments across all three first stage equations. The inability to reject the Hansen test (*J-stat*=1.96, p-value=0.743) confirms the "validity" of the excluded instruments, in the sense that these instruments should not be included as explanatory variables in the second stage. And finally, the Stock-Yogo relative bias test (Kleibergen-Paap *F*-stat=5.60, Stock-Yogo 20 percent relative bias critical value=5.56) confirms that the maximum potential weak instrument bias associated with our use of an IV approach with a two country-44 year panel will be less than one-fifth the potential bias associated with the use of OLS with our three endogenous regressors.

# *Data Appendix*

## *Canadian Pig Iron*

Canadian Pig Iron Production, By Province (Net Tons)[1]:

| | |
|---|---|
| 1870–1886 | Inwood (1986), Pg. 105–6, *Halifax Herald* (1890), January 16. |
| 1887–1913 | Geological Survey of Canada, *Mining and Mineral Industry Returns, 1887–1920, Blast Furnaces*, National Archives of Canada (NAC), Record Group (RG) 87, Volume 18–19. |

Canadian Pig Iron Production, By Blast Furnace (Net Tons):

| | |
|---|---|
| 1870–1886 | Inwood (1984), Table 4.1, *Halifax Herald* (1890), January 16. |
| 1887–1913 | Geological Survey of Canada, *Mining and Mineral Industry Returns, 1887–1920, Blast Furnaces*, NAC, RG 87, Volume 18. |

Canadian Steel Ingot Production, By Province (Net Tons):

| | |
|---|---|
| 1887–1890 | NAC, RG 87, Volume 18–19. |
| 1891–1893 | Linear interpolation between 1890 and 1894. |
| 1894–1900 | Geological Survey of Canada, *Report of Progress*, Statistical Section. |
| 1901–1904 | NAC, RG 87, Volume 18–19. |
| 1905–1906 | Dominion Iron and Steel Corporation, *Annual Report* (1905), Lake Superior Corporation, *Annual Report* (1906), Public Archives of Nova Scotia, Manuscript Group 3, Volume 1873, Number 52. |
| 1907–1913 | NAC, RG 87, Volume 18–19. |

Total Employment, By Blast Furnace, Canada (Number Employees):

| | |
|---|---|
| 1870–1886 | Various Years and Furnaces, Robert Bell, *Papers and Correspondence*, NAC, R7346-11-9-E (formerly MG 29-B15), Hamelin and Roby (1969), Pg. 250, Hardy (1995), Pg. 102–5, Harrington (1874) and (1883), Massey (1976), *Montreal Gazette* (1881), May 31. |
| 1887–1913 | Geological Survey of Canada, *Mining and Mineral Industry Returns, 1887–1920, Blast Furnaces*, NAC, RG 87, Volume 18–19. |

Total Employment, By Blast Furnace, Canada (Person-Days):

| | |
|---|---|
| 1870–1904 | Total Production ÷ Production Per Day, Various Years, Robert Bell, *Papers and Correspondence*, NAC, R7346-11-9-E (formerly MG 29-B15), *Canada Iron Furnace Company: Radnor Forges* (1893), Harrington (1874), Pg. 58–60, *Journal of the United States Association of Charcoal Iron Workers* (1883), Pg. 58, *London Mining Journal* (1881), April 28, MacDonald (1909), Pg. 240–3, Milot (1983), *Montreal Herald* (1879), December 21, *Montreal Gazette* (1881), May 31. |
| 1905–1913 | Days in Blast, Geological Survey of Canada, *Mining and Mineral Industry Returns, 1887–1920, Blast Furnaces*, NAC, RG 87, Volume 19. |

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[1] Net or Short tons = 2000 lbs; Gross, Long, or Metric tons = 2240 lbs.

Canadian Blast Furnace Labor Remuneration (CAD/Person Day):
1870–1913 (Wages and Salaries in Primary Iron and Steel, Urquhart, Table 4.6) x (Share Pig Iron in Primary Iron and Steel, Urquhart, Pg. 377) x (Share Furnace Q in Aggregate Pig Iron Q) ÷ Total Furnace Employment.

*International Pig Iron*

U.S. Pig Iron Production, Aggregate (Metric Tons):
1870–1913 USHS, Series Db74.

U.S. Crude Steel Production (000 Metric Tons):
1870–1913 Mitchell (2003) Series D9.

U.K. Pig Iron Production, Aggregate (Gross Tons):
1870–1913 Mitchell and Deane (1962), Pg. 132.

German Pig Iron Production (Metric Tons):
1870–1913 Mitchell (2003), Series D8.

European Pig Iron Production, Aggregate (Metric Tons):
1870–1913 Mitchell (1993), Pg. 459–461.

*Canadian Macroeconomy*

Canadian Federal Election Years:
1870–1913 HS1, Series W46.

Canadian Party in Power:
1870–1913 Political party of Prime Minister, HS1, Series W6.

Canadian Population (000s):
1870–1913 HS1, Series A1.

Population of Western Provinces (000s):
1871, 1881, 1891, 1901, 1911 HS1 Series A9-12.
1870–1913 OLS Regression: Western Population=f(constant, total population, urban population, net migration, net wheat exports).

Canadian Gross National Product (000 CAD):
1870–1913 Urquhart, Table 1.1.

Canadian GNP Deflator (1900=100):
1870–1913 Urquhart, Table 1.6.

Canadian Wholesale Price Index (1900=100):
1868–1913 All commodities, HS1 Series J1.

