CONVERGENCE IN THE AGE OF MASS MIGRATION

ALAN M. TAYLOR

Northwestern University and National Bureau of Economic Research

JEFFREY G. WILLIAMSON

Harvard University and National Bureau of Economic Research

Abstract

Between 1870 and 1913 convergence among present OECD members (or an even wider sample of countries) was dramatic, about as dramatic as it has been over the past century and a half. What were the sources of the convergence? One prime candidate is mass migration. This paper offers some estimates which suggest that migration could account for very large shares of the convergence in labor productivity and real wages, though a much smaller share in GDP per capita. One might conclude, therefore, that virtual cessation of convergence in the interwar period could be partially explained by the imposition of quotas and other barriers to migration.

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International migration, international investment, convergence, economic development 1870–1913

Taylor is Assistant Professor of Economics at Northwestern University and Faculty Research Fellow at the National Bureau of Economic Research. Williamson is Laird Bell Professor of Economics at Harvard University and Research Associate at the National Bureau of Economic Research. This research has been supported in part by the National Science Foundation, grants SES-90-21951 and SBR-92-23002. We gratefully acknowledge the skillful research assistance of Steve Saeger and the comments and suggestions of Moses Abramovitz, Steven Dowrick, Robert Fogel, Cormac Ó Gráda, Timothy Hatton, and seminar participants at the All-UC Group in Economic History Fall Conference (Pasadena, Calif., November 1994), the European Science Foundation Conference on Migration and Development (Aghia Pelaghia, Crete, October 1994), the Eleventh International Economic History Congress (Univ. Bocconi, Milan, Italy, September 1994), the First European School of Historical Economics (Firenze, July 1994), the European University Institute, Harvard University, the University of Illinois at Chicago, the Universidad Torcuato Di Tella, the Universidad Carlos III, the University of Chicago, and the University of Michigan.

The exportation of labourers and capital from old to new countries, from a place where their productive power is less to a place where it is greater, increases by so much the aggregate produce of wealth of the old and the new country.… Colonization, in the present state of the world, is the best affair of business, in which the capital of an old and wealthy country can engage.

—John Stuart Mill[1]

It must be emphasized that without the change in the proportions of the factors of production that occurs as a result of migration or population growth, differences in factor prices in various countries will persist, and the factors of production of the world as a whole will not be used to their best advantage.

—Eli F. Heckscher[2]

I. Introduction

Some fifty million Europeans emigrated in the century before 1913. The vast majority, about 46 million, left Europe for the New World and the numbers increased over time. The Old World population rose from about 192 million in 1800 to about 423 million in 1900, so annual gross emigration rates averaged about two per thousand over the century, and even higher—above ten per thousand in many countries—after 1880 (Kenwood and Lougheed 1992). This "mass" migration was on a scale not witnessed before nor since, and it generated debate on the impact of the migrations in sending and receiving regions, the relative power of "push" and "pull," the distributional consequences of the migrations (who gained and who lost), and whether the migrations should have been controlled or free. A central premise everywhere in the debate has, of course, been that migration improved the lot of those who moved since real wages were higher in the destination regions. But what about the stayers in the Old World and the natives in the New World? Did the mass migrations have a powerful impact on labor markets in the sending and receiving regions? Economists like John Stuart Mill, writing before the mass migrations began in

[1] Mill (1929 [1848]).

[2] Flam and Flanders (1991, 59). Heckscher understood that with impediments to trade or with specialization outside cones of diversification (a failure of "harmonic equilibrium," in his words), factor price convergence would be incomplete and factor migration necessary to obtain factor price equalization.

earnest, and Eli Heckscher, writing just after they ceased, well understood the causes and consequences of such massive factor flows: factor price differentials, if not fully erased by trade in products, would stimulate factor migrations, raising world economic efficiency and eliminating factor price gaps between the "new" and "old" countries.

Unless it was offset by other forces, mass migration must have eased global labor market disequilibrium in the late nineteenth century and, thus, promoted convergence. Labor endowments shifted from poor sending to rich receiving regions thus helping erase some of the wage and labor productivity gaps between them. It certainly helped drive a wedge between labor force growth in the Old World and New: 0.7% versus 2.4% per annum between 1870 and 1910, respectively. The process reached its apex when migration rates surged around the turn of this century (Table 1).[3] The age of uncontrolled mass migration ceased, of course, after the U.S. quotas were imposed in the 1920s, and whatever contribution the migrations made to economic convergence must have ceased as well.

The question of convergence has long captivated theorists and empiricists, but the aim of this paper is to show how the convergence literature must confront and incorporate the processes of international migration if our explanations are to be sufficiently comprehensive to cover historical experience since 1850. Closed-economy growth-convergence models are certainly inappropriate for any discussion of the late nineteenth century world economy, since it was characterized by a remarkably free flow of goods, capital and people. Indeed, this paper documents an important contribution of mass migration to convergence 1870–1910: a very large share of the significant convergence observed would have been erased had migration been suppressed. The estimated contribution of the mass migration is so large, in fact, that its impact on convergence must have been offset by a variety of countervailing forces: independent disequilibrating forces of technical change (faster in rich countries); and dependent offsetting forces of capital accumulation (international capital chasing after the migrants or native capital

[3] Migration rates shown in Table 1 are derived from data in Appendix 2, averaged 1870–1910, and net rates reflect adjustments for underenumerated return migration. The labor force migration rates γM adjust for the estimated labor content of the migrant flow relative to the population stock, γ. Cumulative impacts on stocks over the 40 years 1870–1910 are given by the formula exp(40×[average net migration rate 1870–1910])–1.

accumulation stimulated by the presence of migrants), of natural resource exploitation (frontier expansion and land settlement stimulated by population expansion), of trade (migrant labor favoring the expansion of labor-intensive activities in rich countries) or of productivity advance (migrant-labor induced scale economies). All of these processes no doubt warrant further investigation, modeling and empirical evaluation before a complete picture of late nineteenth century convergence can be assembled.

II. Convergence: Contemporary Debate and Late Nineteenth Century Facts

The central questions in the convergence debate are two: first, do we observe convergence in the world economy? second, what explains convergence or its absence?

Convergence models include the venerable first-generation contributions and their recent refinements (for example, Solow 1956; Mankiw, Romer and Weil 1992). The "new" growth theory has focused attention on generating endogenous growth, and even the possibility of divergence, without appeal to a *deus ex machina* like exogenous technological change. Some models allow for divergence via long-run increasing returns, from learning-by-doing or various externalities, or by adding additional accumulable factors such as human capital (for example, Barro and Sala-i-Martin 1995; Lucas 1988; Lucas 1990; Romer 1986). Others have refined the notion of convergence to include local and global variants (Durlauf and Johnson 1995).

Empirical work has proliferated, led by the pioneering contributions from Moses Abramovitz (1986) and William Baumol (1986) that built on the macroeconomic data collected by Angus Maddison (1982; 1989; 1991). Abramovitz related the observed "catching up" of postwar Europe (on the United States) to a more general principle reminiscent of the "leader's handicap" theory of Veblen (1915) or the "advantages of backwardness" theory of Gerschenkron (1962): namely, a country with lower productivity may exploit the technological gap with respect to the leader, import or imitate best practice technology and, hence, raise labor productivity and living standards. Abramovitz found GDP per worker dispersion has generally diminished over the last century or so (Table 2, column 1), with an implied average convergence speed of about 1% per annum, with particularly rapid convergence in the post-WWII period. Although Abramovitz characterized the convergence before 1913 as weak, it turns out that the speed of convergence then was very close to the long-run average. The interwar evidence seemed to suggest lost

opportunities for catching up arising from autarkic tendencies in the world economy that obstructed capital, labor and technology flows.[4]

Abramovitz (1986) anticipated many refinements contained in the subsequent literature. He noted further the distinction to be drawn between the convergence hypothesis and the catch-up hypothesis: economic growth may depend on other factors besides technologically driven catch up, for example, physical or human capital deepening (Mankiw, Romer and Weil 1992; Dowrick and Nguyen 1989). Furthermore, catch-up would be "self-limiting"—declining to zero as the productivity gap diminished.[5] Abramovitz also cited "trade and its rivalries" (including international factor flows) as important ingredients in the convergence process, although he did not pursue the subject in depth. Abramovitz contrasted convergence as measured by dispersion levels—now termed "σ-convergence"—with convergence measured by the extent to which poor countries grow faster than rich ones, as given by a Baumol-style (partial) correlation of growth rates and initial per capita income or productivity—now termed "β-convergence" (Barro and Sala-i-Martin 1992). He also noted many of the statistical problems later to plague convergence analysis, such as sample-selection bias (a tendency to accept falsely the convergence proposition when using only a sample of now-rich countries) and the errors-in-variables problem (a tendency for a growth rate versus initial income regression to generate false acceptance if there is measurement error in the historical data). Such problems were cause for criticism of Baumol's exploratory econometric analysis (De Long 1988).

We have touched on convergence theory—what about fact? Tables 2 and 3 show exactly what it is we wish to explain. There we offer four measures of σ-convergence across the late nineteenth century. The last column is based on a 17-country sample that includes the twelve current European OECD countries listed in Table 3 plus three New World members, Australia, Canada and the USA, and two New World non-members, Argentina and Brazil. The first three columns exclude Ireland. The rate of convergence 1870–1913 in the first column was about 1%

[4] The convergence speed is measured by the rate of decline of log (σ/μ), where σ is the standard deviation and μ is the mean.

[5] That is, a "strong convergence" property where productivity or welfare levels converge over time, to be differentiated from "weak convergence" where only growth rates converge over time, with possible permanent gaps in levels.

per annum, roughly equal to the long-run convergence rate over the past century or so. The degree of convergence depends greatly, however, on the measure used and on the purchasing-power parity (PPP) comparison adopted. All three newer estimates in columns 2 through 4 record lower rates of convergence 1870–1913. Note also the extent to which late-nineteenth century convergence is diminished by the switch from Maddison's 1982 data (Table 2, column 1, the same data used by Abramovitz) to Maddison's revised 1991 data (Table 2, column 2). The sensitivity stems from the estimation methodology. Using individual country growth rates, Maddison projects backwards from the 1970s or 1980s GDP benchmarks constructed from PPP comparisons. This approach invites concern about long-run index-number problems and raises doubts about the accuracy of the implicit back-projected PPPs assumed to be stable over the past century and even longer. Thus, the availability of new data based on real wages, and using additional PPP benchmarks from the 1920s and 1900–13, provides a welcome consistency check on Maddison's aggregates (O'Rourke and Williamson 1997; Williamson 1995). In short, we use three measures of convergence performance: Maddison's newest GDP per capita data, Maddison's newest GDP per worker data and Williamson's real wage data. Our agnosticism about which variable provides the "correct" convergence criterion is also rooted in theoretical and empirical concerns to be discussed later: the dynamics of wage and output measures *should* be distinct and interest in a particular variable depends on the questions under consideration.

III. Migration and Convergence in Partial Equilibrium

Although technological catching up may well have been operative in the late nineteenth century, we identify instead another powerful convergence force. This paper takes seriously the possibility that "trade and its rivalries" mattered for late-nineteenth century convergence, a possibility already supported by other work on the Atlantic economy (Taylor 1996; O'Rourke and Williamson 1995a; O'Rourke and Williamson 1995b; O'Rourke, Williamson and Hatton 1994; O'Rourke and Williamson 1994; O'Rourke, Taylor and Williamson 1996). In particular, it takes seriously the possibility that international migrations can generate significant convergence (Barro and Sala-i-Martin 1995; Hamilton and Whalley 1984). If such is true generally, then it certainly ought to hold for the late nineteenth century when mass migrations reached a crescendo.

