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New results on the tariff–growth paradox

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This article investigates the question of how openness affected the growth of income in the late nineteenth-century Atlantic economy. More specifically, is the tariff-growth correlation identified by O'Rourke (2000) driven by European offshoots? Is the correlation perhaps explained by the concurrent integration of intranational markets before 1914? And what can other measures of openness tell us about the growth process in the nineteenth century? This note offers some answers. The results can be summarised as follows: O'Rourke's primary finding is not altered by changes in the sample; incorporating measures of inter- and intranational market integration into the analysis again supports O'Rourke's findings, but apparently leaves no role for intranational market integration; and evidence from trade-flow data suggests that there may been a pro-growth role for tariffs in a non-reciprocal trade environment.

1. Introduction

With the post-Second World War rise of global capital and commodity markets as well as the extension of international financial institutions' reach, the relationship between economic growth and openness to world markets has become an increasingly contentious issue.

Since the early 1990s, a substantial literature addressing the empirics of growth and openness has been amassed (cf. Dollar 1992, Edwards 1992, 1993, 1998; Ben-David 1993, Sachs and Warner 1995, Harrison 1996, Krueger, 1998). By and large, this literature has come down strongly in favour of the argument that openness promotes economic growth. Of the few dissenting voices, the most influential by far has been that of Rodriguez and Rodrik (2001). However, their message seems to question the methods, data, and inferences of the openness-growth literature, not necessarily its underlying claims.[1]

In marked contrast, studies which have approached the question from the perspective of the nineteenth century have argued that the relationship

[1] In a more recent paper, Rodrik *et al.* (2004) take a stronger line on the role of openness on growth: 'once institutions are controlled for, trade is almost always insignificant' (p. 131).

between openness and growth has not always been consistent (cf. Clemens and Williamson 2001, 2002, 2004; Vamvakidis, 2002). In this regard, the nineteenth century makes for a particularly instructive case study on the relationship between growth and openness, due to the extremes in commercial relations witnessed over the period.

After the Revolutionary and Napoleonic Wars, the external economic relations of countries within the Atlantic orbit emerged from near shambles. Evidence from international commodity markets demonstrates surprisingly large price gaps in even the most integrated of markets (Jacks 2005). However, with the application of rediscovered and new commercial instruments, the integration of markets slowly eroded existing price gaps and created new areas of economic interaction. Coupled with these developments, tremendous improvements in the technology of communication and transport were achieved in the nineteenth century, namely the telegraph, railways, and the application of steam technology to ocean-going vessels. In one of the seminal contributions to the literature, O'Rourke and Williamson (1999) paint a particularly clear picture of the place of institutions and technology in advancing this first wave of globalisation.

And as might be expected, such advances in international integration did not go unnoticed, especially by those whose livelihood was enhanced or threatened by these developments. From 1850, the cause of free trade made some inroads in continental Europe thanks to its great proselytiser, the United Kingdom. The proliferation of most-favoured-nation status helped spread the word, culminating in a relatively short-lived period of European free trade until 1879 when protectionist measures came back in favour (Bairoch 1989).

However, one of the more puzzling aspects of this time of retrenchment is the positive correlation between economic growth and tariff levels, first pointed out by Bairoch (1972) but most dramatically demonstrated by O'Rourke (2000) who found that tariffs were positively correlated with growth in a panel of European and European-offshoot countries between 1870 and 1914, even after controlling for a number of other potential determinants of growth. Although at times harshly criticised for ignoring the counterfactual of a world with no tariff reprisals and/or inferring causality from mere correlation, this 'tariff–growth paradox' for the later nineteenth century persists (Clemens and Williamson 2001, 2004). In what follows, the underlying question is whether there is a causal relationship between these two variables or a simple – and, thus, convenient – correlation.

More specifically, this article attempts to answer the following questions. Is the tariff–growth correlation identified by O'Rourke (2000) robust to different samples? Is the correlation perhaps explained by the concurrent integration of domestic markets before 1914 and its effects on growth? And what can other measures of openness tell us about the growth process in the nineteenth century?

The results of the analysis can be summarised as follows: O'Rourke's primary finding is not altered by changes in the sample; incorporating measures of domestic and international market integration into the analysis again supports O'Rourke's findings, but apparently leaves no independent role for domestic market integration in spurring economic growth; and evidence from trade-flow data suggests that there may have been a pro-growth role for tariffs via export promotion.

2. Evidence on the tariff-growth paradox

In the following section, the evidence on the tariff–growth paradox for the late nineteenth century is confronted. This article tries to broaden the scope of existing work by considering three new avenues: a different sample than that used by O'Rourke (2000), a different measure of trade barriers on domestic and international markets, and a different measure of openness based on the work of Frankel and Romer (1999).

A different sample

The mechanisms by which openness could potentially promote growth are a diverse lot. Some of the contenders suggested by the literature are commodity and product specialisation, embodied technological change and knowledge spillovers resulting from trade in goods, and, especially for more recent periods, foreign direct investment; yet a prime mover remains elusive. One thing, however, is fairly clear and that is the historical record. Contrary to the empirical evidence suggesting that openness had positive growth effects in the majority of countries in the pre-World War I era and has universally positive growth effects in the post-World War II era, the ten countries examined by O'Rourke (2000) in the late nineteenth century yield a positive correlation between tariffs and growth rates, irrespective of the model of economic growth tested.

However, as Irwin (2002a, b) points out, these results may be unduly biased by the inclusion in the sample of certain labour-scarce, land-abundant countries (that is, Australia, Canada and the United States). With their high potential for growth and relative lack of tax-gathering apparatus, the correlation between tariffs and growth may be spurious as these countries may have found recourse to revenue-generating tariffs necessary in a time of economic expansion.

This suggests that the countries sampled by O'Rourke may not be representative. To address this concern, certain of O'Rourke's sample countries are dropped (namely Australia, Canada, Denmark, and Sweden) and replaced with other, perhaps more representative countries (namely Austria-Hungary, Belgium, Russia, and Spain). The countries, then, in the dataset used here are the aforementioned substitutions plus France, Germany, Italy, Norway, the United Kingdom, and the United States. With only one New World entrant, the new sample is predominantly European.[2] Otherwise, the methodology, data sources, and reported results are exactly the same as those reported in O'Rourke (2000).

Thus, the key estimating equation in this section treats the annual growth rate of real GDP *per capita* as a function of the (period-specific) initial level of tariffs and a number of controls capturing other possible determinants of growth. The underlying data are recorded as averages over 5-year windows between 1875 and 1914 (1875/9, 1880/4 . . . 1905/9, 1910/4). This leaves seven periods of growth (1875/9–1880/4, 1880/4–1885/9 . . . 1900/4–1905/9, 1905/9–1910/4) across ten countries for estimation, that is, 70 observations in the full panel. Data sources and definitions are detailed in Appendix I.