Canadian Agriculture Price Index:

| | |
|---|---|
| 1870–1890 | Average WPI Vegetable Products and Animal Products, HS2, Series K35, K36. |
| 1890–1913 | WPI Farm Products, HS2, Series K49. |

Canadian Manufacturing Value Added (000 CAD):

| | |
|---|---|
| 1870–1913 | Urquhart, Table 1.1. |

Canadian Other Manufacturing Value Added (000 CAD):

| | |
|---|---|
| 1870–1913 | Manufacturing Value Added - Primary Iron and Steel Value Added, Urquhart, Table 4.5. |

Canadian Manufacturing Wages and Salaries (CAD):

| | |
|---|---|
| 1870–1913 | Urquhart (1993), Table 4.6. |

Canadian Manufacturing Total Employment (000s):

| | |
|---|---|
| 1871, 1881, 1891 | HS2, Series R21. |
| 1900–1913 | Keay (2010), *Canadian Natural Resource Industries Data Appendix*. |
| 1870–1913 | OLS Regression: Total L = f(constant, urban population, manufacturing output, year, year squared). |

Share Urban Population, Canada:

| | |
|---|---|
| 1871, 1881, 1891, 1901, 1911 | HS2, Series A68. |
| 1870–1913 | OLS Regression: Share Urban=f(constant, manufacturing share, population, net migration). |

Canadian Net Migration (000s):

| | |
|---|---|
| 1870–1913 | Green and Urquhart (1987), Table 4. |

Canadian Gross Migration (000s):

| | |
|---|---|
| 1870–1913 | HS2, Series A350. |

Canadian Net Wheat Exports (000s Bushels):

| | |
|---|---|
| 1870–1913 | Green and Urquhart (1987), Table 4. |

Canadian Wheat Prices:

| | |
|---|---|
| 1870–1913 | Wholesale market prices, HS2, Series M228. |

Canadian Grain Price Index:

| | |
|---|---|
| 1870–1913 | Wholesale Prices, Grains and Flour, HS1, Series J3. |

Canadian Pork Exports:

| | |
|---|---|
| 1870–1913 | Hogs, HS2, Series M419. |

Gross Fixed Capital Formation, Canada (000 CAD):

| | |
|---|---|
| 1870–1913 | Green and Urquhart (1987), Table 3. |

Foreign Capital Inflows, Canada (000 CAD):

| | |
|---|---|
| 1870–1913 | Current Account Balance, Green and Urquhart (1987), Table 3. |

Domestic Savings, Canada (000 CAD):
1870–1913 Residual (Gross Fixed Capital Formation-Foreign Capital Inflows), Green and Urquhart (1987), Table 3.

Canadian Other Manufacturing TFP Index:
1870–1913 Cost function specification of Tornqvist index of relative input prices for all manufacturing industries, other than primary iron and steel: $P$ = wholesale price index, weighted average all non-iron and steel commodities; $WL$ = index of average annual wages and salaries per non-iron and steel manufacturing worker; $WK$ = long term bond yields; $SL, SK$ = wage and salary share non-iron and steel manufacturing value added, assumed CRS.

$$\frac{}{} = \left\{\frac{/}{/}\right\}^{\times \quad +} \bullet \left\{\frac{/}{/}\right\}^{\times \quad +}$$

*International Macroeconomy*

U.S. Gross Private Saving Rate:
1870–1909 USHS, derived from sources for Figure Ce-E.
1910–1913 Interpolation from McLean (2007), Figure 1.

U.K. Gross Private Saving Rate:
1870–1913 Edelstein (1982), Table 8.6.

U.S. Real Wage Index:
1870–1913 U.S. Unskilled Nominal Wage Index, David and Solar (1977), Table B1 ÷ U.S. CPI, David and Solar Base, USHS, Series Cc2.

U.K. Real Wage Index:
1870–1913 U.K. Real Wage Index, Not Allowing for Unemployment, Mitchell and Deane (1962), Pg. 343.

German Real Industrial Wage Index:
1870–1913 Money wages from industry ÷ CPI (1913=1.00), Mitchell (2003), Pg. 186–87 and 864.

U.S. Gross Immigration (000s):
1870–1913 USHS, Series Ad1.

U.S. Total Population (000s):
1870–1913 USHS, Series Aa7.

U.K. Emigration (000s):
1870–1913 Outbound Passengers from British Ports, Mitchell and Deane (1962), Pg. 49.

U.K. Total Population (000s):
1870–1913 Mitchell and Deane (1962), Pg. 10.

U.S. Long Term Corporate Interest Rate:
1870–1913 Long Term Railway Bond Yields, USHS, Series Cj1195.

U.S. Long Term Government Bond Yields:
1870–1899 U.S. Government Bond Yields, USHS, Series Cj1192.
1900–1913 Index using U.S. Government Bond Yields (1880–1913), Accominotti, Flandreau and Rezzik (2010).

U.K. Short Term Interest Rate:
1870–1913 Open Market Discount Rate, NBER Macro-History Data Set, Series M13016.

U.K. Long Term Government Bond Yields:
1870–1880 Index using England 3 percent Consol Yields, NBER Macro-History Data Set, Series M13041b.
1880–1913 U.K. Government Bond Yields, Accominotti, Flandreau and Rizzek (2010).

U.K. Wholesale Price Index:
1870–1913 Overall Index, Mitchell and Deane (1962), Pg. 472–3.

U.S. Wholesale Price Index:
1867–1890 All Commodities, Warren and Pearson Index, USHS, Series Cc113.
1891–1913 All Commodities, BLS, USHS, Series Cc66.

U.S. Agriculture Price Index:
1870–1890 USHS, Series Cc114.
1890–1913 USHS, Series Cc86.

U.S. Grain Price Index:
1870–1880 Northern Wheat, USHS, Series Cc206.
1880–1890 Chicago Wheat, USHS, Series Cc207.
1890–1913 Spring and Winter Wheat, USHS, Series Cc208.