Did migration lower wages in receiving countries while raising them in sending countries?[6] The debate is at least as old as the industrial revolution, appearing first in Britain in the 1830s where witnesses before Parliamentary committees—including the Reverend Malthus—asserted that Irish immigrants were crowding out native unskilled workers. The assertion has been repeated often enough since. As Michael Greenwood and John McDowell (1986, 1745–47) point out, it certainly has a long history in the United States. The debate reached a crescendo there in 1911 after the Immigration Commission had pondered the problem for five years. The Commission concluded that immigration contributed to low wages and poor working conditions. What was said in the sending countries? The migrants and their children clearly benefited, but what about those left behind? In the early 1880s, it was readily apparent where Knut Wicksell stood on this issue. Wicksell asserted that emigration would solve the pauper problem which then blighted labor-abundant and land-scarce Swedish agriculture. The 1954 Irish Commission on Emigration appears to have shared Wicksell's view, at least as applied to Ireland. The Commission concluded that a century of mass emigration had had a very positive effect on Irish wages. In the words of the Irish Commissioners, "emigration…has reduced the pressure of population on resources…and thus helped to maintain and even to increase our income per head" (1954, 140). Frequently, then, authorities have asserted that migration raised living standards in sending regions and lowered them in receiving regions.

Can theory or fact support such assertions? Historical correlations between rates of labor force growth, migration, the real wage and labor productivity are unlikely to offer any clear answer to the question. True, from 1870 to 1913 there is a *positive* correlation between migration and population increase on the one hand and real wages on the other, but such correlations tell us more about labor supply responses than about the presence or absence of diminishing returns. In the absence of increasing returns, and in the presence of a given technology and at least one fixed factor (like land), all comparative static models in the classical Wicksellian tradition predict that migration tends to make labor cheaper in the immigrating country and scarcer in the emigrating country, especially in the short run when dynamic responses can be ignored.

[6] The following three paragraphs draw on Hatton and Williamson (1994a, 20–21).

A familiar partial equilibrium analysis of the assertion is offered in Figure 1. New World real wages and marginal value productivities are on right and Old World real wages and marginal value productivities on the left. The "world" labor force is distributed between the two regions along the horizontal axis. Derived labor demand in the Old World is denoted by OW and in the New World by NW. L* is the distribution of labor that is consistent with wage parity between the two regions, while the actual distribution at two points in the late nineteenth century is denoted by L_{70} and L_{90}. The wage gaps in 1870 and 1890 are indicated by GAP_{70} and GAP_{90}. While estimation of Harberger triangles is not our goal in this paper, one has been identified for 1890 by the shaded area. One could easily calculate the dead-weight loss, however, as did Hamilton and Whalley (1984) for the contemporary world economy. One could also calculate the mass migration that would have been required to eliminate wage gaps entirely. However, our purpose is instead to account for the measured convergence across the late nineteenth century. Suppose all the labor force redistribution over these two decades was attributable to mass migration. Suppose at the same time there were independent accumulation events, technological catch-up, and price shocks, all of which, at least on net, favored the Old World, and thus induced a relative shift in Old World labor demand upward to OW′. In that case, the observed convergence would have been measured by the fall in the wage gap from GAP_{70} to GAP_{90}', and mass migration would have accounted for a share $(GAP_{70} - GAP_{90})/(GAP_{70} - GAP_{90}')$ of that fall.

There is no reason why the derived labor demand functions cannot be estimated. Given data on wage gaps and labor force distributions, there is also no reason why counterfactual analysis cannot be applied to a diagram like Figure 1. Indeed, Figure 1 has been drawn to be consistent with such late-nineteenth century estimates (using labor demand elasticity parameters estimated later in this paper). Furthermore, there is no reason why the two-region case in Figure 1 cannot be expanded to include our 17-country real-wage sample, allowing a decomposition of the contribution of mass migration to the convergence observed before WWI.

IV. Measuring the Impact of Migration on Convergence

Our multi-country study uses a counterfactual simulation approach. Our purpose is to assess migration's role in accounting for convergence as measured by the decline in dispersion between 1870 and 1910. The relevant data is shown in Table 3: real wage dispersion declines by 28% over

the period, GDP per capita dispersion by 18% and GDP per worker by 29%.[7] What contribution did international migration make to that measured convergence? To answer the question, we ask another: what would have been the measured convergence 1870–1910 had there been no (net) migration? The no-migration counterfactual invokes the *ceteris paribus* assumption: in each country, we adjust population and labor force taking into account the average net migration rate observed during the period, and we assume that technology, capital stocks, prices and all else remain constant. Such assumptions may impart bias to our calculation of the impact of mass migration on convergence, but before pondering that possibility, let's see whether the magnitudes are large enough to warrant further debate over bias.

A country with a cumulative net migration rate M, will be assumed to experience a counterfactual population change of $POP^* = M$ in the terminal year, where we use x^* to denote $d\ln x$, the log-derivative of x.[8] *Ceteris paribus*, migration affects long-run equilibrium output and wages through its influence on aggregate labor supply. We assume a CES aggregate production function for output, $Y = (aL^\rho + bK^\rho + cR^\rho)^{1/\rho}$, where L is labor input, K capital and R land.[9] Log-differentiating this equation produces the standard growth accounting result

$$(1) \qquad Y^* = \theta_L L^* + \theta_K K^* + \theta_R R^*,$$

where the θ_j are factor shares. Under long-run full employment conditions, competitive wages are equal to labor's marginal product, which is the marginal productivity condition $wL/Y = a(L/Y)^\rho$. Differentiating implies

$$(2) \qquad w^* = (1 - \rho)(Y - L)^*,$$

[7] The dispersion measure is variance divided by mean squared; cf Table 1 where the square root of this measure was adopted for consistency with Abramovitz (1986).

[8] For the present we ignore any endogenous response of native population growth (natural increase) to changes in the migration rate. Such effects are quite conceivable: for example, the much discussed "Walker effect" in the late nineteenth century United States. However, the existence and certainly the magnitude of such effects remains open to debate. In this exercise, we simply seek a reliable lower bound estimate of M to provide us with a conservative estimate of migration impacts on convergence.

[9] The results of this section also generalize to an arbitrary production function with standard properties. Note that there is no technical change, as we are only concerned here with comparative statics.

where, without loss of generality, we assume the producer price P is equal to one. Solving (1) and (2), taking K and R as fixed, produces an equation for the endogenous changes in wages and output:

(3) $Y^* = \theta L^*$;

(4) $w^* = \eta^{-1} L^*$;

where $\theta = \theta_L$, and $\eta = F_{LL}{}^{-1}(w/L)$ is the elasticity of labor demand with respect to the wage holding all other inputs fixed. In the CES case it is easy to show that $\eta^{-1} = -\sigma^{-1}(1 - \theta)$, where $\sigma = (1 - \rho)^{-1}$ is the elasticity of substitution.[10]

Thus, the long-run migration impact on wages and output may be derived if migrant streams of population measured by M can be converted into labor supply shocks L^*. Suppose, therefore, that for a given country a share α_M of its migrant stream is active in the labor force, while its total population has an active share α_{POP}. Moreover, assume that migrants have an effective-worker (or worker-quality) ratio of μ with respect to the total labor force—for example, a wage gap exists between the migrant stream and the resident labor force due to, say, skill premia. Hence, the labor content of the population is $L = \alpha_{POP}\, POP$, and the labor content of the migrant flow is $dL = \mu\, \alpha_M\, M\, POP$. Defining $\gamma = \alpha_M/\alpha_{POP}$ (the migrant-to-population ratio of labor-force participation rates) we obtain the expression $L^* = \mu\, \gamma\, M$.

We can now derive the simulation equations used to calculate the impact of migration on GDP per capita, per worker, and real wages:

(5) $w^* = \eta^{-1} L^* = \mu\, \gamma\, \eta^{-1} M;$

(6) $Y^* - POP^* = \theta L^* - M(1-\rho) = (\mu\, \gamma\, \theta - 1)\, M;$

[10] Note that all impacts on wages and outputs are calculated as linear approximations. As we shall see, some of the calculated impacts are large, and so the approximations may not be valid. To check this we also calculated estimated impacts using a calibrated CES production function, given estimates of factor shares and the substitution parameter. It turns out that the differences are small and do not materially affect the conclusions of this paper. For example, the estimated wage impact on a "large shock" case like Argentina is 46% in the linear approximation, and 40% using the CES form. For Ireland, the impacts are –33% and –35%, respectively. For countries with smaller migration rates, the impacts are barely affected at all. Note also that under the *ceteris paribus* assumption, the price structure is invariant under the counterfactual so that the impacts on the nominal wage, the producer real wage, and the consumer real wage are identical: $w^* = (w/P)^* = (w/CPI)^*$, where *CPI* is the consumer price deflator.

$$(7) \qquad Y^* - L^* = \theta L^* - \mu\gamma M(1-\rho) = \mu\gamma(\theta - 1)M.$$

The simulations use the above equations to assess the impact of the mass migrations 1870–1910 on convergence in our "greater-Atlantic-economy" sample of 17 countries.

The data requirements for the counterfactuals are described in Appendix 2, but we offer a brief summary here. Where possible, we have used standard published sources. For real GDP, population and labor force we use Maddison's (1991) latest estimates, with extensions, adjustments and modifications to bring Argentina, Brazil, Portugal, and Spain into the study, and to split the United Kingdom into Great Britain and Ireland. For real wages we use Williamson's (1995) database on internationally comparable real wages. For migration we modify Willcox (1929–31) and other standard time-series sources; specifically, we sought to bias our *M* estimates downwards to prevent our overstating the migration-convergence linkage, and we did this by using upper-bound estimates of return migration rates to give conservative net flow estimates (see Appendix 2).[11]

We know much more about some parameters than others. Migrant quality is poorly documented, and the same migrant may have exhibited different quality relative to stayers back home and native-born abroad. The baseline assumption has been to set the effective worker ratio $\mu = 0.8$ since we know that immigrants were considered low quality in the United States and that they typically entered at the bottom of the job ladder.[12]

The parameter γ (relative labor participation rates) is based on detailed studies of Anglo-American experience (Kuznets 1952; O'Rourke, Williamson and Hatton 1994). We expect γ to exceed unity, since migrant streams self-select and have a relatively high proportion of young adult males. Estimates of γ from the United States and Britain range between 1.53 and 1.78 for

[11] Our procedure was to compare the implicit return-rate in the raw immigration data series with other scholars' estimates of return rates as summarized in the work of Wyman (1993) and Nugent (1992). We then used the more conservative (higher) figure in the final analysis.

[12] Note that the concern here is with migrants' raw productivity, not adjusted for skills, experience or other characteristics. Still, given that the literature often asserts that Europe suffered a brain drain by the loss of the best and the brightest, we later subject μ to sensitivity analysis in the range 0.8–1.2. Note that an overstatement of μ or γ tends to understate the impact on GDP per capita while overstating the impact on the real wage and labor productivity. Thus, sensitivity analysis is especially important for these two parameters given the several measures of convergence being studied.

the late nineteenth century, so a mid-point estimate of 1.65 was chosen as the baseline parameter. Guided by working-age population shares, one might guess α_M to have been around 90% and α_{POP} around 60%. Labor's share (θ) is documented in various country-studies of factor distribution, most of which were done in the 1960s. These estimates were supplemented by constructing alternative estimates of $\theta = wL/Y$ from data on average nominal wages, nominal output and labor force. Independent estimates of θ were thus derived for almost all countries, with the remainder covered by contiguous-country estimates (for example, Brazil uses Argentina's θ estimate).