Table 1 summarises the data employed throughout this study while columns 1, 3, and 5 in Table 2 report the results reported in O'Rourke (2000) of an unconditional convergence model of growth with country, time, and country/time fixed effects, respectively. Columns 2, 4, and 6 report the identical model and estimation procedure (OLS) on the new sample. Additionally, heteroskedastic and auto-correlation consistent standard errors are employed in attempt to alleviate some of the obvious concerns that might arise with such a panel.

Regardless of sample or estimation technique, the initial level of tariffs – measured as customs receipts divided by the value of total imports – is positively correlated with the subsequent rate of real GDP *per capita* growth and is, in most cases, statistically significant at the 5 per cent level. Repeating the same sort of exercise with respect to a factor accumulation model of growth, Table 3 likewise leads us to the conclusion that the positive tariff–growth correlation reported by O'Rourke (2000) is fairly robust, in that it holds up to changes in sample, model specification, and estimation technique. Furthermore, this result matters, as a one standard deviation increase in the (logged) initial tariff level (=0.878) is predicted to increase the growth of GDP *per capita* by 0.23 to 1.00 standard deviations (=0.825). Finally, the interested reader can also be directed to Appendix II which reports the results of exercises which pool across the two samples and which attempt to control for changes in human capital, differences in the sources of tax revenue, changes in agricultural population shares, and differences in domestic business cycles. In short, none of these modifications alters the basic story related in this section.

A different measure of trade barriers

One of the more common criticisms of studies on the relationship between openness and growth is the inappropriateness of tariff measures which rely

[2] All the following regressions were also run without the United States to fully purge the results of any potential New World influence. These results suggest no discernible impact from the inclusion of the United States and are, therefore, unreported.

Table 1. *Data summary.*

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Average annual growth rate	70	1.339	0.825	−0.508	3.757
Initial real GDP *per capita* (logged)	70	7.707	0.412	6.840	8.490
Initial tariff rate	70	0.086	0.035	0.011	0.403
Initial tariff rate (logged)	70	−2.449	0.878	−4.550	−0.910
Change in capital-labour ratio	70	18.997	12.906	−0.370	58.700
Change in land-labour ratio	70	−2.877	4.060	−10.550	9.060
Initial international trade costs	62	0.393	0.142	0.222	0.958
Initial intranational trade costs	62	0.157	0.070	0.055	0.351
Bilateral trade between countries *i* & *j* as a share of country 's GDP (logged)	5,726	−5.915	1.734	−18.833	−1.862
Distance between countries *i* & *j* (logged)	5,726	7.462	1.105	4.922	9.321
Shared border between countries *i* & *j*	5,726	0.110	0.313	0	1
Common language between countries *i* & *j*	5,726	0.091	0.288	0	1
Population of country *i* (logged)	5,726	10.071	0.981	7.543	11.489
Population of country *j* (logged)	5,726	9.399	1.295	7.410	12.988
Area of country *i* (logged)	5,726	12.841	1.721	10.326	16.080
Area of country *j* (logged)	5,726	13.204	1.787	10.326	16.916
Length of country *i*'s coastline (logged)	5,726	8.001	2.818	0	10.301
Length of country *j*'s coastline (logged)	5,726	6.986	5.404	0	10.790
Interaction between border and area of country *i* (logged)	5,726	1.384	3.968	0	16.080
Interaction between border and area of country *j* (logged)	5,726	1.349	3.865	0	16.916
Interaction between border and common language	5,726	0.054	0.227	0	1
Real GDP *per capita* (logged)	70	0.831	0.414	−0.050	1.610
Average annual growth rate	70	1.339	0.824	−0.510	3.760
Observed trade-to-GDP ratio	70	0.287	0.162	0.078	0.713
Predicted trade-to-GDP ratio	70	0.139	0.087	0.032	0.379
Population (logged)	70	10.100	1.109	7.540	11.900
Real GDP (logged)	70	10.933	1.189	7.920	13.030
Real GDP (logged) ∗ Observed trade ratio	70	3.003	1.583	0.950	7.340
Population (logged) ∗ Observed trade ratio	70	2.740	1.378	0.930	6.360
Initial real GDP *per capita* (logged)	70	0.799	0.413	−0.065	1.585
Balance-of-trade over GDP	430	−2.520	4.111	−18.730	4.170
Initial tariff rate (logged)	420	2.143	0.901	−0.616	3.769
Change in balance-of-trade over GDP	420	−0.023	1.102	−4.703	5.791
Change in tariff rate	407	0.010	2.035	−8.810	14.810
Growth rate of GDP (net of exports)	420	2.365	3.099	−9.130	13.750

Table 2. *Unconditional convergence model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	O'Rourke (2000)	New Sample	O'Rourke (2000)	New Sample	O'Rourke (2000)	New Sample
Estimation by:	OLS	OLS*	OLS	OLS*	OLS	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	No	No	Yes	Yes
Number of significant f.e. terms:	0	0	n/a	n/a	10	10
Constant			**4.170**	*0.603*		
			(0.000)	*(0.833)*		
Initial real GDP *per capita* (logged)	*0.288*	*0.440*	**−0.761**	*0.222*	**−5.027**	**−9.658**
	(0.735)	*(0.549)*	**(0.054)**	*(0.560)*	**(0.007)**	**(0.001)**
Initial tariff rate (logged)	**1.538**	**0.943**	**0.691**	**0.216**	*0.511*	**0.841**
	(0.038)	**(0.092)**	**(0.013)**	**0.023**	*(0.513)*	**(0.048)**
D1879			*−0.566*	*−0.330*	**−2.383**	**−3.912**
			(0.262)	*(0.419)*	**(0.012)**	**(0.001)**
D1884			**−1.079**	**−0.743**	**−2.589**	**−3.923**
			(0.032)	**(0.054)**	**(0.002)**	**(0.001)**
D1889			**−0.913**	**−0.714**	**−2.223**	**−3.551**
			(0.065)	**(0.100)**	**(0.002)**	**(0.001)**
D1894			*−0.756*	*0.166*	**−1.841**	**−2.095**
			(0.122)	*(0.674)*	*(0.005)*	**(0.001)**
D1899			*0.040*	**−0.859**	*−0.789*	**−2.398**
			(0.933)	**(0.028)**	*(0.160)*	**(0.001)**
D1904			*0.113*	*0.079*	*−0.295*	**−0.704**
			(0.812)	*(0.871)*	*(0.530)*	**(0.089)**
N	70	70	70	70	70	70
R-squared	0.267	0.118	0.252	0.176	0.453	0.410
Adjusted R-squared	0.128	n/a	0.154	n/a	0.274	n/a
Prob (F-statistic)	0.000	0.025	0.018	0.051	0.000	0.001