U.S. Pork Exports:
1870–1913 Hogs, U.S. Commerce and Navigation Reports, Various Years
1870–1913 Pork Products (excl. Lard), U.S. Department of Agriculture Technical Bulletin 764, March 1941.

U.K. GDP Deflator (1900=1.00):
1867–1913 Nominal GDP / Constant Dollar GDP, Mitchell (2007), Pg. 907 and 913.

U.S. GDP Deflator (1900=1.00):
1867–1913 USHS, Series Ca13.

U.K. Nominal GDP (M£):
1870–1913 Feinstein (1972), Table 1.

U.S. Nominal GDP ($M):
1870–1913 USHS, Series Ca10.

U.K. Net Foreign Investment (M£):
1870–1913 Feinstein (1972), Table 15.

U.S. Gross Fixed Capital Formation ($M):
1870–1909 Current USD, USHS, Series Ca200 x Series Ca207.
1910–1913 Index using nominal U.S. GDP.

U.S. Manufacturing TFP Index:
1870–1913 Cost function specification of Tornqvist index of relative input prices for all manufacturing industries: *P* = producer prices for all non-farm commodities; *WL* = nominal unskilled wages; *WK* = RR bond yields; *SL, SK* = wage and salary share manufacturing value added, with linear interpolation between census dates, assumed CRS.

*Railways*

Miles of 1st Main RR Track in Operation, Canada (000s):
1867–1913 HS1, Series S28.

Ton-Miles, Canada (000s):
1870–1913 Total revenue, steam and express railways, Urquhart (1993), Table 6.1 ÷ revenue / ton-mile, average Canadian railways, Inwood and Keay (2013), *Data Appendix*.

Total Railway Employment, Canada (000s):
1870–1913 Steam and express railways, Urquhart (1993), Table 6.8.

Railway Capital Stock, Canada (000 1900 CAD):
1870–1913 (Steam and express railway value added - wages and salaries paid) ÷ user cost for capital, Urquhart (1993) Table 6.2 and 6.3, and Harris, Keay, and Lewis (2014), *Data Appendix*.

Ton-Miles, U.S. (000 000s):
1870–1890 13 railroads, USHS, Series Q283.
1890–1913 All railroads, USHS, Series Q340.

Total Railway Employment, U.S. (000s):
1870–1879, 1881–1889 Interpolation based on miles in operation, USHS, Series Q321.
1880, 1890–1913 USHS, Series Q398.

Railway Capital Stock, U.S. (000 1900 USD):
1870–1913 USHS, Series Df893 and Series Df980.

U.K. Railway Labor Productivity and TFP:

| | |
|---|---|
| 1870–1912 | Average all lines, Crafts, Mills, and Mulatu (2005), Table 3. |
| 1913 | Interpolation based on Canadian RR Q/L and TFP. |

### *Port of Montreal Traffic*

# Vessels:

| | |
|---|---|
| 1870–1880 | Index using from U.K. (U.K. flag) with cargo. |
| 1881–1895 | Index using from all ports (U.K. flag) with cargo. |
| 1896–1908, 1910 | From U.K. (all flags), Dominion Shipping Reports, Trade and Navigation Reports, *Sessional Papers*. |
| 1909, 1911–13 | Index using from all ports (all flags). |

Registered Tonnage:

| | |
|---|---|
| 1870–1880 | Index using from U.K. (U.K. flag) with cargo. |
| 1881–1895 | Index using from all ports (U.K. flag) with cargo. |
| 1896–1908, 1910 | From U.K. (all flags), Dominion Shipping Reports, Trade and Navigation Reports, *Sessional Papers*. |
| 1909, 1911–13 | Index using from all ports (all flags). |

Freight Tonnage (by Weight):

| | |
|---|---|
| 1870–1875 | Out-of-sample prediction of weight share of registered tons (OLS Regression: Weight share=f(constant, # vessels, registered tonnage)) x registered tonnage. |
| 1876–1880 | Weight share of registered tons (from U.K. (U.K. flag) with cargo) x registered tonnage. |
| 1881–1904 | Weight share of registered tons (from all ports (U.K. flag) with cargo) x registered tonnage. |
| 1905 | Linear interpolation weight share of registered tons x registered tonnage. |
| 1906–1908 | Weight share of registered tons (from all ports (U.K. flag) with cargo) x registered tonnage. |
| 1909-1913 | Out-of-sample prediction of weight share of registered tons (OLS Regression: Weight share=f(constant, # vessels, registered tonnage)) x registered tonnage. |

### *Pig Iron Trade*

Canadian Gross Exports, Pig Iron (000 CAD):

| | |
|---|---|
| 1870–1913 | Donald (1915), Table G1. |

Canadian Gross Imports, Pig Iron (000 CAD):

| | |
|---|---|
| 1867–1880 | Trade and Navigation Reports, *Sessional Papers*. |
| 1880–1913 | Donald (1915), Table G3. |

Canadian Dutiable Imports, Pig Iron, from United Kingdome and United States:

| | |
|---|---|
| 1868–1913 | Trade and Navigation Reports, *Sessional Papers*. |
| 1868 | Index using Pig Iron, Copper, Lead (Dominion). |

| | |
|---|---|
| 1869–1875 | Index using Pig, Scrap, Galvanized, Booms, Billets, Slabs (ON, NS, NB). |
| 1875–1879 | Pig Iron (Cwt). |
| 1880 | Linear Interpolation. |
| 1881–1883 | Pig Iron + Pig Iron from Charcoal. |
| 1884–1893 | Pig Iron, Kentledge, Cast Scrap. |
| 1894–1913 | Pig Iron + Pig Iron from Charcoal. |