Lastly, η was estimated as $-\sigma/(1-\theta)$, with σ estimated using standard techniques from the theory of labor demand (Hamermesh 1993). Appendix 1 reports the estimation of σ using panel techniques on a 14-country subsample over the four decades 1870–1910. A "best guess" estimate of σ=1.00 (Cobb-Douglas technology) was used to derive the baseline estimates of η, a value close to the modern 70-country average of σ=0.75 reported by Hamermesh (1993).[13]

V. The Contribution of Mass Migration to Convergence

Table 4 presents the baseline results. The upper panel shows real wages, GDP per capita, and GDP per worker in 1910 under the counterfactual assumption of zero net migration after 1870 in all countries. The second panel indicates the proportionate impact with respect to the actual levels for each country shown in Table 3. The third and fourth panels report counterfactual convergence or divergence.

The results certainly accord with intuition: in the absence of migration, wage and labor productivity levels would have been much higher in the New World and much lower in the Old; and in the absence of migration, income per capita levels would typically (but not always) have been marginally higher in the New World and typically (but not always) marginally lower in the Old. Not surprisingly, the biggest counterfactual impact is seen in the countries that experienced the biggest migrations: by 1910, Irish wages would have been lower by 24%, Italian by 22% and Swedish by 8% and Argentine wages would have been higher by 27%, Australian by 17%, Canadian by 18% and American by 9%. Labor productivities would have been similarly affected.

[13] While σ=1.00 was used in the baseline analysis, alternative values of σ=0.5 and σ=2.0 were used in the sensitivity analysis. Note that, by (5) and (7), the wage and productivity impacts of any labor force shock will be the same in proportionate terms when σ=1.0, as usual with Cobb-Douglas technology.

There are only a few such country-specific estimates reported in what is otherwise an enormous literature on the mass migrations, but what few there are seem to be roughly consistent with those reported in the second panel of Table 4. For example, about two decades ago one of the present authors (Williamson 1974, 387) used a computable general equilibrium (CGE) model to estimate that in the absence of immigration U.S. real wages would have been 11% higher in 1910 (here estimated to be 8% higher), and income per capita 3% higher (matching the present estimate). More recently, another computable general equilibrium application to the U.S. found the impact to have been 34% in 1910 (O'Rourke, Williamson and Hatton 1994).[14] One of the present authors (Taylor 1997) used a computable general-equilibrium model to estimate that in the absence of immigration Argentine real wages would have been 25% higher in 1910 (again matching the present estimate).[15] Britain offers another example: O'Rourke, Williamson and Hatton estimate that emigration served to raise the real wage by 12% in 1910 (here estimated to be 6%).[16] A Norwegian study (Riis and Thonstad 1989, Table 8.6) found the impact of emigration to have raised income per capita in 1910 by 6% (here estimated to be 4%). A study for Sweden (Karlstrom 1985, Table 6.4) found the 1890 impact of emigration to have raised wages by 9% and income per capita by 2% (our figures, for 1910, are 7% and 2% respectively). While estimates obviously vary somewhat in the literature, there seems to be general agreement among them and our own, especially given that they were estimated in very different ways and under widely different assumptions.

Overall, the results in Table 4 lend strong support to the hypothesis that mass migration made an important contribution to convergence in the late nineteenth century. Starting with the third panel first, we observe that real wage dispersion would have *increased* 7% 1870–1910, in contrast to the actual 28% decline seen (Table 3). GDP per worker dispersion would have declined only 9% (versus actual, 29%), and GDP per capita dispersion would have declined only 9% (versus actual, 18%). New World-Old World wage gaps actually declined from 108% in 1870 to 85% in 1910, but in the absence of mass migration they would have *risen* to 128% in 1910 (a 10% counterfactual rise in the wage ratio, versus an 11% actual decline).

[14] The 34% CGE impact was reduced to 9.2% with allowance made for international capital mobility.

[15] The 25% CGE impact was reduced to 21% with allowance made for international capital mobility.

[16] The 12% CGE impact was reduced to 6.6% with allowance made for international capital mobility.

Pairwise comparisons are also easily constructed using Table 4 and compounding the percentages. Wage gaps (measured here as New World premia) between many Old World countries and the U.S. fell dramatically as a result of mass migration: without Irish emigration (some of which went to America) and U.S immigration (some of which was Irish), the American-Irish wage gap would have risen from 134% to 168%, while in fact it fell to 86%; without Italian emigration (a large share of which went to America) and U.S. immigration (much of it Italian), the American-Italian wage gap would have risen from 342% to 374%, while in fact it fell to 240%; without British emigration and Australian immigration, the Australian-British wage gap would have fallen only from 90% to 76%, while in fact it fell to 42%; and without Italian emigration and Argentine immigration, the Argentine-Italian wage gap would have risen from 135% to 210%, while in fact it fell to 90%. Furthermore, the mass migrations to the New World had an impact on economic convergence within the Old World: without the Swedish emigration flood and the German emigration trickle, the German-Swedish wage gap would have evolved from plus 107% (German higher) to minus 9% (Swedish higher), while in fact it evolved to minus 15% (Swedish higher); and without the fact that Irish emigration exceeded British emigration by far, the British-Irish wage gap would have fallen only from 37% to 30%, while in fact it fell to just 4%.[17]

A summary is offered in Table 5. In terms of the convergence accounted for by migration, the counterfactuals suggest that more than all (119%) of the real wage convergence 1870–1910 was attributable to migration, and almost three-quarters (72%) of the GDP per worker convergence. In contrast, one half (50%) of the GDP per capita convergence might have been due to migration.

The contribution of mass migration to convergence in the full sample and in the New and Old World differ, the latter being smaller and in some cases even negative. While the negative numbers may appear at first to be inconsistent with economic intutition, they make good sense when we appeal to segmentation in the global labor market. Immigrant flows were not everywhere efficiently distributed, since barriers to entry limited destination choices for many

[17] Although the impact of mass migration *within* the Old World was much smaller than between the Old and New World, remember the caveat that migrations within Europe were underenumerated, another bias working against our migration-convergence hypothesis.

southern Europeans. This point is central to discussions about Latin migration experience, and it is invoked as an important determinant of Argentine economic performance (Díaz-Alejandro 1970; Hatton and Williamson 1994b; Taylor 1992; Taylor 1994). Thus migrants did not always obey some simple market-wage calculus; kept out of the best high-wage destinations, or having alternative cultural preferences, many went to the "wrong" countries. The South-South flows from Italy, Spain and Portugal to Brazil and Argentina were a strong force for local (Latin), not global, convergence. Furthermore, while barriers to exit were virtually absent in most of the Old World, policy (like assisted passage) still played a part in violating any simple market-wage calculus.[18]

However, the small contribution of migration to convergence in each region illustrates our opening point: the major contribution of mass migration to late nineteenth century convergence was the enormous movement of almost 50 million Europeans to the New World, and the impact that this movement had on convergence between the two regions. The real wage convergence, as noted elsewhere, is in large part due to a narrowing of New World-Old World wage gaps, which fall from 108% in 1870 to 85% in 1910. The New World-Old World story stands in contrast to the quantitatively less important convergence within each region, an effect only further obscured by the imperfect wage-migration correlation (Williamson 1995).

The relative insensitivity of GDP per capita convergence to migration is a result of countervailing effects inherent in the algebra. For real wages or GDP per worker, higher values of γ (the migrant-to-population ratio of labor-force participation rates) amplify the impact of migration, but with GDP per capita the impact is muted. Why? In the former two cases, migration has a bigger impact on GDP, wage levels and labor force, the bigger is the relative labor content of the migrations. In the case of GDP per capita, the impacts are less clear. For example, with emigration, population outflow generally offsets diminishing returns in production, leaving a net positive impact on output per capita; but selectivity will take away a disproportionate share of the labor force ($\gamma > 1$), lowering output via labor supply losses, a negative impact on output per capita. The two exactly cancel out when, in equation (2), $\mu \gamma \theta = 1$. In our baseline case, $\mu = 0.8$

[18] Beyond our sample barriers to exit did exist—most emigration from Russia was illegal. On this, and for a more detailed discussion of migration policy, see Foreman-Peck (1992) and Nugent (1992).

and $\gamma = 1.65$, so $\theta = 0.758$ is the critical value. The sample θ range from 0.41 (Belgium) to 0.64 (U.S.), so muted GDP per capita effects are no surprise. By our calculation, four decades of immigration lowered GDP per capita never by more than 9% anywhere in the New World (Argentina), and by as little as 3% in the U.S., to be contrasted with wage and GDP per worker impacts of 27% and 9% respectively.[19] Similar reasoning applies to the Old World: Irish emigration after 1870 may have induced something like a 24% rise in wages and GDP per worker, but it may have induced only about a 13% rise in GDP per capita; Swedish emigration after 1870 may have raised wages and GDP per worker by about 8%, but it served to raise GDP per capita by only roughly 2%.

Table 6A explores the sensitivity of our results to various parameter values. The results seem robust for real wages and GDP per worker: for most parameter combinations, wage convergence is always more than explained by migration. As a conservative estimate, we could assert that mass migration accounted for at least all the real wage convergence and at least two thirds of the GDP per worker convergence. Finally, note the sensitivity of the GDP per capita impact to parameter assumptions. This should now come as no surprise given the previous discussion. When μ or γ are allowed to rise (so that $\mu \gamma \theta > 1$), the perverse divergence effect of migration appears for GDP per capita. Thus, our results raise another qualification to the convergence debate: when modeling migration and convergence, demographic considerations suggest care be taken in the selection of the variable documenting convergence.

VI. Qualifying the Bottom Line

So far, our baseline results argue that mass migration accounted for 119% of the real wage convergence observed in our sample of 17 New World and Old World countries between 1870 and 1910. Have we overexplained late nineteenth century convergence? Perhaps, but the fact is hardly surprising given that there were *other* forces at work, and at least one of them was strongly anti-convergent. First, what about capital accumulation? We know that capital accumulation was faster in the New World, so much so that the rate of capital deepening was faster in the U.S. than in any of her competitors (Wolff 1991), and the same was probably true of other rich New World

[19] This labor-supply compensation effect operated in addition to the usual human-capital transfer effects invoked to describe the net benefit to the U.S. of the millions received before WWI (Uselding 1971; Neal and Uselding 1972).

countries. There is evidence therefore that the mass migrations may have been at least partially offset by capital accumulation, and a large part of that capital widening was being carried by international capital flows which reached magnitudes unsurpassed before or since (Obstfeld and Taylor 1997; Eichengreen 1990; Edelstein 1982; Zevin 1992). Indeed, migration may have *induced* some of these capital flows. Second, what about the forces of trade of which so much was made by Eli Heckscher in 1919 and Bertil Ohlin in 1924 (Flam and Flanders 1991)? Their idea was that spectacular transport innovations in the late nineteenth century caused commodity prices to converge and trade to boom. As exports expanded among trading partners, the derived demand for their abundant factors boomed while that for their scarce factors slumped. Factor prices (like real wages) tended to converge as a result. Samuelson (1948) got us thinking about the strong assumptions needed for factor price *equalization*, but factor price *convergence* requires weaker assumptions and they are supported by the late nineteenth century evidence (Williamson 1996; O'Rourke and Williamson 1994; O'Rourke, Taylor and Williamson 1996). Third, what about the forces of technological catch up stressed by Gerschenkron (1962) and Abramovitz (1986)? Finally, what about the forces of human capital accumulation so prevalent in the new growth theory, and which have been suggested as an important force for convergence in the late nineteenth century (Easterlin 1981; Sandberg 1979)?