Note: OLS* denotes ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

Table 3. *Factor accumulation model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	O'Rourke (2000)	New Sample	O'Rourke (2000)	New Sample	O'Rourke (2000)	New Sample
Estimation by:	OLS	OLS*	OLS	OLS*	OLS	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	Yes	Yes	Yes	Yes
Number of significant f.e. terms:	10	10	0	0	10	10
Initial real GDP *per capita* (logged)			**1.464** **(0.072)**	**1.085** **(0.022)**	**−3.796** **(0.026)**	**−8.586** **(0.001)**
Change in capital-labour ratio	**19.528** **(0.002)**	*0.009* *(0.479)*	**22.527** **(0.001)**	*0.014* *(0.356)*	**18.550** **(0.005)**	*0.016* *(0.224)*
Change in land-labour ratio	*14.189* *(0.307)*	**0.098** **(0.007)**	*18.235* *(0.188)*	**0.104** **(0.003)**	**22.748** **(0.091)**	**0.035** **(0.073)**
Initial tariff rate (logged)	**1.853** **(0.006)**	**0.831** **(0.073)**	**1.737** **(0.009)**	**0.752** **(0.083)**	*0.570* *(0.422)*	*0.654* *(0.127)*
D1879					**−2.589** **(0.003)**	**−3.822** **(0.001)**
D1884					**−2.508** **(0.015)**	**−3.617** **(0.001)**
D1889					**−1.892** **(0.064)**	**−3.301** **(0.001)**
D1894					**−1.527** **(0.011)**	**−1.857** **(0.004)**
D1899					**−0.940** **(0.068)**	**−2.270** **(0.001)**
D1904					**−0.397** **(0.353)**	**−0.675** **(0.082)**
N	70	70	70	70	70	70
R-squared	0.414	0.187	0.447	0.203	0.569	0.434
Adjusted R-squared	0.291	n/a	0.319	n/a	0.405	n/a
Prob (F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000

Note: OLS* denotes ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

on the ratio of customs revenues to imports. An even more pointed argument is raised when the effects of prohibitive tariffs are considered.[3] These insights are obviously valid, but the fact remains that the customs-revenue-to-imports ratio is one of the most accessible measures of openness, especially with respect to historical studies of eras where the most prevalent barriers were tariffs.

In what follows, an attempt will be made to remedy this situation and incorporate different measures of trade barriers. Here, estimates of trade costs taken from Jacks (2005) will serve as proxies for domestic and international market integration and will be incorporated into the framework laid out above. Before proceeding directly to the empirics, a few words of explanation regarding these estimates are probably in order. The basic intuition behind them is that, assuming arbitrage takes place between two locations, the size of commodity price differentials can inform the researcher about the size of trade costs separating the locations through the use of threshold regressions (Balke and Fomby 1997, Hansen and Seo 2002). To this end, price series for a representative commodity – in this case, wheat – were collected and analysed for the period from 1870 to 1913.

Specifically, estimates of trade costs were generated at the city-pair level (for example, Lyon/Marseilles and London/Marseilles) for five-year subperiods – starting with 1875/9 and ending with 1905/9 – in order to match up exactly with the intervals of the growth/tariff dataset used above.[4] The set of city-pair estimates were then averaged to form measures of national trade costs. For example, the underlying dataset contains monthly wheat prices for twelve prominent French cities. Estimates of trade costs were made for all unique city-pair combinations ($66 = 12*11/2$) in a given period, and then averaged to arrive at the domestic trade cost estimate for France. At the same time, the French price data was compared to its equivalent in four international markets – namely Bruges, London, Lwow, and New York City – and estimates were made for all city-pair combinations ($48 = 12*4$) in a given period, and then averaged to arrive at the international trade cost estimate for France. The same procedure was repeated for every country in the commodity price dataset (Austria-Hungary, Belgium, France, Germany, Italy, Norway, Russia, Spain, the UK, and the US). Comparing the international trade cost estimates to the tariff rate used before proves to be encouraging as the correlation between the two is strong, but not perfect – around 0.55 in levels and 0.60 in logs. Thus, there seems to be some

[3] More relevant for studies of present-day economies is the issue of non-tariff barriers to trade. However, as Bairoch (1989) notes, their role in the nineteenth century was very limited.

[4] To be precise, the trade cost measures used in the regressions are actually the estimated trade costs scaled by the observed price of wheat; thus, they are unit-less measures which are fully comparable across time and space. In the text, the term ‘trade costs’ is, thus, used as a shorthand.

reason to believe that the trade cost estimates accurately capture barriers to trade, both across and within countries.

In a broader sense, this approach of substituting trade cost estimates as an alternate trade barrier is justified, as Harrison (1996, p. 421) notes, because 'price comparisons between goods sold in domestic and international markets could provide an ideal measure of the impact of trade policy, particularly in the absence of domestic policy distortions'. It also potentially allows for improvement on previous results for two reasons. Most obviously, it circumvents the use of the customs-revenues-to-imports ratio. Additionally, it allows us to explicitly test the hypothesis that the tariff–growth correlation masks important pro-growth forces working at the domestic level. More precisely, the late nineteenth century was not only a time of increasing international integration but also domestic market integration. With no controls for the potentially pro-growth effect of countries 'getting prices right' in domestic markets, cross-country growth regressions may place too much emphasis on tariffs if their evolution was concurrent with the process of domestic integration.

Table 4 reports the results of incorporating measures of domestic and international trade costs, estimated as the share of trade costs in final prices. Columns 1 to 2 contain the estimates of factor accumulation models with these new variables both with country and country/time fixed effects. Beyond the broad agreement with the estimates in Table 3, the most noticeable result is the consistently positive and significant coefficient on the international-trade-costs variable. In contrast, the domestic-trade-costs variable is inconsistently signed as well as statistically insignificant.

Columns 3 to 6 use the same specifications as the previous cols, but allow the two measures of trade costs to enter in separate estimating equations. The performance of cols 4 and 6 suggest that the domestic-trade-costs variable has little, if any, explanatory power. On the other hand, the international-trade-costs variable is again strongly and positively correlated with growth.

Taken together, what these results suggest is that there is little role for domestic market integration in explaining growth, or at least in explaining away the positive correlation between tariffs and growth. Indeed, the robust performance of the international-trade-costs variable lends strength to the argument that the tariff–growth correlation may not be just an artifact of the data: two independent measures of international barriers to trade suggest that after controlling for a number of other determinants those countries which were more distant – whether physically or economically – tended to grow faster.

A different measure of openness

Although the story implied by the previous measures of openness is pretty straightforward, we might do well to consider a different aspect of openness.