U.S. Dutiable Imports, Pig Iron (Gross Tons):

| | |
|---|---|
| 1870, 1913 | USStatAb, Various Years. |
| 1871–1912 | Taussig (1915), Pg. 159. |

U.K. Pig Iron Exports into United States (Gross Tons):

| | |
|---|---|
| 1870 | Linear Interpolation |
| 1871–1888, 1891-1913 | U.S. Commerce and Navigation Annual Report, Dutiable Pig Iron Imports from England, Scotland and Ireland (average over years ending June 30). |
| 1875, 1888–1891 | Interpolation using index from Carr and Taplin (1962), Pg. 167, Table XXVI, U.K. Pig Iron Exports to the United States. |

U.S. Pig Iron Exports (Gross Tons):

| | |
|---|---|
| 1870, 1913 | USStatAb, Various Years. |
| 1871–1912 | Taussig (1915), Pg. 159. |

*Output Prices*

Price, Imported Pig Iron, Toronto (CAD/Net Ton):

| | |
|---|---|
| 1868–1889 | Taylor and Mitchell (1931), Pg. 79, Annual Average. |

Price, Summerlee No. 2 Pig Iron, Montreal (CAD/Net Ton):

| | |
|---|---|
| 1890–1913 | Department of Labour (1914), Pg. 165 and 203, Annual Average. |

Price, Cleveland No. 3 Pig Iron, United Kingdom (£/Ton):

| | |
|---|---|
| 1867–1913 | Mitchell and Deane (1962), Pg. 493. |

Price, No. 1 Foundry Pig Iron, Philadelphia (USD/Ton):

| | |
|---|---|
| 1867–1913 | USStatAb (1900), Pg. 429, (1914), Pg. 676. |

CAD-USD Official Exchange Rate:

| | |
|---|---|
| 1867–1913 | USHS, Series Ee618 (derived from USD-Sterling). See also http://www.globalfinancialdata.com |

CAD-Sterling Official Exchange Rate:

| | |
|---|---|
| 1867–1913 | USHS, Series Ee618 (derived from USD-Sterling, post-1880 = 4.835:1). See also http://www.globalfinancialdata.com |

*United Kingdom-Montreal Transport Costs: Ocean*

Ocean Freight Rates, Pig Iron, Westbound, Liverpool to Montreal (CAD/Net Ton):

| | |
|---|---|
| 1868–1871 | Index using United Kingdom-New York City freight rates, reported by Bell (1884), Pg. 304–7. |
| 1872–1873 | Angier (1920), and *Fairplay,* (1872) February 10 and July 20, (1873) January 25, February 22, March 22. |
| 1874 | Index using United Kingdom-New York City freight rates reported in *Iron Age*, annual averages using the earliest available quotation for each month - generally the first Monday. |
| 1875–1878 | *Iron Age* (1875) March 25, September 2, October 14, (1876) July 20, December 14, (1877) March 8, August 2, August 16, (1878) May 9. |
| 1879–1881 | Canada, House of Commons (1882), *Debates*, Pg. 1212. |
| 1884–1903 | British Board of Trade (1905), *Report: British Trade Representative in Canada*, Parliamentary Papers, CD. 2337, LXXXIV, Pg. 262. |
| 1904–1905, 1908–1909, 1911–1912 | Index using Outbound Freight Rates, United Kingdom-Montreal, British Dominions Royal Commission (1914), *Report*, Parliamentary Papers, CD. 7173, Pg. 109. |
| 1906 | British Board of Trade (1908), *Report: British Trade Representative in Canada*, Parliamentary Papers, CD. 3868, Pg. 42. |
| 1907, 1910, 1913 | British Board of Trade (1913), *Report: British Trade Representative in Canada*, Parliamentary Papers, CD. 6870, Pg. 26. |

U.K. Rail and Port Costs, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1880 | Rail cost to U.K. port + loading charge, *Iron Age* (1880) July 5, Pg. 20. |
| 1868–1913 | Index 1880 value using U.K. rail revenue/ton-mile. |

U.K. Rail Revenue/Ton-Mile (CAD/Ton/Mile):

| | |
|---|---|
| 1871, 1880, 1890, 1900, 1911 | Cain (1980), Table 5. |
| 1868–1913 | Linear interpolation. |

U.K. Insurance on Westbound Freight, Pig Iron (Percent U.K. Price):

| | |
|---|---|
| 1868, 1889 | *Iron Age* (1878) May 9, (1888) August 23, (1889) July 4. |
| 1868–1913 | Interpolation using exponential decay from 10 percent in 1868 to 3 percent in 1889. |

Montreal Port Charges, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1880 | Wharfage, Montreal Dock, *Montreal Times* (1880) Pg. 1201, (1881) Pg. 1178, and *Public Archives of Nova Scotia* (1907), MG3, Volume 1877, Number 44, December 27. |
| 1868–1913 | 1880 Percent x Freight Cost to Montreal Dock. |

Montreal Brokerage Fees, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1884 | *Iron Age* (1884), July 31. |
| 1868–1913 | 1884 Percent x Freight Cost to Montreal Dock. |

Total Westbound Ocean Transport Cost, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1868–1913 | Liverpool, U.K. to Montreal, U.K. Rail and Port Cost + Ocean Freight Rate + Insurance + Montreal Port Charges + Montreal Brokerage. |