To the extent that schooling is a good proxy for human capital accumulation, we can reject at least one of these four forces quickly: schooling was not an important force accounting for real wage or labor productivity convergence in the late nineteenth century (O'Rourke and Williamson 1995a; Prados de la Escosura, Sanchez and Oliva 1993).[20] But what about the other three forces? Although the evidence is still incomplete, we do know something about the relative importance of Heckscher-Ohlin trade-related forces: they may have accounted for as much as 30% of the real wage convergence in the late nineteenth century (O'Rourke, Williamson and Hatton 1994; O'Rourke, Taylor and Williamson 1996; O'Rourke and Williamson 1994).

[20] A related point has been made by Richard Nelson and Gavin Wright regarding U.S. industrial leadership since 1870, with an early resource advantage gradually eroded by the increased tradability of oil and minerals, to be replaced by a later advantage built on human capital (Nelson and Wright 1992; Wright 1990).

The evidence on the role of global capital market responses is even more tentative, but Table 6B offers some upper-bound estimates under conditions of perfect international capital mobility. Allowance must be made for the mass migration of capital from Old World to New, some of it chasing after labor and all of it chasing after abundant natural resources. The dual scarcity of labor and capital in the open spaces of the New World was the key international factor market disequilibrium of that era, and it implied massive flows of both mobile factors (Green and Urquhart 1976). International capital market integration was probably as well developed by the turn of the century as it is now (Neal 1985; Neal 1990; Zevin 1992; Obstfeld 1995).

In Table 6B, the zero-net-migration counterfactual is implemented in a model where the labor supply shocks generate capital inflows or outflows in order to maintain a constant (world-plus-country-risk) rate of return on capital in each country. Specifically, log-differentiating the CES production function and marginal productivity conditions (cf equations 1 and 2) yields:

$$(1') \qquad Y^* = \theta_L L^* + \theta_K K^* + \theta_R R^*.$$

$$(2a') \qquad w^* = (1 - \rho)(Y - L)^*,$$

$$(2b') \qquad r^* = (1 - \rho)(Y - K)^*,$$

where, r is the rate of return on capital, and under a constant-returns-to-scale assumption $\theta_L + \theta_K + \theta_R = 1$. Given resources ($R^* = 0$) and treating K as fully endogenous ($r^* = 0$), we can solve again for wage and output responses with modified θ and η:

$$(3') \qquad Y^* = \frac{\theta_L}{\theta_L + \theta_R} L^* = \theta' L^*;$$

$$(4') \qquad w^* = (\rho - 1)\left(\frac{\theta_R}{\theta_L + \theta_R}\right) L^* = \eta'^{-1} L^*;$$

where θ' and η' are implicitly defined constants. Hence, the wage, productivity and output per capita responses are

$$(5') \qquad w^* = \eta'^{-1} L^* = \mu\,\gamma\,\eta'^{-1} M;$$

$$(6') \qquad Y^* - POP^* = \theta' L^* - M = (\mu\,\gamma\,\theta' - 1) M;$$

$$(7') \qquad Y^* - L^* = \theta' L^* - \mu\,\gamma\, M = \mu\,\gamma\,(\theta' - 1) M.$$

Based on an assumption that $\theta_R = 0.1$, Table 6B suggest that capital-chasing-labor may have been a powerful anti-convergence influence in the late nineteenth century greater Atlantic economy. The net result of the capital mobility assumption is that about 40% of wage convergence is accounted for by international factor movements, leaving approximately 60% to other forces. The

findings for labor productivity are qualitatively similar: capital-chasing effects erase about three-quarters of the pro-convergence effects of labor migration. The results for GDP per capita are somewhat inconclusive, but it does appear that the simultaneous movement of labor and capital in the late-nineteenth century might have been a net *anti*-convergence influence on per capita incomes.

Figure 2 offers a stylized treatment of the various countervailing forces, using the baseline estimates from Tables 6A and 6B. As we have argued above, several forces contributed positively to convergence in the late nineteenth century, not only mass migration (labor market integration forces, labeled LMI in Figure 2), but also commodity-price convergence (commodity market integration forces, labeled CMI), and any number of residual forces (RESID) such as technological catch up, unmeasured intra-European migration, human capital accumulation and the like. Conversely, as noted above, the capital flows of the late nineteenth century were an anti-convergence force, in that they raised wages and labor productivity in the rich New World, while lowering wages and labor productivity in the poor Old World (capital market integration, KMI, in Figure 2). If the previously-cited 30% CMI figure (the impact on wage convergence of commodity-price convergence) is plausible, only a modest part of the late nineteenth century convergence may have been a result of technological catching up or human capital accumulation, the central elements of modern convergence models. Almost an order of magnitude larger were the pro-convergence effects of labor movements,, and the anti-convergence effects of capital movements.

VII. Concluding Remarks

This paper suggests that the convergence literature has missed two crucial features of the late nineteenth century world economy. First, the key axis around which convergence centered was between Old World and New: along that axis hangs most of the convergence story for real wages 1870-1913 (Williamson 1995). Second, the conventional closed-economy assumption is simply inappropriate given the degree of integration in the world economy at that time, whether in goods markets, labor markets or capital markets. These insights have been applied elsewhere. In other papers, Kevin O'Rourke, Timothy Hatton and the present authors have shown that integration in product markets arising from spectacular ocean and railroad freight declines could account for

much of the Anglo-American real wage convergence; and for a broader group of countries, terms-of-trade effects and endowment changes could account for a large share of the convergence in the wage-rental ratio. In short, an open-economy perspective is vital to understanding late-nineteenth century convergence (O'Rourke and Williamson 1994; O'Rourke and Williamson 1995b; O'Rourke, Taylor and Williamson 1996; O'Rourke, Williamson and Hatton 1994).

Will this analysis of late-nineteenth-century mass migration hold up to closer scrutiny? It certainly will need more sophisticated analysis to help confirm it: since we have presented only a partial equilibrium analysis, a variety of omitted variables could offset rather more or less of the mass migration impact than we allow in Figure 2—in which case technological catching-up might claim a more important role than the residual now suggests.[21] Still, we expect our results to offer a new perspective on the convergence debate, one relevant for economic historians and macroeconomists (Williamson 1996). The convergence power of free migration, when it is tolerated, is likely to be substantial given the late-nineteenth century evidence. Cheap labor did not wait for foreign capital to seek it out; it did not ignore distant immobile natural resources that beckoned it to move; it did not wait for human capital accumulation or spillovers to initiate catching up at home; it just went in search of higher wages elsewhere. Convergence explanations based on technological or accumulation forces in closed-economy models miss this point. The millions on the move in the late nineteenth century didn't.

[21] It does appear, however, that factor accumulation effects are the main source of convergence, at least for a sample drawn from the late-nineteenth century "Greater Atlantic Economy" (Taylor 1996).

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Table 1
Summary Data: Net Migration Rates and Cumulative Impact, 1870–1910

	Persons Adjusted Net Migration Rate 1870–1910	*Persons* Adjusted Cumulative Population Impact 1910	*Labor Force* Adjusted Net Migration Rate 1870–1910	*Labor Force* Adjusted Cumulative Labor Force Impact 1910
Argentina	11.74	60%	15.50	86%
Australia	6.61	30%	8.73	42%
Belgium	1.67	7%	2.20	9%
Brazil	0.74	3%	0.98	4%
Canada	6.92	32%	9.14	44%
Denmark	-2.78	-11%	-3.67	-14%
France	-0.10	0%	-0.13	-1%
Germany	-0.73	-3%	-0.96	-4%
Great Britain	-2.25	-9%	-2.97	-11%
Ireland	-11.24	-36%	-14.84	-45%
Italy	-9.25	-31%	-12.21	-39%
Netherlands	-0.59	-2%	-0.78	-3%
Norway	-5.25	-19%	-6.93	-24%
Portugal	-1.06	-4%	-1.40	-5%
Spain	-1.16	-5%	-1.53	-6%
Sweden	-4.20	-15%	-5.55	-20%
United States	4.03	17%	5.31	24%
New World	6.01	29%	7.93	40%
Old World	-3.08	-11%	-4.06	-13%

Notes and Sources:
Adjustments according to “baseline” parameter estimates. Rates per thousand per annum. Minus denotes emigration. See text and Appendix 2.

Table 2
Summary Data: Convergence, 1870–1980s

Variable:	GDP/work hr.	GDP/capita	GDP/work hr.	Realwages
References:	Abramovitz	This study	This study	This study
	Maddison	Maddison	Maddison	Williamson
	PCD	*DFCD*	*DFCD*	
	(ICP Phase II)	(ICP Phase V)	(ICP Phase V)	
Sample size:	N=16	N=16	N=16	N=17
A. Coefficient of Variation (CV)				
1870	0.51	0.38	0.44	0.54
1913	0.33	0.33	0.37	0.46
1937	—	—	—	0.49
1950	0.36	0.36	0.43	0.42
1987	0.15*	0.11†	0.13	0.33
B. Implied convergence speed (p.a.)				
1870-1913	1.01%	0.34%	0.36%	0.37%
1913–1937	—	—	—	-0.20%
1913-1950	-0.24%	-0.23%	-0.37%	0.24%
1950–1987	3.02%*	2.91%†	3.14%	0.66%
Overall	1.12%*	1.00%†	1.01%	0.42%

Notes:
In this table the coefficient of variation (CV) is standard deviation divided by the mean. Implied convergence speed is rate of decline of ln(CV). Alternate terminal dates are *=1979,†=1989.
Sources:
Abramovitz (1986); Maddison (1982; 1991); Williamson (1995); O'Rourke and Williamson (1997).

Table 3
Summary Data: Convergence, 1870–1910

	Real wages		GDP per capita		GDP per worker	
	1870	1910	1870	1910	1870	1910
Levels:						
Argentina	61	95	915	2,226	1,946	5,317
Australia	127	135	3,123	4,586	7,811	10,573
Belgium	60	87	2,104	3,171	4,836	7,059
Brazil	39	85	425	549	1,101	1,422
Canada	99	205	1,365	3,263	3,781	7,876
Denmark	36	99	1,624	3,005	2,943	5,900
France	50	71	1,638	2,503	3,336	5,031
Germany	58	87	772	1,424	2,996	5,510
Great Britain	67	95	3,055	4,026	7,132	9,448
Ireland	49	91	—	—	—	—
Italy	26	50	1,244	1,933	2,309	3,920
Netherlands	57	77	2,064	2,964	5,322	7,795
Norway	32	79	1,190	1,875	2,800	4,719
Portugal	18	24	612	901	1,346	2,024
Spain	30	36	1,308	1,962	3,194	4,919
Sweden	28	100	1,316	2,358	2,814	5,019
United States	115	170	2,254	4,559	5,925	10,681
Dispersion (1870=100):						
All	100	72	100	82	100	71
New World	100	75	100	71	100	65
Old World	100	81	100	70	100	61
New World/Old World:						
Gap (Parity=100):	208	185	105	128	116	129

Notes and Sources:
Dispersion measure is variance divided by the square of the mean (or CV squared), using an index with 1870=100. See text and Appendix 2.