Table 4. *Factor accumulation with alternate trade barrier measures.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	New Sample	New Sample	New Sample	New Sample	New Sample	New Sample
Number of significant f.e. terms:	5	8	0	0	10	10
Initial real GDP *per capita* (logged)	*1.039*	**−4.526**	**0.716**	**0.977**	**−4.531**	**−4.775**
	(0.247)	**(0.065)**	**(0.043)**	**(0.081)**	**(0.064)**	**(0.046)**
Change in capital-labour ratio	*0.016*	*0.010*	*0.017*	*0.014*	*0.010*	*0.010*
	(0.231)	*(0.402)*	*(0.179)*	*(0.307)*	*(0.400)*	*(0.410)*
Change in land-labour ratio	**0.102**	*0.044*	**0.099**	**0.097**	*0.044*	*0.040*
	(0.008)	*(0.305)*	**(0.010)**	**(0.011)**	*(0.306)*	*(0.331)*
Initial international trade costs	**1.787**	**0.549**	**1.918**		**0.473**	
	(0.092)	**(0.069)**	**(0.063)**		**(0.081)**	
Initial intranational trade costs	*0.693*	*−1.119*		*0.419*		*−0.610*
	(0.395)	*(0.835)*		*(0.302)*		*(0.900)*
D1879		*−0.033*			**−2.144**	**−2.219**
		(0.937)			**(0.035)**	**(0.027)**
D1884		*−0.123*			**−2.148**	**−2.205**
		(0.833)			**(0.019)**	**(0.014)**
D1889		**1.157**			**−2.213**	**−2.274**
		(0.031)			**(0.002)**	**(0.001)**
D1894		*0.341*			*−0.952*	*−0.978*
		(0.599)			*(0.150)*	*(0.138)*
D1899		**1.363**			**−1.760**	**−1.801**
		(0.089)			**(0.001)**	**(0.001)**
D1904		**2.084**			**−0.727**	**−0.750**
		(0.054)			**(0.082)**	**(0.056)**
N	62	62	62	62	62	62
R-squared	0.286	0.470	0.282	0.273	0.470	0.469
Prob (F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000

Note: Estimation by ordinary least squares with heteroskedastic/auto-correlation consistent statistics, and country fixed effects; p-values in parentheses.

Rather than rely on what are, in large part, price-based measures of openness, in this section the objective will be developing a quantity-based measure of openness.

In one of the more novel approaches to the openness-growth literature, Frankel and Romer (1999) suggest the use of the geographic component of countries' trade as an instrument for openness. The motivation for this approach is that most other studies have failed to account for the potential endogeneity of incomes and openness. What they find is that instrumental variables (IV) estimates of openness, measured as the ratio of the volume-of-trade to GDP, are consistent with OLS exercises that show a positive and significant effect of trade on the level of incomes in the cross-section. Turning to the long-run, Irwin and Tervio (2002) demonstrate that this result also holds for the entirety of the twentieth century.

Building on this work, here the aim will be to relate observed and predicted trade shares not only to the level of income, but also to the growth rate of income. The basic building block of the analysis flows from Frankel and Romer's (1999) insight that a significant portion of a country's trade can be explained by the gravity model of trade. What the gravity model proposes is that a country's trade to GDP ratio will be increasing with the size of its trading partners, the existence of common borders and languages with its trading partners, and access to waterways, but decreasing with the size of the domestic market and the distance separating nations. By using the gravity model, predictions of a country's trade shares can then be used to act as an instrument for observed trade shares in a cross-country growth regression.

The gravity equation used to capture the non-income dependent component of a country's trade is the following:

$$\begin{aligned}\ln(\text{trade}_{ijt}/\text{GDP}_{it}) = {}& \beta_0 + \beta_1 \ln \text{Dist}_{ij} + \beta_2 \text{Border}_{ij} + \beta_3 \text{Lang}_{ij} \\ & + \beta_4 \ln \text{Pop}_{it} + \beta_5 \ln \text{Pop}_{jt} + \beta_6 \ln \text{Area}_i + \beta_7 \ln \text{Area}_j \\ & + \beta_8 \ln \text{Coast}_i + \beta_9 \ln \text{Coast}_j + \beta_{10} \text{Border}_{ij} \ln \text{Area}_i \\ & + \beta_{11} \text{Border}_{ij} \ln \text{Area}_j + \beta_{12} \text{Border}_{ij} \text{Lang}_{ij} + \mu_t + e_{ijt} \qquad (1)\end{aligned}$$

where the dependent variable is the bilateral volume of trade for countries *i* and *j* as a share of country i's GDP in time *t*, *Dist* is the distance separating countries *i* and *j*, *Border* is an indicator variable denoting a shared border between countries *i* and *j*, *Lang* is an indicator variable denoting a common language countries between *i* and *j*, *Pop* is the level of population of countries *i* and *j* in time *t*, *Area* is the area of countries *i* and *j*, *Coast* is the length of coastline for countries *i* and *j*, and μ and *e* are time- and observation-specific error terms, respectively.

Table 5 reports the results for this exercise. The results look sensible in that they imply trade-enhancing effects for borders, languages, trading partner's size – captured with both population and area – and waterways, but

Table 5. *The bilateral trade equation.*

Dependent variable: Bilateral trade between countries *i* & *j* as a share of country *i*'s GDP (logged)	Coefficient	p-value
Distance between countries *i* & *j* (logged)	−0.586	0.000
Shared border between countries *i* & *j*	8.549	0.000
Common language between countries *i* & *j*	0.855	0.000
Population of country *i* (logged)	−0.196	0.000
Population of country *j* (logged)	0.277	0.000
Area of country *i* (logged)	−0.042	0.077
Area of country *j* (logged)	0.231	0.000
Length of country *i*'s coastline (logged)	0.030	0.002
Length of country *j*'s coastline (logged)	0.051	0.000
Interaction between border and area of country *i* (logged)	−0.225	0.000
Interaction between border and area of country *j* (logged)	−0.354	0.000
Interaction between border and common language	−0.328	0.087
Number of observations:	5,726	
Number of significant time effets:	44	
R-squared	0.421	
Prob (F-statistic)	0.000	

Note: Estimation by ordinary least squares with heteroskedastic/auto-correlation consistent statistics and time fixed effects.

trade-dampening effects for distance, domestic market size – again captured with population and area – and some of the interaction terms suggested by Frankel and Romer (1999).[5]

In order to arrive at a measure of a country's aggregate trade share, the estimated geographic components of its bilateral trade with every other country for which data are available are summed, according to the following equation:

$$\hat{T}_{it} = \sum_{i \neq j} e^{\hat{\beta}' X_{ijt}} \qquad (2)$$

where the $\hat{\beta}$ term is the vector of estimated coefficients generated by the gravity model and the X_{ijt} term is the vector of associated independent variables identified above.