*Montreal-Hamilton Transport Costs: Rail*

Grand Trunk Rail Revenue/Ton-Mile (CAD/Ton/Mile):

| | |
|---|---|
| 1868–1872 | Index using PA revenue/ton-mile. |
| 1872–1875 | NAC, RB 30, Volume 10394, "Grand Trunk Railway Statistics." |
| 1876-1878 | NAC, RG 2, Series 3, Volume 46, Pg. 91, "Transcript of Hearings before the Royal Commission on Railways," Montreal, December 9, 1887. |
| 1879–1895 | NAC, RB 30, Volume 10394, "Grand Trunk Railway Statistics." |
| 1896–1897 | *The Grand Trunk Railway System* (1901), Canadian National Railway Archives, Montreal. |
| 1897, 1900 | Cruikshank (1987), Table 2. |
| 1898–1899, 1901–1913 | Index using CPR revenue/ton-mile. |

CPR Rail Revenue/Ton-Mile (CAD/Ton/Mile):

| | |
|---|---|
| 1885–1913 | HS1, Series S146. |

Pennsylvania Rail Revenue/Ton-Mile (CAD/Ton/Mile):

| | |
|---|---|
| 1868–1913 | Revenue from freight/ton-mile from Pennsylvania Railroad System, *Poor's Manual of Railroads*. |

Railway Insurance and Miscellaneous Costs, Pig Iron (Percent Railway Cost):

| | |
|---|---|
| 1887 | Assumed 10 Percent. |
| 1868–1913 | Index using U.K. insurance on westbound freight. |

Montreal to Hamilton, Railway Transport Cost, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1887 | Insurance + full car load rate, NAC, RG 19, Volume 2720–21, File 1, Montreal Rolling Mills, May 28, 1887, and NAC, RG 19, Volume 3727a, File 27, March 22, 1886. |
| 1868–1913 | Index using GTR revenue/ton-mile. |

*Pittsburgh-Hamilton Transport Costs: Rail*

Pittsburgh to Buffalo, Railway Transport Cost, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1889 | Insurance + $/gross ton, *Iron Age* (1889) November 9. |
| 1868–1913 | Index using Pennsylvania revenue/ton-mile. |

Buffalo to Hamilton, Railway Transport Cost, Pig Iron (CAD/Net Ton):

| | |
|---|---|
| 1888 | Insurance + $/gross ton, Interstate Commerce Commission, *Report, Volume 3* (1888), Pg. 496-504, and NAC, RG 2, Series 3, Volume 46, Pg. 54. |
| 1868–1913 | Index using GTR revenue/ton-mile. |

*United Kingdom-New York City Transport Costs: Ocean*

Ocean Freight Rates, Pig Iron, Westbound, United Kingdom to New York City (USD/Gross Ton):

| | |
|---|---|
| 1868–1871 | Bell (1884), Pg. 304-7. |
| 1872–1873 | Angier (1920) and *Fairplay*, (1872) February 10 and July 20, (1873) January 25, February 22, March 22. |
| 1874–1893 | *Iron Age*, annual averages using the earliest available quotation for each month - generally the first Monday. |
| 1894–1901 | Index using freight rates for ore from Huelva, Spain-New York City, reported in Jacks and Pendakar (2008): http://www.sfu.ca/~djacks/data/publications/Global freights, 1869–1913.xls . |
| 1902–1903 | Iron from Stockton-New York City, reported in Jacks and Pendakar (2008). |
| 1904–1913 | Index using freight rates for ore from Huelva, Spain-New York City, reported in Jacks and Pendakar (2008). |

New York City Port Charges (USD/Gross Ton):

| | |
|---|---|
| 1870–1913 | Wharfage, New York City Dock = 2¢ / ton up to 200 tons, 1.5¢ / ton thereafter, as specified in N.Y. Statute Passed April 10 1860, Chapter 416, Section 3 × Average tonnage U.K. vessels = weighted average sail tonnage / vessel + steam tonnage / vessel, from Jacks and Pendakar (2008) × assumed 0.67 tons pig iron / vessel volume tonnage, based on averages from six ship wreck cargos: *Ellen Forrester* (1868), 69 tons with 100 tons pig iron; *Boko* (1877), 203 tons with 100 tons of pig iron; *Lady Darling* (1880), 649 tons with 42 tons pig iron; *Margaret Galbraith* (1882), 841 tons with 100 tons of pig iron; *A.J. Rogers* (1898), 340 tons with 585 tons of pig iron; and *Flying Enterprise* (1952), 6711 tons with 1270 tons of pig iron. |

Brokerage Fees, Pig Iron (USD/Gross Ton):

| | |
|---|---|
| 1870–1913 | 1.5 shillings/gross ton, from *Iron Age* (1884), July 31. |

Total Westbound Ocean Transport Cost, Pig Iron (USD/Gross Ton):

| | |
|---|---|
| 1870–1913 | Stockton United Kingdom to New York City, U.K. Rail and Port Cost + Ocean Freight Rate + Insurance + Port Charges + Brokerage. |

*New York City-Pittsburgh Transport Costs: Rail*

New York City to Pittsburgh, Railway Transport Cost, Pig Iron (USD/Gross Ton):

| | |
|---|---|
| 1870–1913 | Pittsburgh to Buffalo pig iron railway transport cost (including insurance) / mile x 371 miles. |

*Input Transport Costs: Ore to Hamilton*

Railway Transport Costs, Iron Ore Mine to Upper Lake Port (CAD/Ton):

| | |
|---|---|
| 1867–1913 | Insurance + Marquette Mine to Marquette dock, includes dock handling charges, Lake Carriers' Association (1923), *The Iron Ores of Lake Superior*, Pg. 70. |

Great Lakes Insurance (Percent U.S. Iron Ore Price):

| | |
|---|---|
| 1867–1913 | U.K. ocean freight insurance x (distance Marquette to Buffalo (751 nm) / distance Liverpool to Montreal (2812 nm)). |