Table 4
Counterfactual Convergence, 1870–1910 with Zero Net Migration

	Real wages		GDP per capita		GDP per worker	
	1870	1910	1870	1910	1870	1910
Levels:						
Argentina	61	121	915	2,424	1,946	6,730
Australia	127	158	3,123	4,920	7,811	12,346
Belgium	60	91	2,104	3,272	4,836	7,442
Brazil	39	87	425	552	1,101	1,444
Canada	99	243	1,365	3,533	3,781	9,318
Denmark	36	92	1,624	2,898	2,943	5,491
France	50	70	1,638	2,499	3,336	5,017
Germany	58	85	772	1,406	2,996	5,390
Great Britain	67	90	3,055	3,918	7,132	8,934
Ireland	49	69	—	—	—	—
Italy	26	39	1,244	1,692	2,309	3,048
Netherlands	57	75	2,064	2,931	5,322	7,649
Norway	32	72	1,190	1,818	2,800	4,276
Portugal	18	23	612	901	1,346	2,024
Spain	30	34	1,308	1,962	3,194	4,919
Sweden	28	93	1,316	2,300	2,814	4,639
United States	115	185	2,254	4,714	5,925	11,628
Change (counterfactual versus actual):						
Argentina		27%		9%		27%
Australia		17%		7%		17%
Belgium		5%		3%		5%
Brazil		2%		1%		2%
Canada		18%		8%		18%
Denmark		-7%		-4%		-7%
France		0%		0%		0%
Germany		-2%		-1%		-2%
Great Britain		-5%		-3%		-5%
Ireland		-24%		-13%		-24%
Italy		-22%		-12%		-22%
Netherlands		-2%		-1%		-2%
Norway		-9%		-3%		-9%
Portugal		-3%		-2%		-3%
Spain		-3%		-2%		-3%
Sweden		-8%		-2%		-8%
United States		9%		3%		9%
Dispersion (1870=100):						
All	100	107	100	91	100	91
New World	100	81	100	70	100	62
Old World	100	87	100	73	100	69
New World/Old World:						
Gap (Parity=100):	208	228	105	139	116	155

Notes and Sources:
Dispersion measure and actual data as in Table 3. On counterfactual, see text.

Table 5
Summary: Counterfactual Convergence, 1870–1910 with Zero Net Migration

Dispersion (1870=100)	Actual 1910	Counterfactual 1910	Convergence explained 1870–1910 (change in ln[dispersion])
Real wages:			
All	72	107	119%
New World	75	81	27%
Old World	81	87	35%
GDP per capita:			
All	82	91	50%
New World	71	70	-4%
Old World	70	73	12%
GDP per worker:			
All	71	91	72%
New World	65	62	-10%
Old World	61	69	25%

Notes and Sources:
See text and Table 4. Convergence explained is counterfactual-actual ratio of change in ln[dispersion].

Table 6A
Sensitivity Analysis I: Capital Immobile

A. Real wage convergence 1870-1913

γ=	1.55	1.55	1.65	1.75	1.75
Δθ=	0.10	-0.10	0.00	0.10	-0.10
μ=	0.80	0.80	0.80	1.20	1.20
σ=2.0	44%	68%	60%	74%	116%
σ=1.0	87%	136%	119%*	147%	224%
σ=0.5	172%	260%	230%	277%	401%

B. GDP per capita convergence 1870-1913

	35%	85%	50%*	-50%	9%

C. GDP per worker convergence 1870-1913

	51%	83%	72%*	90%	148%

Notes:
See text. Sample is all countries (N=17). Variable shown is convergence explained by migration (change in ln[dispersion]) from Table 5 calculations performed for various parameter combinations. "Baseline" estimates (Table 5) shown by asterisk.

Table 6B
Sensitivity Analysis II: Capital Mobile

A. Real wage convergence 1870-1913

γ=	1.55	1.55	1.65	1.75	1.75
Δθ=	0.10	-0.10	0.00	0.10	-0.10
μ=	0.80	0.80	0.80	1.20	1.20
σ=2.0	16%	23%	20%	28%	38%
σ=1.0	33%	45%	41%*	56%	77%
σ=0.5	66%	91%	82%	112%	153%

B. GDP per capita convergence 1870-1913

	-12%	-2%	-19%*	-81%	-77%

C. GDP per worker convergence 1870-1913

	18%	26%	23%*	32%	45%

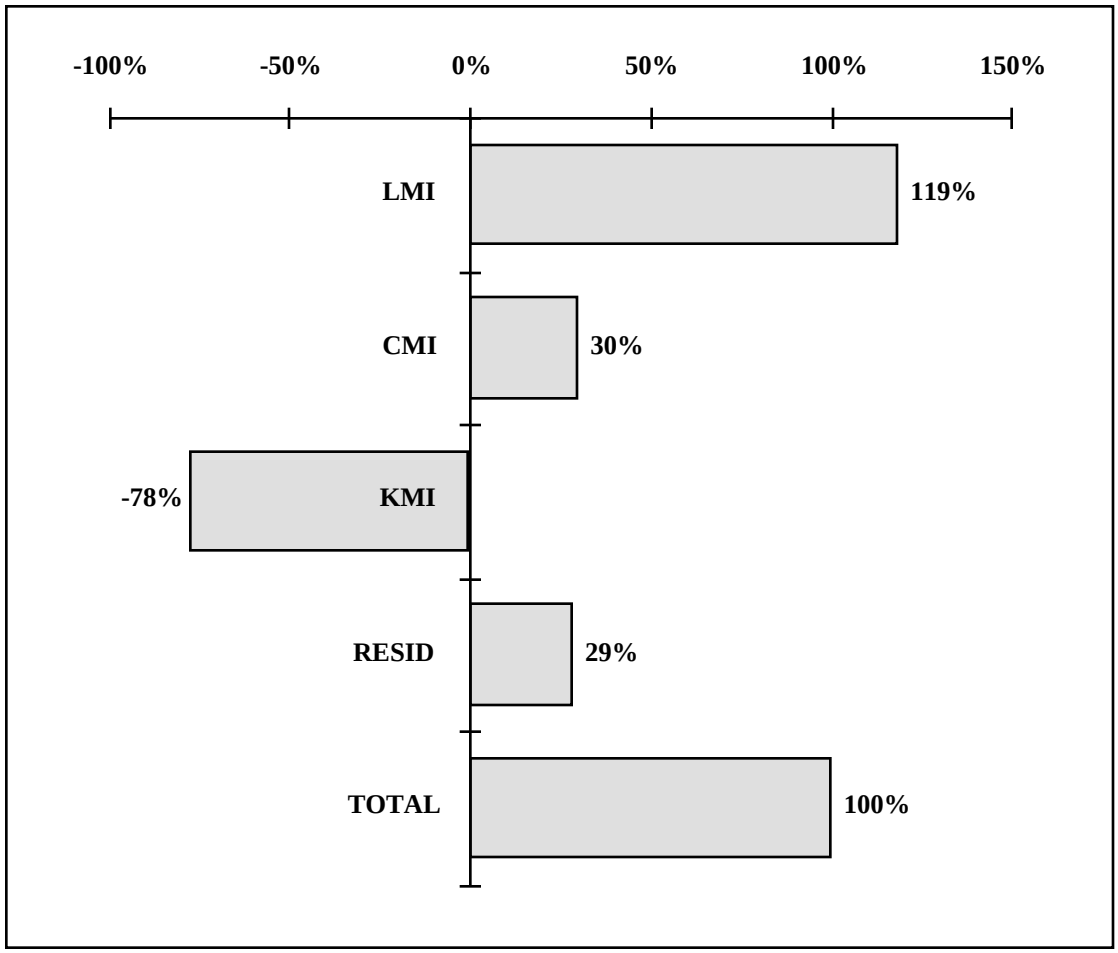
Notes:
See text. Sample is all countries (N=17). Variable shown is convergence explained by migration (change in ln[dispersion]) from text calculations performed for various parameter combinations. "Baseline" estimates (Table 5) shown by asterisk.

Figure 1

[INSERT HERE]

Figure 2

Stylized Convergence 1870–1910



APPENDIX 1: LABOR DEMAND ECONOMETRICS

The underlying objective of our regression analysis was to estimate the elasticity of substitution, σ, in both the New World and Old World. The estimate of σ was used, along with independent information on labor's share of income (θ, see Appendix 2), to provide an estimate of $\eta = F_{LL}^{-1}\ (w/L)$, the short-run wage elasticity of labor demand *holding all other inputs fixed*, and, thus, an estimate of the impact of migration-induced labor-supply shocks on wages.

In this appendix we discuss the econometric methodology. Data sources for the econometric estimation (and for the rest of the paper) are documented in Appendix 2. Data for the econometrics consisted of a 14 country sample with annual estimates of real GDP, labor force, and real wages, from which "decadal" averages (1870-79, 1880-89, 1890-99, and 1900-13) were derived to generate a panel with four observations for each country.

Estimation Strategy and Results

We assume a general CES production function with technical change, $Y = Ae^{rt}\ (aL^{\rho} + bK^{\rho} + cR^{\rho})^{1/\rho}$ it can be shown that producer wages w/P are related to aggregate output per worker according to $\ln(Y/L) = \alpha + \sigma \ln(w/P) + \rho rt$, where $\sigma=1/(1-\rho)$ is the CES elasticity of substitution. If σ and θ are known, the labor demand elasticity is given by $\eta = -\sigma/(1-\theta)$. Estimates of σ may be taken from a number of estimating equations.

Three different theoretical frameworks formed the basis for our estimation strategy. The first follows the example of Arrow, Chenery, Minhas, and Solow (ACMS), by estimating log value-added per worker as a function of the log real wage. The basic panel estimation equation in this case was:

$$\text{(ACMS)} \ln(Y/L)_{it} = \sigma \ln (w/P)_{it} + \alpha_i + \psi_t + \varepsilon_{it.}$$

where the α_i are country effects (dummies), the ψ_t are time controls (either a trend or dummies), and the ε_{it} are error terms.

The second theoretical framework is the marginal productivity condition (MPC):

$$\text{(MPC)} \qquad \ln(L)_i = \tau \ln(Y)_i - \sigma \ln (w/P)_{it} + \alpha_i + \psi_t + \varepsilon_{it.}$$

A third alternative is to use the reciprocal relationship (RR) of the ACMS equation:

$$\text{(RR)} \qquad \ln(W/P)_i = (1/\sigma) \ln (Y/L)_i + \alpha_i + \psi_t + \varepsilon_{it.}$$

In all cases, the correct P is an output deflator or producer price series, but these are not widely available in our sample for the pre-1914 era. Indeed, many deflators used by Maddison et al. for the nineteenth century are just CPI (consumer price index) deflators. We will be using CPI deflators in the results that follow, though the results are not qualitatively different when the available producer price series are used instead. The reader is referred to our earlier version of this paper for those results (NBER Working Paper no. 4711, April 1994). For the present, (W/P) will be a real wage consisting of a nominal wage deflated by a CPI. We are fortunate in that we have an internationally commensurate set of such real wage series for the sample in question.

We used all three of the above methods with eight different specifications on our panel data as follows:

1. cross section for 1870–1879;
2. cross section for 1880–1889;
3. cross section for 1890–1899;
4. cross section for 1900–1913;

5. pooled;
6. pooled with country effects;
7. pooled with country effects and period effects;
8. pooled with country effects and a common time trend.