[5] At first pass, some concern may be warranted over the use of the population figures in the construction of the predicted trade shares. After all, population might have some endogenous component which is correlated with the error term in the following income or growth equations. Yet the sample correlation between population and both the level and growth rates of income are very weak statistically and *negative*. Correcting the reported confidence intervals as suggested by Staiger and Stock (1997) produces nearly identical results, but greatly complicates the exposition of results. These corrections will, thus, remain unreported.

Table 6. *Relationship between observed and predicted trade shares.*

Dependent variable: Observed trade-to-GDP ratio	Coefficient	p-value	Coefficient	p-value
Predicted trade-to-GDP ratio	1.328	0.000	0.816	0.000
Population (logged)			−0.062	0.000
Constant	0.102	0.000	0.799	0.000
Number of observations:	70		70	
R-squared	0.504		0.609	
Prob (F-statistic)	0.000		0.000	

Note: Estimation by ordinary least squares with heteroskedastic/auto-correlation consistent statistics.

To assess the quality of the proposed instrument, Table 6 reports the results of an OLS estimate of the predicted trade share on the observed trade share. Given the R-squared value, it seems that the specification is a good statistical fit, which is reassuring in the context of IV estimation. Controlling for the size of the domestic market with the population term improves the fit as large nations tend to trade less internationally. These results are highly favourable when compared to those of Frankel and Romer (1999) and Irwin and Tervio (2002). The former find that for a cross-section of 150 countries in 1985, predicted trade shares – in conjunction with controls for population and area – explain 52 per cent of the variation in observed trade shares. In the case of Irwin and Tervio (2002), they are likewise able to explain roughly 50 per cent of the variation in eight cross-sections ranging from 1913 to 1990. Thus, it seems that the predicted trade share will act as a reasonable instrument for the observed trade share.

Along those lines, Panel A of Table 7 reports the results from a 'naïve' OLS estimation of the effects of trade shares on the level of real income *per capita*, thus ignoring any potential endogeneity between the two variables. Even taking these results with a grain of salt, it is apparent that they make intuitive sense: the level of income in a given country and time period is positively related to the degree of openness and the size of the domestic market.

Making the correction for potential endogeneity, Panel B of Table 7 shows that the change in estimates is slight when employing the predicted trade shares as instruments for the observed trade shares. Interestingly enough, these four estimates of the effects of trade do not suffer from the lack of precision encountered by Frankel and Romer (1999) and Irwin and Tervio (2002) in that the coefficients remain highly statistically significant.

The remaining panels of Table 7, C and D, attempt to correct for any spurious correlation between the two variables since they are generally trending upward over time. Here, estimation takes place by means of seemingly-unrelated-regression (SUR) where observations on income and trade shares in a given time period are treated as a single equation. The coefficients on the trade shares and population are restricted to be equal

Table 7. *Relationship between income and trade shares.*

Dependent variable: Real GDP *per capita* (logged)	Coefficient	p-value		Coefficient	p-value
Panel A. OLS			Panel C. SUR		
Observed trade-to-GDP ratio	**2.009**	**0.000**	Observed trade-to-GDP ratio	**1.206**	**0.000**
Population (logged)	**0.207**	**0.000**	Population (logged)	**0.049**	**0.000**
Constant	**−1.740**	**0.000**	Constant	*−0.002*	*0.799*
Number of observations:	70		Number of observations:	70	
R-squared	0.387		R-squared	0.823	
Prob (F-statistic)	0.000		Prob (F-statistic)	0.000	
Panel B. 2SLS			Panel D. SUR		
Instrumented trade-to-GDP ratio	**2.198**	**0.000**	Predicted trade-to-GDP ratio	**1.482**	**0.000**
Population (logged)	**0.227**	**0.000**	Population (logged)	**0.062**	**0.000**
Constant	**−2.005**	**0.016**	Constant	*0.000*	*0.959*
Number of observations:	70		Number of observations:	70	
R-squared	0.385		R-squared	0.781	
Prob (F-statistic)	0.000		Prob (F-statistic)	0.000	

Note: Estimation in Panel A by ordinary least squares with heteroskedastic/auto-correlation consistent statistics and time fixed effects; estimation in Panel B by two-stage least squares with heteroskedastic/auto-correlation consistent statistics and time fixed effects.

across equations. Although the coefficients register as being somewhat smaller than before, they still suggest a powerful role for trade on incomes.

Although previous studies have imputed pro-growth effects from the positive correlation between the level of income and the instrumented trade share, it is generally not demonstrated what the direct contribution of trade shares is to growth. Here, the example set by Alesina and Spolaore (2003) is followed. In their work, they develop a convincing model of the evolution of income in which the growth rate of *per capita* income should be positively related to openness and the size of the domestic market, but that the interaction between these two terms should be negative, that is, large countries have less to gain from increasing openness than small ones.

In Table 8, the estimates from the specification proposed by Alesina and Spolaore (2003) are reported. Interestingly, the results are highly consistent with their model, especially if real income is thought to be the true measure of a country's size. Thus, Tables 7 and 8 when taken together imply strong pro-growth effects of openness when it is constructed as a quantity-based variable.

Table 8. *Relationship between growth and trade shares.*

Dependent variable: Average annual growth rate of real GDP *per capita*				
Size variable:	Initial Real GDP		Initial Population	
Constant	**−4.844**	*−3.781*	*−1.285*	*−2.664*
	(0.053)	*(0.219)*	*(0.674)*	*(0.434)*
Observed trade-to-GDP ratio	**12.410**	**13.257**	*4.463*	*4.393*
	(0.035)	**(0.037)**	*(0.512)*	*(0.524)*
Size (logged)	**0.570**	**0.648**	*0.290*	*0.213*
	(0.012)	**(0.022)**	*(0.335)*	*(0.506)*
Size * Observed trade ratio	**−1.185**	**−1.223**	*−0.539*	*−0.577*
	(0.032)	**(0.034)**	*(0.443)*	*(0.403)*
Initial real GDP *per capita* (logged)		*−0.264*		*0.297*
		−(0.569)		*(0.421)*
N	70	70	70	70
Prob (F-statistic)	0.050	0.107	0.176	0.406

Note: Estimation by ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

3. Discussion

Looking over the body of empirical results presented in the previous section, it seems that they have unearthed contradictory results: the price-based measures suggest openness was negatively related with growth while the quantity-based measure suggests openness was positively related with growth. Is there any plausible story that can be told to resolve this inconsistency?

One of the more natural ways to interpret the result that tariffs are positively correlated with growth is in terms of infant industry arguments, given the predominance of this theme in the economic literature of the nineteenth century. Of course, this line of reasoning flies in the face of the parallel finding that quantity-based openness measures are positively correlated with growth, as the infant-industry argument would seem to imply a drop in the volume of trade as economies substitute domestic alternatives for imports. Furthermore, there seems to be little empirical basis for making such infant-industry arguments in the nineteenth century (Irwin 2002a, Williamson 2003).