Great Lake Freight Rates, Iron Ore (CAD/Ton):

| | |
|---|---|
| 1867–1913 | Insurance + Marquette MI to Buffalo NY, includes unloading charges, Lake Carriers' Association (1923), *The Iron Ores of Lake Superior*, Pg. 77–78. |

Total Transport Costs, Iron Ore Mine to Hamilton (CAD/Ton Iron):

| | |
|---|---|
| 1870–1913 | (Rail costs, mine to upper lake port + Great Lake freight charges, upper lake port to Buffalo + pig iron rail costs, Buffalo to Hamilton) x (average ton iron ore/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used). |

*Input Transport Costs: Coke to Hamilton*

Total Transport Costs, Connelsville PA Coke Ovens to Hamilton (CAD/Ton Iron):

| | |
|---|---|
| 1870–1913 | (Rail costs, furnace to Pittsburgh + pig iron rail costs, Pittsburgh to Hamilton) x (average ton coke/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used). |

*Input Transport Costs: Ore to Pittsburgh*

Total Transport Costs, Iron Ore Mine to Pittsburgh (USD/Gross Ton Pig Iron):

| | |
|---|---|
| 1870–1913 | (Rail costs, mine to upper lake port + Great Lake freight charges, upper lake port to lower lake port + coke rail costs, Pittsburgh to Buffalo) x (average ton iron ore/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used). |

*Input Transport Costs: Coke to Pittsburgh*

Railway Transport Costs, Connelsville PA Coke Ovens to Pittsburgh (USD/Ton):

| | |
|---|---|
| 1887 | Insurance + $/gross ton, American Iron and Steel Association (1913), Pg. 100. |
| 1870–1913 | Index using Pennsylvania revenue/ton-mile. |

### *Prices and Productivity: Ore*

Price, Marquette Iron Ore, Bessemer (CAD/Ton):

| | |
|---|---|
| 1867–1910 | At lower Lake ports, Lake Carriers' Association (1911), *The Iron Ores of Lake Superior*, Pg. 42. |

Price, Marquette Iron Ore, Non-Bessemer (CAD/Ton):

| | |
|---|---|
| 1867–1910 | At lower Lake ports, Lake Carriers' Association (1911), *The Iron Ores of Lake Superior*, Pg. 42. |

Price, Cleveland Iron Ore, United Kingdom (Shillings/Ton):

| | |
|---|---|
| 1870–1875 | Average annual at Middlesbrough, Carr and Taplin (1962), Table VIII. |
| 1860–1890 | Average unit values at mine, *Mineral Statistics of Great Britain* (1891), Parliamentary Papers, CD. LXXVIII, Pg. 5. |
| 1890–1913 | Average unit values at mine, *Mines and Quarries of Great Britain, General Report and Statistics, Part III: Output* (Various Years), Parliamentary Papers. |

Price, Minette Ore, Westphalia (Shillings/Ton Pig Iron):

| | |
|---|---|
| 1880–1913 | Allen (1978), Appendix Table 2. |

Employment Index, Metallic Mineral Mining, Canada (1870=1.00):

| | |
|---|---|
| 1870–1913 | Total wages and salaries ÷ wage index, Urquhart (1993), Table 3.7, and Harris, Keay and Lewis (2014), *Data Appendix*. |

Capital Stock, Metallic Mineral Mining, Canada (000 1900 CAD):

| | |
|---|---|
| 1870–1913 | (Value added – wages and salaries) ÷ user cost for capital, Urquhart (1993), Table 3.7, and Harris, Keay and Lewis (2014), *Data Appendix*. |

Output Index, Metallic Mineral Mining, Canada (1870=1.00):

| | |
|---|---|
| 1870–1913 | Value added ÷ output price index, Urquhart (1993), Table 3.7, and Harris, Keay, and Lewis (2014), *Data Appendix*. |

Total Employment, Iron Ore Mining, United States (000s):

| | |
|---|---|
| 1870, 1880, 1890, 1900, 1910 | Workers in active days, USHS, Series M214. |
| 1870–1913 | Total employment, mining, USHS, Series D128. |

Output, Iron Ore Mining, United States (000 Long Tons):

| | |
|---|---|
| 1875, 1890-1913 | USHS, Series M205. |
| 1870–1874, 1876–1889 | Interpolation based on 1.75 tons ore / ton pig iron produced. |

### *Prices and Productivity: Coke*

Price, Bituminous Coal at Baltimore (CAD/Short Ton):

| | |
|---|---|
| 1867–1913 | USStatAb (1920), Table 305. |

Price, Connelsville Coke, FOB at Ovens (CAD/Short Ton):
1868–1890 Index using (Bituminous Coal at Baltimore - Rail transport costs, Connelsville to Pittsburgh).
1890–1913 NBER Macro Dataset, Series M04138.

Price, All U.K. Export Coal, FOB at London (Shillings/Ton):
1870–1913 Mitchell and Deane (1962) Pg. 483.

Price, Coke at Blast Furnace, Westphalia (Shillings/Ton):
1880–1913 Allen (1978), Appendix Table 1.

Employment Index, Coal Mining, Canada (1870=1.00):
1870–1913 Total wages and salaries ÷ coal and petroleum products wage index, Urquhart (1993), Table 3.7, and Harris, Keay and Lewis (2014), *Data Appendix*.

Capital Stock, Coal Mining, Canada (000 1900 CAD):
1870–1913 (Value added – wages and salaries) ÷ user cost for capital, Urquhart (1993), Table 3.7, and Harris, Keay and Lewis (2014), *Data Appendix*.

Output Index, Coal Mining, Canada (1870=1.00):
1870–1913 Value added ÷ output price index, Urquhart (1993), Table 3.7, and Inwood and Keay (2013), *Data Appendix*.