Specifications 1 through 5 omit country effects, and therefore rest on an assumption of common technologies. Specifications 1 through 4 still permit common technical change since the time dimension is removed. Specification 6 allows different constant technologies, and specifications 7 and 8 allow different technologies but with common rates of technical change. We could only free these assumptions further (e.g., to allow a different technology and different rates of technical change for each country) by introducing different effects for each period and country and interacting them. This would use up all degrees of freedom using period effects, and even using trends the resulting estimates are imprecise.

The results for our selected specifications were as follows:

ACMS Specification	_	-	standard errorNdegrees of freedomR210.540.1814120.4320.550.1814120.4330.400.1814120.2940.340.2014120.1950.490.0956540.3660.660.0856410.9670.160.0956380.9880.130.0956400.98MPC Specification_standard errorNdegrees of freedomR210.500.1814110.9320.500.1814110.9330.360.1714110.9240.290.1914110.9150.430.0856530.9260.180.0656401.0070.170.0756371.0080.160.0756391.00RR Specification1/_ standard errorNdegrees of freedom	R2
1	0.80	0.26	14	12	0.43
2	0.78	0.26	14	12	0.43
3	0.73	0.33	14	12	0.29
4	0.55	0.33	14	12	0.19

5	0.75	0.13	56	54	0.36
6	0.96	0.11	56	41	0.96
7	0.48	0.27	56	38	0.97
8	0.37	0.26	56	40	0.97

Comparison to Existing Estimates of _

There already exists a large empirical literature which attempts to estimate the elasticity of substitution, both in the context of labor demand and production functions. These studies have generated estimates of _ which vary substantially and depend very strongly on the choice of the estimation equations and data.

Hamermesh ADDIN (1993) ADDIN extensively surveys the empirical labor demand literature. Those studies which are most comparable to our estimates are 15 studies of homogeneous labor demand utilizing data at the aggregate or large industry level to estimate _. Most of these studies directly estimated _ using some variant of the marginal productivity condition. Estimates of __ranged from 0.21 to 6.86, although _ was between 0.3 and 0.8 in two-thirds of the studies. Hamermesh surveyed approximately 70 studies which utilized aggregate data, and concluded that the mean estimate of _ was 0.75.

The other major branch of the literature is based on the CES production function and estimation equations similar to ACMS. According to Berndt ADDIN (1976) ADDIN those studies which have utilized cross-sectional data have generated estimates close to one, while estimates based on time series data have generally been lower. Berndt was able to reconcile these differences by improving the quality of the time series data, resulting in estimates of _ closer to one.

Our _ estimates generally fall within the ranges estimated in previous studies and also demonstrate the same dependence on the choice of functional form. Our “best guess” is _=1.0, with a range of 0.5 to 2.0 considered for the purposes of sensitivity analysis.

APPENDIX 2: ECONOMETRIC AND SIMULATION DATA

ECONOMETRIC DATA

The 14 countries in our econometric sample were those countries included in Williamson's "Evolution of Global Labor Markets" (1995) for which real GDP data was also available. The countries are: Belgium, Denmark, France, Germany, Great Britain, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Australia, Canada, and the United States. However, the real wage data set has since been revised and is fully described in O'Rourke and Williamson ADDIN (1997) ADDIN . Annual estimates for real GDP and labor force were also calculated, and then decadal averages (1870-79, 1880-89, 1890-99, and 1900-13) were utilized to generate the four observations for each country. The idea was to focus on benchmark observations, ignoring short-run annual variations, thus emerging with a panel totaling 56 observations. In each case, we attempted to exclude the impact of territorial changes.

SIMULATION DATA

The simulation exercises utilized the above data and additional data on real wages (at the benchmark years 1870 and 1910), GDP per capita (at benchmark years), GDP per worker (at benchmark years), labor's share in income (best estimates available) and avergage migration rates (between benchmark years) for all 17 countries—the above mentioned 14 plus Argentina, Brazil and Ireland.

ABBREVIATIONS

EHS	Mitchell, Brian R., *European Historical Statistics, 1750–1975*, 2nd ed., New York: Facts on File, 1980.
IHSAA	Mitchell, Brian R., *International Historical Statistics, The Americas and Australasia*, Detroit: Gale Research, 1983.
IHSE	Mitchell, Brian R. *International Historical Statistics, Europe, 1750-1988*, 3rd ed., New York: Stockton Press, 1992.

Real GDP (Y)

For all but three of the countries in the sample (Great Britain, Portugal and Spain), estimates of real gross domestic product (GDP) were based on the estimates of Angus Maddison, *Dynamic Forces in Capitalist Development*, Oxford: Oxford University Press, 1991, Tables A.1, A.6, and A.8. For those countries for which we used Maddison's estimates, 1985 real GDP (at 1985 U.S. relative prices) was taken from Table A.1, p. 197. Maddison's GDP indices (1913 = 100) for the years 1870-1985 were then used to generate estimates of real GDP (in 1985 U.S. relative prices) for the years 1870-1913. For the simulation exercises, GDP at benchmark years (1870 and 1910) was also sought for Argentina and Brazil.

ARGENTINA

1870 and 1910 (benchmark years): Real GDP in 1913 in millions of 1985 U.S. dollars from Maddison, op. cit. Table 1.5, p. 24. Estimates for 1870 and 1910 utilize a chain index with the real output index from Roberto Cortés Conde, "Estimaciones del PBI en la Argentina 1875–1935," Ciclos de Seminarios, Universidad de San Andres, March 1994. 1875 output proxies for 1870.

BRAZIL

1870 and 1910 (benchmark years): Real GDP in 1913 in millions of 1985 U.S. dollars from Maddison, op. cit. Table 1.5, p. 24. Estimates for 1870 and 1910 utilize a chain index with the real GDP series from Mitchell, *IHSAA*,Table K1, p. 898.

GREAT BRITAIN

Maddison's estimates of real GDP for the United Kingdom correct for Irish independence but still include Northern Ireland. Because we are interested in focusing on Great Britain, we wanted to exclude Northern Ireland's contribution to output from our data series. In order to exclude the output contribution of the Republic of Ireland we utilized the "compromise" GDP index of C. H. Feinstein (*Statistical Tables of National Income, Expenditure and Output of the U.K. 1855-1965*, Cambridge: Cambridge University Press, 1972, T18-20). Maddison includes two estimates of 1913 real GDP (in millions of 1985 U.S. dollars) for the U.K., one which is adjusted for border changes (i.e., excludes the Republic of Ireland), and another which is unadjusted. Feinstein's index was combined with both of these GDP estimates to calculate 1920 GDP for the UK both including the Republic of Ireland ($174,154 million) and excluding it ($167,724 million). This provides us with an estimate of Irish GDP in 1920 of $6,430 m. Combined with information on the population of the Irish republic (3,103,000 in 1920, from Feinstein, op. cit., T120-1), we can also calculate GDP per head in Ireland ($2,072). If we then assume that GDP per head was the same in Northern Ireland as in the Republic of Ireland (an understatement of Northern Ireland's relatively favorable economic condition), this implies that Northern Ireland accounted for $2,607 million of the U.K.'s output in 1920 (given a population of 1,258,000). We can then subtract this figure from $167,724 million (UK GDP after Irish independence) to generate an estimate of Great Britain's GDP in 1920: $165,118 million. Given a population of 42,460,000, this implies a GDP per person of $3,889. This implies that each inhabitant of Great Britain produced 1.877 times more output than each inhabitant of Ireland in 1920. We assumed that this productivity differential was constant throughout the 1870-1920 period. We therefore divided the population of Ireland by 1.877 to calculate a productivity-adjusted population (where each "population unit" in Ireland and Great Britain produces the same output). Great Britain's share of the productivity-adjusted population in each year was then multiplied by total U.K. output to derive an estimate of GDP in Great Britain for the years 1870-1913.

PORTUGAL

The real GDP index for 1870 to 1985 was taken from A. B. Nunes, E. Mata, and N. Valerio, "Portuguese Economic Growth 1833-1985," *Journal of European Economic History* 18, 2 (Fall 1989), Table 1, pp. 292-5. This was then combined with OECD estimates of 1985 Portuguese real GDP at current PPP exchange rates. (OECD, Department of Economics and Statistics, *National Accounts, 1960-1989, Main Aggregates: Volume 1*, Paris: OECD, 1991, p. 145).

SPAIN

The real GDP index for 1870 to 1985 was derived from L. Prados de la Escosura, "Spain's Gross Domestic Product, 1850-1990: A New Series," Dirección General de Planificación, Documentos de Trabajo, D-93002, March 1993, Table D.1, pp. 101-103. This was then combined with OECD estimates of 1985 Spanish real GDP at current PPP exchange rates. (OECD, op. cit., p. 145).

Population (POP)

Population estimates were sought at the 1870 and 1910 benchmark years. For most countries we used mid-year estimates from Maddison, op. cit., Table B.2. For consistentcy with the GDP data, 1870 figures for France exclude Alsace-Lorraine, for Germany include Alsace-Lorraine, and for Italy include Rome, all as per Maddison's data.

ARGENTINA

Total population from Vicente Vázquez-Presedo, *Estadísticas historicas argentinas*, vol. 1, Buenos Aires: Ediciones Macchi, 1971, pp. 15–16.

BRAZIL

Total population from Mitchell, *IHSAA*, Table B1, p. 51. Interpolation applied along an exponential growth trend between census years.

GREAT BRITAIN

Total population from Feinstein, op. cit., T120–1.

PORTUGAL

Total population from M. I. B. Baganha, *Portuguese Emigration to the United States, 1820-1930*, New York: Garland Publishing, 1990, Table IV:III, pp. 213-4.

SPAIN

Total population derived from Prados de la Escosura, op. cit, Tables D.1 and D.2, pp. 101-106.

Labor Force (L)

Labor force estimates for most countries were based on Maddison, op. cit., although we were unable to replicate his data and it is unclear how he determined the proportion of the working age population which was in the labor force. Estimates of the working age population were obtained for census years, and annual observations were then obtained by interpolation. If necessary, mid-year observations were calculated by averaging the annual estimates of working age population. Maddison's estimates of the labor force in 1870 and 1913 were then compared to the working age population in those years. The average ratio of the labor force over the working age population in those three years was then calculated. This ratio was then multiplied by our annual estimates of the mid-year working age population to generate annual estimates of the labor force.

ARGENTINA

1870 and 1910 (benchmark years): Based on interpolation of census labor force figures for 1869, 1895 and 1914 reported in Roberto Cortés Conde, *El progreso argentino, 1880–1914*, Buenos Aires: Editorial Sudamericana, 1979.

AUSTRALIA

1870-1901: Sum of total workforce in Victoria, New South Wales, Southern Australia, Queensland and Tasmania; G. Withers, unpublished database, n.d. 1902-1913: Civilian employment (mid-year), linked to Withers' data using a factor of 1.0376 (the ratio of Withers' 1901 total workforce to Butlin's 1901 civilian employment); R. Maddock and I. W. McLean (eds.), *The Australian Economy in the Long Run*, Cambridge: Cambridge University Press, 1987, Statistical Appendix, Table 1, p. 353.

BELGIUM

1866-1920: Working age population (15-64 years old) for census years 1866, 1880, 1890, 1900, 1910, and 1920; United Nations, Department of Economic and Social Affairs, *The Aging of Populations and its Economic and Social Impliciations*, New York: United Nations, 1956, p. 123. Border adjustment factor of 1.008 derived from Maddison, op. cit, Tables B.2 and B.7. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

BRAZIL

1870 and 1910 (benchmark years): Labor's share in population assumed constant, equal to Argentine value in 1913, and applied to population data in benchmark years.