A more viable alternative might then be in terms of export promotion.[6] If tariffs were associated with greater levels of exports, then a positive correlation between growth and both the level of tariffs and the volume of trade would be consistent. And as noted by Bairoch (1974, 1993), higher levels of protection were positively associated with export growth in the late nineteenth century. However, given the accounting definition of GDP, what

6 Although not generally tied to protection, export promotion as an engine of growth in the nineteenth century has a notable pedigree in economic history; see North (1955), Caves (1971), Harley (1980), and Williamson (1980).

Table 9. *Relationship between the BOT, tariffs, and growth.*

	Coefficient	p-value
Panel A		
Dependent variable: Balance-of-trade over GDP		
Initial tariff rate (logged)	**1.697**	**0.000**
Constant	**−6.056**	0.000
N	420	
R-squared	0.363	
Prob (F-statistic)	0.000	
Panel B		
Dependent variable: Change in balance-of-trade over GDP		
Change in tariff rate	**0.067**	**0.013**
Constant	**−0.025**	**0.065**
N	407	
R-squared	0.154	
Prob (F-statistic)	0.014	
Panel C		
Dependent variable: Growth rate of GDP (net of the BOT)		
Change in balance-of-trade over GDP	**0.353**	**0.012**
Constant	**2.373**	**0.000**
N	410	
R-squared	0.373	
Prob (F-statistic)	0.012	

Note: Estimation by ordinary least squares with heteroskedastic/auto-correlation consistent statistics and country/time fixed effects; p-values in parentheses.

is needed is some indication of changes in both exports and imports if we are to say anything about effects on income and growth. So the question becomes, was the *net* balance of trade at all associated with the level of tariffs? Panel A of Table 9 shows that the two were positively correlated in levels while Panel B offers strong evidence, pointing to a positive correlation between the two variables in a differenced specification. Taken at face value, the point estimates suggest that, when evaluated at the sample means, an increase of 1 percentage point in the level of tariffs led to an increase of roughly 0.7 percentage points in the balance-of-trade to GDP ratio. Finally, Panel C attempts to relate changes in the balance-of-trade to GDP ratio to the growth rate of incomes. In this case, the dependent variable is GDP net of the balance-of-trade, as it has long been recognised in the empirical literature that failing to do so induces correlation between the two by definition (Michaely 1977, Balassa 1978). The estimates indicate that an increase in the balance-of-trade to GDP ratio had a significant impact on the growth rate of net GDP *per capita*, leaving room for arguments revolving around capacity utilisation and the attainment of economies of scale.

These results can clearly be related to the recent work of Clemens and Williamson (2004). Their key finding is that the general trade environment is crucial in determining the appropriate response of trading partners in setting their own tariff policy. Given the commitment of certain key players in the late nineteenth century to the cause of free trade – Belgium, Denmark, but above all, the United Kingdom, many nations could effectively play the game unilaterally with very little fear of reprisal. Of course, this corresponds nicely with the insight advanced some time ago by McCloskey (1980) that free trade might have been detrimental to a nation's health when others were not reciprocating.

However, the exact means by which tariffs could have stimulated growth in exports, and hence the balance of trade, remains somewhat veiled. Bhagwati (1992) and Dick (1994) suggest models of export-promoting protection in the absence and presence of increasing returns to scale, respectively. Yet at the moment, the only constraints we can impose to generate the positive correlation between tariffs and the balance of trade is that the partial derivative on exports with respect to the level of tariffs be positive and greater in absolute value than the corresponding partial derivative on imports. This is clearly not enough information to implement the aforementioned models. What is suggested, then, for future research is more detailed examination of the effects of tariffs on the balance of trade at the sectoral level.

4. Conclusion

This article investigates the question of how openness affected the growth of income in the late nineteenth-century Atlantic economy. This is, of course, an old question. And while what has been presented cannot represent the final word, it hopefully does contribute to an understanding of the complexity of the question as well as an appreciation of the more salient features of the openness–growth relationship in the nineteenth century.

First, it has been demonstrated that the Bairoch hypothesis once again withstands close scrutiny. Following the work of O'Rourke (2000), the growth–tariff correlation remains, even after incorporating a new sample of countries – countries which were predominantly politically mature and land-scarce. Avoiding the potential bias identified by Irwin (2002a, b), the new sample yields estimates which substantiate O'Rourke's original findings.

Turning to a new price-based measure of openness, the second set of results also fails to overturn the Bairoch hypothesis. Here, estimates of domestic and international trade costs are substituted for the customs-revenue-to-imports ratio. These estimates serve a twofold purpose: first, they allow for a move away from the customs-revenue-to-import ratio as the sole proxy for the general level of protection; second, they allow one to test the hypothesis that the tariff–growth correlation masks important pro-growth forces working at the domestic level. On this second point, the estimates give no indication that the process of domestic market integration had any independent effect on growth. However, a positive and significant correlation between growth and international trade costs arises. In so far as these international trade costs proxy for levels of protection, the tariff–growth correlation remains unscathed.

In the final exercise, quantity-based measures of openness are constructed. Specifically, estimates of the geographic component of trade are used as instruments for observed levels of the volume of trade. The results concur with the original findings of Frankel and Romer (1999) and the subsequent findings of Irwin and Tervio (2002). Indeed, they demonstrate an even more statistically significant effect of openness on the level of real income than most estimates for the twentieth century. Applying these new measures of openness to the growth models of Alesina and Spolaore (2003), a positive and strong correlation between openness and growth also emerges.

Thus, a contradiction seemingly arises from these results, namely that growth was positively associated with both the level of tariffs and the volume of trade. However, framing the discussion in terms of export-promotion, evidence is presented demonstrating the positive effect, on the one hand, of changes in the level of tariffs on changes in the balance of trade, and on the other, of changes in the balance of trade on growth rates.

At the very least, then, it seems that Bairoch's original hypothesis refuses to die after all these years. Perhaps by digging deeper into the sources it can finally be put to rest or accepted as an exception to the rule equating openness with economic growth.

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Appendix I: Data sources and definitions

Kevin O'Rourke kindly provided the data underlying his 2000 study. This allowed for not only less data entry, but more importantly a means to exactly match data definitions across the two samples.