Total Employment, Anthracite Coal Mining, United States (000s):
1870–1913 USHS, Series Db72.

Output, Anthracite Coal Mining, United States (000 Short Tons):
1870–1913 USHS, Series Db67.

*Pig Iron Trade Policy*

Canadian Bounty, Pig Iron (CAD/Net Ton):
1870–1913 Domestic ore, usual process, Donald (1915), Table D.

Canadian Tariff, Pig Iron (CAD/Net Ton):
1870–1906 Donald (1915), Table F.
1907–1913 "Preferential Tariff" on U.K. imports, "General Tariff" on U.S. imports.

Canadian Tariff, Coke (CAD/Ton):
1870–1913 Donald (1915), Table F.

U.S. Tariff, Pig Iron (USD/Gross Ton):
1870–1913 Taussig (1915), Pg. 139.
U.S. Tariff, Iron Ore (USD/Gross Ton):
1870–1883 Ad valorem x U.K. Ore Price in USD, Taussig (1910, 5th Edition: 2010), Pg. 202, 231.
1884–1913 Specific (USD/Gross Ton), Taussig (1910, 5th Edition: 2010), Pg. 255, 290, 320.

U.S. Tariff, Coke (USD/Gross Ton):
1870–1913 Taussig (1910, 5th Edition: 2010), Pg. 160, 254, 290, 320.

*Calculating Effective Protection*

Canadian Effective Transport Protection, Pig Iron (CAD/Net Ton Pig Iron):
1870–1913 Weighted average transport cost (United Kingdom-Montreal + Montreal-Hamilton) and (Pittsburgh-Buffalo + Buffalo-Hamilton), using share U.K. and U.S. dutiable imports as weights – (transport cost ore + coke / ton pig iron).

Canadian Effective Tariff Protection, Pig Iron (CAD/Net Ton Pig Iron):
1870–1906 Bounty on pig iron + tariff on pig iron - (tariff on coke x average ton coke/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used).
1907–1913 Bounty on pig iron + weighted average tariff on pig iron (using share U.K. and U.S. dutiable imports as weights) – (tariff on coke x average ton coke/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used).

U.S. Effective Transport Protection, Pig Iron (USD/Gross Ton Pig Iron):
1870–1913 United Kingdom to Pittsburgh total transport cost – (transport cost ore + coke / ton pig iron).

U.S. Effective Tariff Protection, Pig Iron (USD/Gross Ton Pig Iron):
1870–1913 Specific tariff on pig iron – (tariff on coke x average ton coke/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used) – (tariff on ore x average ton ore/ton pig iron, *U.S. Census of Manufacturing*, Blast Furnaces, Materials Used).

Effective Protection, Pig Iron (CAD or USD/Net or Gross Ton Pig Iron):
1870–1913 Effective tariff protection + effective transport protection.

*Other Excluded Instruments*

Canadian Tonnage and Number of Vessels:
1867–1913 Net tons, all vessels, registered in Canada, Canadian Year Book, Various Years.
1870, 1872, 1905 Linear interpolation.

U.S. Tonnage and Number of Vessels:
1870–1913 Gross tons, vessels over 5 tons, documented in United States, USHS Series Df578 and Df579.

U.K. Sail, Steam Tonnage and Number of Vessels:

| | |
|---|---|
| 1870–1913 | Gross tonnage registered in United Kingdom, Mitchell and Deane (1962), Pg. 218–19. |

Canadian Fish Price Index:

| | |
|---|---|
| 1870–1913 | Wholesale price index for fish and fish products, HS1, Series J6. |

U.S. Fish Price Index:

| | |
|---|---|
| 1870–1879 | Retail Price, Pickled Mackerel (lbs), Philadelphia PA, 1880 U.S. Census Volume 20, Pg. 85–6. |
| 1879–1913 | Average Import Price, Pickled Mackerel (200 lbs barrel), USStatAb, Various Years. |

U.K. Coal Export Price:

| | |
|---|---|
| 1870–1913 | Average annual price, all exports, Mitchell and Deane (1962), Pg. 483. |

Norwegian Sailor's Wages:

| | |
|---|---|
| 1870–1913 | Grytten (2009), Appendix 1, Series 3.1. |

Barometric Pressure for Northern Atlantic:

| | |
|---|---|
| 1870–1913 | Luterbacher et al. (2002), Electronic Supplementary Materials, http://dx.doi.org/10.1007/s00382-001-0196-6. |

British Freight Rate Indexes:

| | |
|---|---|
| 1870–1913 | Coal exports, west-bound, trans-Atlantic, Harley (1989), Table 3. |
| 1870–1913 | Semi-parametric estimate of average British freight rate, Jacks and Pendakar (2008), Figure 2. |
| 1870–1913 | Outbound, Isserlis (1938), Table 8. |
| 1870–1913 | East-bound, North American grain, Mohammed and Williamson (2004), Table 2. |

Electoral Support for Protectionist Political Parties, United States:

| | |
|---|---|
| 1870–1913 | Republican Electoral College vote share, USHS, Series Eb154-156.<br>Republican Presidential vote share, USHS, Series Eb208.<br>Democrat Electoral College vote share, USHS, Series Eb154-156. |

Electoral Support for Protectionist Political Parties, Canada:

| | |
|---|---|
| 1870–1913 | Conservative Party share parliamentary seats, HS1, Series W165. |