CANADA

1861-1921: Population aged 15-64 years old for census years 1861, 1871, 1881, 1891, 1901, and 1911; M. C. Urquhart and K. A. H. Buckley, *Historical Statistics of Canada*, Cambridge: Cambridge University Press, 1965, p. 16. Border adjustment factor of 1.026 derived from Maddison, op. cit, Tables B.2 and B.7. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

DENMARK

1870-1913: Mid-year total labor force ("Ialt Arbejdsstyrken"); S. A. Hansen,*Økonomisk vækst i Danmark*, vol. ii, Copenhagen: Akademisk Forlag, 1974, pp. 202-3. Border adjustment factor of 1.026 derived from Maddison, op. cit, Tables B.2 and B.7.

FRANCE

1861-1911: Working age population (15-64 years old) for census years 1861, 1872, 1881, 1891, 1901, and 1911; United Nations, op. cit, p. 132. 1912-1914: Working age population is assumed to have grown at the same rate as total population for the years 1911-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Annual border factors for all years calculated as the ratio of population given present borders to the population given 1871 borders; République Française, Institut National de la Statistique et des Études Économiques, *Annuaire Statistique de la France*, Paris: INSEE, volume 72, 1966, pp. 68-71. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

GERMANY

1871-1910: Working age population (15-64 years old) for census years 1871, 1880, 1890, 1900, and 1910; United Nations, op. cit, p. 135. 1911-1914: Working age population is assumed to have grown at the same rate as total population for the years 1870-1871 and 1910-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Border adjustment factor of 0.60953 derived from Maddison, op. cit, Tables B.2 and B.7. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

GREAT BRITAIN

1870-1914: Total in civil employment (for United Kingdom); C. H. Feinstein, op. cit., T125-7. Annual border adjustment factor to exclude Ireland equals proportion of total U.K. population in Great Britain (England, Scotland and Wales); Feinstein, op. cit, T120-1.

ITALY

1861-1911: Working age population (15-64 years old) for census years 1861, 1871, 1881, 1901, and 1911; United Nations, op. cit, p. 132. 1912-1914: Working age population is assumed to have grown at the same rate as total population for the years 1911-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Annual border factors for all years calculated as the ratio of population given present borders to the population given actual borders; Istituto Centrale di Statistica, *Sommario di statistiche storiche del Italia, 1861-1975*, Rome: ISTAT, 1976, p. 16. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

NETHERLANDS

1869-1909: Working age population (15-64 years old) for census years 1869, 1879, and 1889. The 1899 and 1909 censuses included an age group for 10-19 year olds. It was assumed that the proportion of the population aged 15-19 in those years was equal to the average proportion of the population aged 15-19 in the 1889 and 1920 censuses (9.63% of total population); United Nations, op. cit, p. 147. 1909-1914: Working age population is assumed to have grown at the same rate as total population for the years 1909-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

NORWAY

1865-1910: Working age population (15-64 years old) for census years 1865, 1875, 1891, 1900, and 1910; United Nations, op. cit, p. 150. 1910-1914: Working age population is assumed to have grown at the same rate as total population for the years 1910-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

PORTUGAL

1864-1910: Working age population (aged 15-64) for census years 1864, 1878, 1890, 1900, and 1910; United Nations, op. cit, p. 153. 1910-1914: Working age population is assumed to have grown at the same rate as total population for the years 1910-1914. Total population from M. I. B. Baganha, op. cit., Table IV:III, pp. 213-4. Economically-active population for years 1890, 1900, and 1911; Mitchell, *IHSE*, p. 151. The average proportion of the working age population which was economically active was then calculated for the years 1890, 1900, and 1911 (73.8%). This proportion was then multiplied by the mid-year working age population to generate the labor force estimate.

SPAIN

1870-1877: Working age population is assumed to have grown at the same rate as total population for the years 1870-1877. Total population derived from Prados de la Escosura, op. cit, Tables D.1 and D.2, pp. 101-106. 1877-1910: Working age population (aged 15-64) for census years 1877, 1887, 1900, and 1910; Carlos Barciela, et al. (eds.), *Estadisticas Historicas de Españ*a, *Siglos XIX-XX*, Madrid: Fundacion Banco Exterior, 1989, Table 2.6, p. 69. 1910-1914: Working age population is assumed to have grown at the same rate as total population for the years 1910-1914. Total population derived from Prados de la Escosura, op. cit, Tables D.1 and D.2, pp. 101-106. Economically-active population for years 1877, 1887, 1900, and 1910; Barciela, et al. (eds.), op. cit, Table 2.14, p. 77. The average proportion of the working age population which was economically active was then calculated for the years 1877, 1887, 1900 and 1910 (65.1%). This proportion was then multiplied by the mid-year working age population to generate the labor force estimate.

SWEDEN

1870-1910: Working age population (aged 15-64) for census years 1870, 1880, 1890, 1900, and 1910; United Nations, op. cit, p. 159. 1910-1914: Working age population is assumed to have grown at the same rate as total population for the years 1910-1914. Total population from Maddison, op. cit, Tables B.2 and B.3. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

UNITED STATES

1870-1910: Working age population (15-64 years old) for census years 1870, 1880, 1890, 1900, and 1910; U.S. Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970*, Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, 1975, Series A123-132, p. 15. Border adjustment factor of 1.0039 derived from Maddison, op. cit, Tables B.2 and B.7. Labor force estimates for 1870, 1890, and 1913; Maddison, op. cit, Table C.7.

Consumer Real Wages (W/CPI)

The consumer real wages for each country are based on the international real wage indices developed by Williamson (1995) and revised in O'Rourke and Williamson (1997). Internationally-comparable real wages were calculated for several base years by utilizing purchasing-power-parity (PPP) exchange rates. These series were then deflated by consumer price indices (CPIs) to obtain the international real wage series. We used the 1870-1913 indices with the real wage in Great Britain in 1905 equal to 100. The data was used to

give consumer real wages in the benchmark years of 1870 and 1910, and to enable estimation of producer real wages (see below).

Labor's Share of Income (θ)

Three approaches were used to obtain estimates of θ:

(a) any existing direct estimates of θ were examined;

(b) an implied $\theta = wL(1-u)/Y$ was calculated using estimates of wage rates, labor force, assumed unemployment rates, *u*, and output;

(c) if all else failed, "neighbor" country estimates were used.

In method (b) the urban unskilled nominal wage was used, it being assumed that this would be a proxy for the average nominal wage. This is reasonable, given that rural wages ought to be less, and urban skilled wages somewhat more, with a typical 1900 distribution of labor being at least 40% rural for most countries. To the extent that this overstates θ we apply an acceptable negative bias to our impact calculations. Sensitivity analysis will allow for ±0.10 variations in θ for each country.

ARGENTINA

(b) Implied θ = 0.620. Labor force of 3,162,000 and GDP of $mn 4,200 million in 1914, from IEERAL, op. cit. Unskilled wage in 1914 of $mn 2.83 per day, from Williamson. Assume 50 work weeks per year, 6 work days per week, 3% unemployment. Considerably higher than the estimate of 0.365 in Laura Randall, *An Economic History of Argentina in the Twentieth Century*, New York, Columbia University Press, 1978.

AUSTRALIA

(b) Implied θ = 0.556. Labor force of 1,950,000 and GDP of $734 million in 1911 from Maddock and McLean, op. cit. Average total annual earnings in manufacturing of $209 in 1912, Wray Vamplew, *Australians: Historical Statistics*, Broadway, N.S.W.: Fairfax, Syme and Weldon, 1987, p. 161.

BELGIUM

(b) Implied θ = 0.400. Labor force of 3,461,000 in 1910 and GDP of F6,500 million in 1913 from Mitchell, *IHSE*. Unskilled wage of F15.5 per week from Williamson. Assume 50 work weeks per year, 3% unemployment.

BRAZIL

(c) Implied θ = 0.620. Use Argentine estimate.

CANADA

(b) Implied θ = 0.540. Labor force of 2,724,000 in 1911 from Mitchell, *IHSAA*. GDP of $2,233 in 1911 from M. C. Urquhart, "Canadian Economic Growth 1870–1980," Queens' University, Institute for Economic Research, Discussion Paper no. 734, 1988, p. 9. Average annual wages in manufacturing of $456 in 1910 from O. J. Firestone, *Canada's Economic Development, 1867–1953*, London: Bowes and Bowes, 1958, p. 207. Assume 3% unemployment.

DENMARK

(b) Implied θ = 0.510. Labor force of 1,231,000 in 1911 and GDP of Kr2,051 million in 1911 from Mitchell, *IHSE*. Unskilled wage of Kr0.34 per hour from Williamson. Assume 50 work weeks per year, 50 hours per week, 3% unemployment.

FRANCE

(a) Implied θ = 0.484. Pre-war data for France was limited to observations for 1890 and 1913, and implied an average share of 48.4%. Jacques Lecaillon, "Changes in the Distribution of Income in the French

Economy," in Jean Marchal and Bernard Ducros (eds.), *The Distribution of National Income*, (New York: St. Martin's Press, 1968), pp. 41-73.

GERMANY

(a) Implied $\theta = 0.428$. German estimates for the Reich in 1893 and 1913: 39.1% and 46.5%, respectively, for an average of 42.8%. There were also estimates for several of the länder (Saxony, Württemberg, Baden and Bavaria) which were broadly comparable to the Reich-wide data for 1893 and 1913. Albert Jeck, "The Trends of Income Distribution in West Germany," in Marchal and Ducros (eds.), op. cit., pp. 78-114.

GREAT BRITAIN AND IRELAND

(a) Implied $\theta = 0.529$. Annual data was available only for the United Kingdom. These figures imply an average of 52.9% over the period of 1870-1913. Feinstein, op. cit.

ITALY

(b) Implied $\theta = 0.485$. Labor force of 16,401,000 and GDP of L19,700 million in 1911 from Mitchell, *IHSE*. Unskilled wage of L12 per week from Williamson. Assume 50 work weeks per year, 3% unemployment.

NETHERLANDS

(c) Implied $\theta = 0.400$. Use Belgian estimate.

NORWAY

(a) Implied $\theta = 0.645$. Bjerke estimates a range 0.61 to 0.68 for 1865-1930, an average of 0.645 over the period. Riis and Thonstad suggest he did it carefully making sure it covered all labor incomes. Riis and Thonstad themselves estimate a production function 1865-1939 and their best guess (p. 124, estimate 8.5b) has labor's share = 0.640, close to Bjerke's 0.645. J. Bjerke, "Estimating Consumption Functions from National Accounts Data," Artikler, no. 53, Oslo: Central Bureau of Statistics of Norway, 1972 (in Norwegian with English summary). C. Riis and T. Thonstad, "A Counterfactual Study of Economic Impacts of Norwegian Emigration and Capital Imports," in I. Gordon and A. P. Thirlwall (eds.), *European Factor Mobility: Trends and Consequences*, London: Macmillan, 1989.

PORTUGAL

(c) Implied $\theta = 0.468$. Use Spanish estimate.

SPAIN

(b) Implied $\theta = 0.468$. Labor force of 6,997,100, unskilled wage of pes 2 per day, and GDP of pes 8,695 million in 1887 from Prados de la Escosura, op. cit, and Barciela, op. cit. Assume 50 work weeks per year, 6 days per week, 3% unemployment.