Average annual growth rate: growth rate of real GDP-per-capita calculated from Maddison (1995); constructed on an annual basis, then averaged over ten-year windows (t, $t+9$).
Initial real GDP-per-capita: level of real logged GDP-per-capita taken from Maddison (1995); averaged over five-year windows (t, $t+4$)
Initial tariff rate: ratio of customs revenue to value of imports calculated from Mitchell (1992, 1993); averaged over five-year windows (t, $t+4$).
Capital-labour ratio: ratio of coal consumption (production plus imports minus exports) to population calculated from Mitchell (1992, 1993); averaged over five-year windows (t, $t+4$).
Change in capital-labour ratio: the difference between the ratio in ($t+5$, $t+9$) and (t, $t+4$) was scaled by the ratio in (t, $t+4$) and multiplied by 100.
Land-labour ratio: ratio of the sum of land devoted to grains, potatoes, sugar beet, vines, olives, citrus, cane, flax, cotton and tobacco to population calculated from Mitchell (1992, 1993); averaged over five-year windows (t, $t+4$).
Change in land-labor ratio: the difference between the ratio in ($t+5$, $t+9$) and (t, $t+4$) was scaled by the ratio in (t, $t+4$) and multiplied by 100.
Domestic and international trade factors: estimates of average trade costs over average prices for wheat from Jacks (2005); estimated over five-year windows (t, $t+4$).
Bilateral trade as a share of GDP: current dollar values of bilateral trade from Barbieri (1996) scaled by GDP deflators and real GDP figures given in Maddison (1995); calculated annually.
Distance: great-circle distances in kilometres taken from Rose (2000); fixed.
Population: thousands of inhabitants taken from Maddison (1995); measured annually.
Area: square-kilometres of landmass taken from League of Nations (1927) with modifications reflecting border changes; fixed.
Coastline: kilometres of coastline (+1) taken from http://www.cia.gov/cia/publications/factbook/ with modifications reflecting border changes; fixed.
Observed trade shares: calculated from current export and import values in Mitchell (1992, 1993) scaled by annual exchange rates taken from Taylor (2000) and by annual GDP deflators and real GDP figures given in Maddison (1995); averaged over ten-year windows (t, $t+9$).
Real GDP: taken from Maddison (1995); averaged over ten-year windows (t, $t+4$)
Balance of trade as a share of GDP: calculated from current export and import values in Mitchell (1992, 1993) scaled by annual exchange rates taken from Taylor (2000) and by annual GDP deflators and real GDP figures given in Maddison (1995); averaged over ten-year windows (t, $t+9$).

Appendix II: Robustness checks

In this section, the results of a few exercises are presented in order to address potential concerns with the specifications and strategies of Section 3. First, there is the issue of sample selection. Tables A.1 and A.2 confront this by reporting the results for the unconditional convergence and factor accumulation models, respectively. For ease of reference, the first, third, and fifth columns of both tables are the results reported in Section 3, using the new sample of ten countries. In turn, the second, fourth, and sixth columns of both tables are the results from using the full sample

Table A.1. *Unconditional convergence model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	New Sample (10)	Full Sample (14)	New Sample (10)	Full Sample (14)	New Sample (10)	Full Sample (14)
Estimation by:	OLS*	OLS*	OLS*	OLS*	OLS*	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	No	No	Yes	Yes
Number of significant f.e. terms:	0	1	n/a	n/a	10	14
Constant			*0.603*	*2.875*		
			(0.833)	*(0.300)*		
Initial real GDP per	*0.440*	**1.142**	*0.222*	*−0.057*	**−9.658**	**−3.357**
capita (logged)	*(0.549)*	**(0.031)**	*(0.560)*	*(0.874)*	**(0.001)**	**(0.016)**
Initial tariff rate	**0.943**	**0.872**	**0.216**	**0.206**	**0.841**	**0.551**
(logged)	**(0.092)**	**(0.064)**	**0.023**	**(0.100)**	**(0.048)**	**(0.097)**
D1879			*−0.330*	**−0.621**	**−3.912**	**−1.892**
			(0.419)	**(0.071)**	**(0.001)**	**(0.003)**
D1884			**−0.743**	**−0.759**	**−3.923**	**−1.886**
			(0.054)	**(0.017)**	**(0.001)**	**(0.001)**
D1889			**−0.714**	**−1.037**	**−3.551**	**−2.045**
			(0.100)	**(0.005)**	**(0.001)**	**(0.001)**
D1894			*0.166*	*−0.234*	**−2.095**	**−1.069**
			(0.674)	*(0.590)*	**(0.001)**	**(0.014)**
D1899			**−0.859**	**−0.625**	**−2.398**	**−1.253**
			(0.028)	**(0.068)**	**(0.001)**	**(0.002)**
D1904			*0.079*	*0.087*	**−0.704**	*−0.229*
			(0.871)	*(0.816)*	**(0.089)**	*(0.476)*
N	70	98	70	98	70	98
R-squared	0.118	0.189	0.176	0.146	0.410	0.327
Adjusted R-squared	n/a	n/a	n/a	n/a	n/a	n/a
Prob (F-statistic)	0.025	0.000	0.051	0.031	0.001	0.001

Note: OLS* denotes ordinary least squares with heteroskedastic and auto-correlation consistent statistics; p-values in parentheses.

Table A.2. *Factor accumulation model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)	(5)	(6)
Sample:	New Sample (10)	Full Sample (14)	New Sample (10)	Full Sample (14)	New Sample (10)	Full Sample (14)
Estimation by:	OLS*	OLS*	OLS*	OLS*	OLS*	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	Yes	Yes	Yes	Yes
Number of significant f.e. terms:	10	14	0	3	10	13
Initial real GDP *per capita* (logged)			**1.085**	**1.784**	**−8.586**	**−2.429**
			(0.022)	**(0.003)**	**(0.001)**	**(0.034)**
Change in capital-labour ratio	*0.009*	*0.008*	*0.014*	**0.014**	*0.016*	**0.014**
	(0.479)	*(0.284)*	*(0.356)*	**(0.085)**	*(0.224)*	**(0.074)**
Change in land-labour ratio	**0.098**	**0.072**	**0.104**	**0.076**	**0.035**	**0.071**
	(0.007)	**(0.001)**	**(0.003)**	**(0.001)**	**(0.073)**	**(0.001)**
Initial tariff rate (logged)	**0.831**	**0.713**	**0.752**	**0.770**	*0.654*	*0.294*
	(0.073)	**(0.099)**	**(0.083)**	**(0.091)**	*(0.127)*	*(0.481)*
D1879					**−3.822**	**−1.912**
					(0.001)	**(0.001)**
D1884					**−3.617**	**−1.675**
					(0.001)	**(0.001)**
D1889					**−3.301**	**−1.709**
					(0.001)	**(0.001)**
D1894					**−1.857**	**−0.753**
					(0.004)	**(0.031)**
D1899					**−2.270**	**−1.185**
					(0.001)	**(0.001)**
D1904					**−0.675**	*−0.192*
					(0.082)	*(0.513)*
N	70	98	70	98	70	98
R-squared	0.187	0.254	0.203	0.306	0.434	0.419
Adjusted R-squared	n/a	n/a	n/a	n/a	n/a	n/a
Prob (F-statistic)	0.000	0.000	0.000	0.000	0.000	0.000