APPENDIX TABLE A4
INTER AND INTRA-CONTINENTAL PIG IRON TRANSPORT COSTS

| Year | Transport Costs to Canada (CAD) | | | | Transport Costs to United States (USD) | | |
|---|---|---|---|---|---|---|---|
| | Pig Iron | | Coke | Ore | Pig Iron | Coke | Ore |
| | Lancashire-Hamilton | Pittsburgh-Hamilton | Connelsville-Hamilton | Marquette-Hamilton | Lancashire-Pittsburgh | Connelsville-Pittsburgh | Marquette-Pittsburgh |
| 1870 | 10.70 | 3.48 | 7.43 | 9.32 | 7.35 | 3.16 | 7.01 |
| 1871 | 10.48 | 3.48 | 7.62 | 10.41 | 7.37 | 3.08 | 6.53 |
| 1872 | 10.87 | 3.57 | 7.53 | 8.67 | 7.85 | 3.18 | 7.22 |
| 1873 | 11.62 | 3.58 | 6.60 | 10.30 | 6.61 | 3.13 | 6.07 |
| 1874 | 9.38 | 3.07 | 5.47 | 7.81 | 5.42 | 2.76 | 7.13 |
| 1875 | 8.24 | 2.56 | 4.70 | 6.94 | 4.04 | 2.33 | 5.55 |
| 1876 | 5.75 | 2.19 | 5.17 | 5.35 | 3.45 | 1.96 | 4.81 |
| 1877 | 6.48 | 2.34 | 4.91 | 5.05 | 3.75 | 2.10 | 3.77 |
| 1878 | 7.53 | 2.20 | 4.35 | 5.53 | 3.90 | 1.95 | 3.49 |
| 1879 | 5.83 | 1.95 | 4.71 | 7.21 | 4.82 | 1.71 | 3.66 |
| 1880 | 8.36 | 2.09 | 4.29 | 6.66 | 5.50 | 1.87 | 4.71 |
| 1881 | 5.91 | 1.92 | 4.44 | 5.45 | 5.13 | 1.69 | 4.31 |
| 1882 | 7.29 | 2.01 | 4.52 | 5.14 | 5.97 | 1.73 | 3.58 |
| 1883 | 6.77 | 2.08 | 4.08 | 4.50 | 4.27 | 1.72 | 3.32 |
| 1884 | 7.17 | 1.88 | 3.51 | 4.10 | 3.81 | 1.55 | 2.91 |
| 1885 | 6.23 | 1.64 | 3.85 | 4.98 | 2.89 | 1.31 | 2.58 |
| 1886 | 6.60 | 1.79 | 3.58 | 5.69 | 3.93 | 1.45 | 3.14 |
| 1887 | 6.17 | 1.74 | 3.57 | 4.56 | 4.25 | 1.26 | 3.50 |
| 1888 | 6.78 | 1.70 | 3.57 | 4.42 | 4.26 | 1.29 | 2.77 |
| 1889 | 6.48 | 1.70 | 3.40 | 4.39 | 4.65 | 1.29 | 2.68 |
| 1890 | 6.39 | 1.62 | 3.41 | 3.98 | 4.55 | 1.22 | 2.65 |
| 1891 | 4.90 | 1.62 | 3.17 | 4.12 | 4.58 | 1.24 | 2.43 |
| 1892 | 4.72 | 1.50 | 3.11 | 3.82 | 3.93 | 1.16 | 2.51 |
| 1893 | 4.63 | 1.48 | 2.95 | 3.31 | 3.86 | 1.13 | 2.33 |
| 1894 | 4.65 | 1.43 | 2.85 | 3.20 | 3.49 | 1.05 | 1.97 |
| 1895 | 4.60 | 1.39 | 2.87 | 3.54 | 3.45 | 1.01 | 1.89 |
| 1896 | 4.58 | 1.38 | 2.76 | 3.01 | 3.49 | 1.02 | 2.11 |
| 1897 | 4.61 | 1.35 | 2.63 | 2.88 | 3.35 | 0.96 | 1.74 |
| 1898 | 4.55 | 1.29 | 2.90 | 2.71 | 3.53 | 0.90 | 1.65 |
| 1899 | 4.56 | 1.37 | 3.14 | 3.66 | 3.94 | 1.06 | 1.70 |
| 1900 | 4.73 | 1.47 | 3.09 | 2.88 | 4.01 | 1.16 | 2.29 |
| 1901 | 4.48 | 1.44 | 3.21 | 2.88 | 3.63 | 1.16 | 1.88 |
| 1902 | 4.59 | 1.47 | 3.22 | 2.95 | 3.34 | 1.22 | 1.92 |
| 1903 | 5.09 | 1.47 | 3.13 | 2.71 | 3.15 | 1.24 | 1.98 |
| 1904 | 4.80 | 1.45 | 3.15 | 3.01 | 3.00 | 1.17 | 1.77 |
| 1905 | 5.21 | 1.46 | 3.11 | 2.97 | 3.07 | 1.19 | 1.96 |
| 1906 | 4.65 | 1.43 | 3.13 | 3.03 | 3.12 | 1.18 | 1.96 |
| 1907 | 5.14 | 1.46 | 3.13 | 2.80 | 3.09 | 1.17 | 1.95 |
| 1908 | 4.87 | 1.44 | 3.09 | 2.81 | 2.84 | 1.19 | 1.86 |
| 1909 | 5.07 | 1.43 | 3.06 | 2.92 | 2.86 | 1.16 | 1.84 |
| 1910 | 5.40 | 1.43 | 3.10 | 2.80 | 3.04 | 1.14 | 1.87 |
| 1911 | 6.12 | 1.47 | 3.04 | 2.51 | 2.99 | 1.14 | 1.77 |
| 1912 | 7.04 | 1.42 | 3.04 | 2.52 | 3.03 | 1.13 | 1.64 |
| 1913 | 5.73 | 1.43 | 7.43 | 9.32 | 2.93 | 1.13 | 1.64 |

*Note*: All values reported per net ton pig iron.
*Sources*: See Data Appendix.

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