UNITED STATES

(a) Implied $\theta = 0.600$. There are several available estimates of labor's share in the United States, although the pre-War data is of questionable quality. W. King calculated the earliest estimates, and these were subsequently revised (generally downward) by Budd. King's estimate of 53.5% in 1890 is roughly comparable to that of Haley for the 1900-1909 period (55.0%), although King's figures show labor's share contracting in both 1900 and 1910. Martin's data (taken from D. G. Johnson) represents an upper bound (59.5% for 1899-1908 and 59.7% for 1909-1918). We considered estimates of 50% (the average of King's data for 1870-1910) and 55% (Haley's 1900-09 and 1905-14 figures). We chose 60% as an upper-bound based on Martin.

Migration Rates (M)

Decadal averages are shown in Table A1. Where only gross flows were available additional assumptions were made to allow estimates of net flows:

Ireland: since return migration was rare, and there were no inflows from other countries, we set net equal to gross.

Italy: the ratio of net to gross falls from .78 to .72 between the 1890s and 1900s, a modest fall given the surge in return migration; a crude linear projection backwards might have that ratio at .84 in the 1880s and .90 in the 1870s; hence, we assume the net rate to have been 3.86 in the 1870s and 5.12 in the 1880s.

Sweden: we project net to gross ratio backwards to the 1870s to be 0.95; hence, we assume net rate in 1870s was 2.81.

Norway: we assume net to gross ratio is like Sweden; we apply Swedish net/gross ratios by decade 1870–1910.

Portugal: we assume net to gross ratio is like Spain; we apply Spanish net/gross ratios by decade 1880–1910, and we assume 1870s ratio was equal to the 1880s ratio.

Spain: we assume rates the same as Portugal in the 1870s.

Brazil: we use the net to gross ratio from the 1890s (0.17) for 1870s and 1880s.

Data was sought on gross and net migration rates for all countries. Annual migratory flows were converted into rates using interpolated census estimates of population. Data for 1870-1910 extracted from the following sources, with exceptions as indicated below: Emigration and immigration from Willcox, Walter F., (ed.), *International Migrations*, New York: National Bureau of Economic Research, 2 vols, 1929. Population at census years from *EHS* or *IHSAA*.

AUSTRALIA

Net immigration from Vamplew, op. cit, pp. 6–7.

PORTUGAL

Emigration: Baganha, op. cit, Table IV:III, pp. 213–4, adjusted for clandestine emigrants. Population: ibid., using intercensal interpolation along exponential trends.

Table A1 reports the raw return rate, averaged 1870–1910, implied by the basic data on gross and net flows for each country (Australia excepted). This was compared to other scholars' estimates of return rates in various studies summarized in Walter Nugent, *Crossings: The Great Transatlantic Migrations, 1870–1914*, Bloomington, Ind.: Indiana University Press, 1992, and in Mark Wyman, *Round-Trip to America: The Immigrants Return to Europe, 1880–1930*, Ithaca, N.Y.: Cornell University Press, 1993. In three cases, our raw data produced return rates implausibly low (Denmark, Ireland and Italy), and so corrected rates based on Wyman's (p. 10) figures were adopted in order to prevent an overestimation bias for the impact of migration.

Table A1
Basic Data: Migration Rates

	M Gross 1870s	M Gross 1880s	M Gross 1890s	M Gross 1900s	M Net 1870s	M Net 1880s	M Net 1890s	M Net 1900s	Corrected Return Rate	Raw Return Rate
Argentina	12.26	24.76	15.78	25.47	4.94	19.07	7.17	15.78		40%
Australia	.	.	.	14.43	9.56	15.07	1.85	-0.02		.
Belgium	-2.03	-2.18	-1.96	-2.32	0.93	1.06	1.80	2.88		178%
Brazil	1.81	3.41	7.78	3.16	0.32	0.60	1.36	0.70		82%
Canada	8.42	18.84	7.50	22.64	-1.14	5.94	5.54	17.35		52%
Denmark	-1.97	-3.74	-2.60	-2.80	-1.95	-3.68	-2.55	-2.58	21%	3%
France	-0.16	-0.28	-0.18	-0.15	-0.09	-0.19	-0.11	-0.01		48%
Germany	-1.35	-2.91	-1.18	-0.43	-1.34	-2.89	-1.12	2.45		50%
Great Britain	-3.87	-5.71	-3.92	-7.08	-1.52	-3.23	-0.93	-3.31		56%
Ireland	-11.28	-16.04	-9.70	-7.93	-11.28	-16.04	-9.70	-7.93	10%	0%
Italy	-4.28	-6.09	-8.65	-17.97	-3.86	-5.12	-6.78	-13.01	50%	22%
Netherlands	-2.66	-4.06	-4.62	-5.36	-0.10	-0.81	-1.16	-0.31		86%
Norway	-4.33	-10.16	-4.56	-7.15	-4.11	-8.99	-3.23	-4.68		20%
Portugal	-2.91	-3.79	-5.04	-5.67	-0.73	-0.95	-0.46	-2.12		76%
Spain	-2.91	-3.91	-4.63	-6.70	-0.73	-0.98	-0.42	-2.50		74%
Sweden	-2.96	-8.24	-5.32	-4.48	-2.81	-7.30	-3.77	-2.93		20%
United States	6.24	9.43	5.66	10.10	3.73	6.32	2.33	3.72		49%

Notes and Sources:
Raw return rate is 1 - (avg. net rate/avg. gross rate) for 1870–1910. Rates per thousand per annum. Minus denotes emigration. On corrected return rate, see Appendix 2.

Table A2
Basic Data: GDP, Population and Labor Force

	Y 1870	Y 1910	POP 1870	POP 1910	L 1870	L 1910
Argentina	1,721	15,293	1,881	6,871	884	2,876
Australia	5,059	20,063	1,620	4,375	648	1,897
Belgium	10,640	23,584	5,056	7,438	2,200	3,341
Brazil	4,052	12,690	9,533	23,113	3,680	8,922
Canada	4,969	22,859	3,641	7,006	1,314	2,902
Denmark	2,913	8,225	1,793	2,737	990	1,394
France	60,397	98,955	36,870	39,540	18,106	19,670
Germany	31,512	91,944	40,805	64,568	10,518	16,687
Great Britain	78,936	163,181	25,838	40,531	11,069	17,271
Ireland	—	—	—	—	—	—
Italy	33,670	68,647	27,062	35,519	14,584	17,511
Netherlands	7,463	17,492	3,615	5,902	1,402	2,244
Norway	2,065	4,470	1,735	2,384	737	947
Portugal	2,656	5,324	4,340	5,909	1,973	2,630
Spain	21,196	38,838	16,200	19,790	6,635	7,895
Sweden	5,480	12,847	4,164	5,449	1,948	2,560
United States	89,933	421,266	39,905	92,407	15,180	39,442

Notes and Sources:
GDP in millions of 1985 US$. Population and labor force in thousands. See Appendix 2.

Table A3
Basic Data: "Baseline" Parameters

	Labor's share	Elas of subsn	Elas of lab dem	M-POP L share	M-POP eff wkr
	θ	σ	η	λ	μ
Argentina	0.62	1.00	-2.63	1.65	0.80
Australia	0.56	1.00	-2.25	1.65	0.80
Belgium	0.40	1.00	-1.67	1.65	0.80
Brazil	0.62	1.00	-2.63	1.65	0.80
Canada	0.54	1.00	-2.17	1.65	0.80
Denmark	0.51	1.00	-2.04	1.65	0.80
France	0.48	1.00	-1.94	1.65	0.80
Germany	0.43	1.00	-1.75	1.65	0.80
Great Britain	0.53	1.00	-2.12	1.65	0.80
Ireland	0.53	1.00	-2.12	1.65	0.80
Italy	0.49	1.00	-1.94	1.65	0.80
Netherlands	0.40	1.00	-1.67	1.65	0.80
Norway	0.65	1.00	-2.82	1.65	0.80
Portugal	0.47	1.00	-1.88	1.65	0.80
Spain	0.47	1.00	-1.88	1.65	0.80
Sweden	0.65	1.00	-2.82	1.65	0.80
United States	0.60	1.00	-2.50	1.65	0.80

Notes and Sources:
See text, and Appendices 1 and 2.

Table A4
Econometric Data

Country	Period	*Y*	*L*	*Y/L*	*W/P*
Australia	1870–79	6,376	768	8.26	119.93
Australia	1880–89	10,147	1,092	9.26	139.56
Australia	1890–99	11,676	1,402	8.35	141.75
Australia	1900–13	16,767	1,764	9.43	129.27
Belgium	1870–79	11,637	2,274	5.11	64.13
Belgium	1880–89	14,293	2,489	5.74	73.84
Belgium	1890–99	17,377	2,788	6.23	85.43
Belgium	1900–13	22,089	3,209	6.87	86.89
Canada	1870–79	5,466	1,442	3.79	114.19
Canada	1880–89	7,666	1,719	4.45	133.14
Canada	1890–99	9,911	1,974	5.01	169.96
Canada	1900–13	19,224	2,611	7.26	187.25
Denmark	1870–79	3,295	1,051	3.13	41.11
Denmark	1880–89	3,857	1,096	3.52	52.51
Denmark	1890–99	5,038	1,179	4.27	70.86
Denmark	1900–13	7,423	1,344	5.50	94.19
France	1870–79	66,778	18,202	3.67	52.04
France	1880–89	74,444	18,704	3.98	60.42
France	1890–99	83,782	19,057	4.40	65.04
France	1900–13	99,150	19,500	5.08	71.28
Germany	1870–79	35,855	10,889	3.29	62.48
Germany	1880–89	42,997	11,843	3.63	68.62

Germany	1890–99	58,152	13,305	4.36	78.12
Germany	1900–13	84,014	15,853	5.28	85.87
Great Britain	1870–79	86,829	11,452	7.13	70.40
Great Britain	1880–89	103,909	12,575	7.90	83.28
Great Britain	1890–99	127,306	14,473	8.51	99.18
Great Britain	1900–13	157,227	16,555	9.29	98.16
Italy	1870–79	34,909	14,716	2.37	26.17
Italy	1880–89	39,067	15,466	2.53	34.27
Italy	1890–99	42,472	16,087	2.64	37.32
Italy	1900–13	61,701	17,122	3.59	46.46
Netherlands	1870–79	7,463	1,402	5.32	62.68
Netherlands	1880–89	9,324	1,535	6.07	79.88
Netherlands	1890–99	11,674	1,714	6.81	87.98
Netherlands	1900–13	16,539	2,148	7.68	77.72
Norway	1870–79	2,331	759	3.07	40.20
Norway	1880–89	2,630	782	3.36	45.79
Norway	1890–99	3,203	835	3.83	67.46
Norway	1900–13	4,130	928	4.44	83.71
Portugal	1870–79	6,236	2,047	3.04	20.05
Portugal	1880–89	7,136	2,163	3.30	27.35
Portugal	1890–99	8,791	2,252	3.90	23.24
Portugal	1900–13	11,861	2,482	4.77	24.64
Spain	1870–79	25,392	6,723	3.78	27.51
Spain	1880–89	30,629	7,007	4.37	25.34
Spain	1890–99	32,269	7,273	4.44	26.76
Spain	1900–13	38,966	7,738	5.03	30.30
Sweden	1870–79	2,914	2,027	1.44	39.21
Sweden	1880–89	3,884	2,176	1.78	51.27
Sweden	1890–99	4,340	2,337	1.86	70.67
Sweden	1900–13	4,893	2,546	1.92	92.20
United States	1870–79	106,008	17,304	6.11	118.41
United States	1880–89	170,021	22,507	7.55	131.35
United States	1890–99	229,235	28,296	8.08	147.42
United States	1900–13	380,661	36,695	10.32	165.89

Notes and Sources:
See Appendix 2.