Note: OLS* denotes ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

Table A.3. *Factor accumulation model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)
Sample:	New Sample (10)	New Sample (10)	Full Sample (14)	Full Sample (14)
Estimation by:	OLS*	OLS*	OLS*	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	Yes	Yes
Number of significant f.e. terms:	0	10	14	14
Initial real GDP *per capita* (logged)	**1.204**	**−8.547**	**1.576**	**−2.966**
	(0.095)	**(0.000)**	**(0.007)**	**(0.037)**
Change in capital-labour ratio	*0.013*	*0.015*	*0.009*	*0.013*
	(0.369)	*(0.258)*	*(0.407)*	*(0.214)*
Change in land-labour ratio	**0.108**	**0.041**	**0.071**	**0.065**
	(0.003)	**(0.012)**	**(0.004)**	**(0.010)**
Initial tariff rate (logged)	**0.756**	**0.651**	**1.176**	**0.944**
	(0.093)	**(0.095)**	**(0.046)**	**(0.063)**
Change in enrolment ratio	*0.007*	*0.009*		
	(0.395)	*(0.367)*		
Initial customs-to-total-revenue ratio (logged)			**−1.476**	**−1.483**
			(0.046)	**(0.017)**
D1879		**−3.821**		**−2.070**
		(0.000)		**(0.004)**
D1884		**−3.683**		**−1.947**
		(0.000)		**(0.001)**
D1889		**−3.286**		**−1.810**
		(0.000)		**(0.000)**
D1894		**−1.861**		*−0.620*
		(0.004)		*(0.152)*
D1899		**−2.246**		**−1.222**
		(0.000)		**(0.002)**
D1904		**−0.652**		*−0.262*
		(0.098)		*(0.299)*
N	70	70	92	92
R-squared	0.208	0.340	0.294	0.435
Prob (F-statistic)	0.000	0.000	0.000	0.000

Note: OLS* denotes ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

of countries. As can readily be seen, the results are materially the same. The key motivation for restricting our attention to the new sample of ten countries is to indirectly address the criticism raised by Irwin (2002a, b) and to keep the sample consistent across specifications, citing the lack of equivalent commodity price data for the excluded countries (Australia, Canada, Denmark, and Sweden).

Second, Tables A.3 and A.4 address the issue of potential omitted variable bias. The first of the two tables attempts to incorporate changes in human capital into

Table A.4. *Factor accumulation model.*

Dependent variable: Average annual growth rate of GDP *per capita*	(1)	(2)	(3)	(4)
Sample:	New Sample (10)	New Sample (10)	New Sample (10)	New Sample (10)
Estimation by:	OLS*	OLS*	OLS*	OLS*
Fixed effects (f.e.) in estimation:	Yes	Yes	Yes	Yes
Number of significant f.e. terms:	0	10	0	0
Initial real GDP *per capita* (logged)	*1.211*	**−8.742**	**0.609**	*0.577*
	(0.381)	**(0.000)**	**(0.047)**	*(0.801)*
Change in capital-labour ratio	*0.014*	*0.020*	*0.006*	*0.003*
	(0.357)	*(0.134)*	*0.586*	*0.769*
Change in land-labour ratio	**0.105**	**0.042**	**0.075**	**0.065**
	(0.005)	**(0.029)**	**(0.006)**	**0.024**
Initial tariff rate (logged)	**0.736**	**0.299**	**0.804**	**0.605**
	(0.085)	**(0.056)**	**(0.045)**	**(0.033)**
Initial agricultural-to-total population ratio (logged)	*0.198*	*1.928*		
	(0.888)	*(0.218)*		
Business cycle			**−23.056**	**−23.888**
			(0.035)	**(0.055)**
D1879		**−4.483**		*0.135*
		(0.000)		*(0.881)*
D1884		**−4.045**		*−0.047*
		(0.000)		*(0.954)*
D1889		**−3.638**		*−0.522*
		(0.000)		*(0.424)*
D1894		**−2.085**		*0.106*
		(0.003)		*(0.851)*
D1899		**−2.403**		*−0.908*
		(0.000)		*(0.333)*
D1904		**−0.734**		*0.077*
		(0.057)		*(0.810)*
N	70	70	70	70
R-squared	0.203	0.448	0.234	0.345
Prob (F-statistic)	0.000	0.000	0.000	0.000

Note: OLS* denotes ordinary least squares with heteroskedastic/auto-correlation consistent statistics; p-values in parentheses.

the analysis as well as to more directly address Irwin's point. In the first instance, measures capturing primary and secondary enrolments as a percentage of population were constructed and then differenced following the same procedure as that for capital- and land-labour ratios in Appendix I. The results are not encouraging as the change in the enrollment ratio proved to be economically and statistically insignificant as can be seen in columns 1 and 2. But these results are perhaps not surprising since the effects of human capital are often hard to identify, even in the twentieth century setting where they presumably play a much greater role than in the late nineteenth century.

Turning to cols 3 and 4, it was Irwin's insight that certain labour-scarce, land-abundant countries (that is, Australia, Canada, and the United States) with their high potential for growth and relative lack of tax-gathering apparatus might have been generating a spurious correlation between tariffs and growth as these countries may have found recourse to revenue-generating tariffs in a time of economic expansion necessary. In this case, the factor accumulation model is augmented to include a variable capturing the proportion of total revenue accounted for by customs revenue. Once again, the tariff-growth correlation fails to disappear. If anything, controlling for this variable suggests an even stronger effect of tariffs on growth as the coefficient values increase noticeably.

Table A.4 incorporates evidence on agricultural population shares and domestic business cycles. As to the first variable, the argument for including it is that much of the growth witnessed in the late nineteenth century might potentially be explained by the shift in certain countries from low-productivity agriculture to high-productivity industry and that the coincidence of an initially large agricultural population and high tariffs might lead us down the wrong path in identifying the sources of income growth during the period. In order to address this charge, the ratio of agricultural-to-total population was constructed and employed in the estimation. The results are reported in cols 1 and 2, but the statistical insignificance of the variable coupled with the resilience of the tariff rate variable led to its being dropped from the results reported in Section 3.

Finally, there may be some concern that what the tariff variable is actually capturing is the effects of domestic business cycles. The story would be as follows. Suppose a country is experiencing a recession and succumbs to pleas to raise tariffs. However, given the nature of the bargaining/legislative process the introduction of a new set of tariffs lags the onset of the recession and coincides with an economic recovery. Thus, a meaningless correlation between growth and tariffs would emerge from the data. Here, O'Rourke's lead is once again followed and deviations from a quadratic trend in GDP *per capita* are used as indicators of the business cycle. The upshot is that in columns 3 and 4 the growth-tariff correlation remains. Furthermore, it is clear that the time-fixed effects in the specifications reported above were already proxying for this variable.