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CAPITAL GOODS PRICES, GLOBAL  
CAPITAL MARKETS AND  
ACCUMULATION: 1870-1950

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### **ABSTRACT**

Conventional wisdom has it that global financial markets were as well integrated in the 1890s as in the 1990s, but that it took several post-war decades to regenerate the connections that existed before 1914. This view has emerged from a variety of tests for world financial capital market integration ranging from the correlation of saving and investment aggregates to the dispersion of security prices and real interest rates. Presumably, we care about global capital market integration because it can have an impact on accumulation performance and the global distribution of the capital stock. Oddly enough, however, the relative price of capital goods, an important component of the user cost of capital, has never been incorporated into studies of capital market integration and almost never in comparative studies of pre-1950 economic growth. This could be an important omission. This paper explores the issue with a panel data base 1870-1950 for eleven OECD countries. It turns out that capital goods prices have been central to accumulation, and therefore to growth and convergence. They have also been as important to the evolution of global capital markets as have been interest rates and other financial costs.

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The conventional wisdom is that global financial markets were as well integrated in the 1890s as the 1990s but that it took several post-war decades to regenerate the connections that existed before 1914. This view emerged from a variety of tests for world financial capital market integration ranging from the correlation of saving and investment aggregates (Feldstein and Horioka 1980; Taylor 1998) to the dispersion of security prices and real interest rates (Neal 1985; Obstfeld and Taylor 1998). The ultimate importance of these connections has been justified in terms of accumulation responses, the growth of nations, and income convergence. Thus, when growth equations are applied to historical cross-sections from the Atlantic economy, measures of financial saving capacity and access to foreign capital are often included (Prados et al. 1993; O'Rourke and Williamson 1997, 1998: Chp. 11; Obstfeld and Taylor 1998). Yet, financial capital markets cannot by themselves speak to the issue of growth without making explicit connections with capital goods and their accumulation.

More specifically, per capita income growth depends to a large extent upon capital accumulation, accumulation depends upon investment, and the investment decision is informed by a comparison of capital's cost with its marginal product. Ignoring taxes, the user cost of capital can be written as  $u = (P_K/P)(i + \delta - \Delta P_K/P_K)$ ,<sup>1</sup> and therefore,  $du = [i + \delta - \Delta P_K/P_K]d(P_K/P) + (P_K/P)d[i + \delta - \Delta P_K/P_K]$ . Ultimately,  $u^* = (P_K/P)^* + (i + \delta - \Delta P_K/P_K)^*$ , where “\*” denotes percentage changes,  $i$  the nominal interest rate,  $\delta$  the depreciation rate,  $P_K$  the price of capital goods, and  $P$  the price of output. Changes in the user cost of capital are driven by changes in the interest rate and by changes in the relative price of capital goods. Given these facts, it is very surprising that the price of capital goods has rarely been incorporated into studies of global capital market integration,

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<sup>1</sup> The user cost of capital is often written in a simpler form  $u = (r + \delta)$  where  $r$  is the real interest rate. This can be derived from the expression in the text by assuming that  $P_K = P$  which also implies that  $\Delta P_K/P_K = \Delta P/P$  or simply the inflation rate. Since this paper focuses on the relative price of capital goods, we refrain from making these simplifying assumptions. Jorgenson (1963) illustrated that the user cost of capital could be characterized as a function of the price of capital goods, the rate of depreciation, the interest rate, and tax policies. The latter can be ignored for most of our period.

accumulation and growth.<sup>2</sup>

This could be an omission that matters. First, it is possible that the international dispersion of the user cost of capital was wider and moved very differently than real interest rates alone suggest. If so, then the incentive to invest and accumulate would also have been far different than real interest rates suggest. Conventional tales about epochs of integrated and disintegrated capital markets may require some revision after evaluating trends in capital goods prices over time; so too may assertions about the contribution of global financial capital markets to convergence before 1914 and divergence afterwards. Second, the relative price of capital goods (and machinery in particular) has been featured prominently in recent studies of post-war growth (De Long and Summers 1991; Jones 1994; Lee 1995; Greenwood and Jovanovic 1998), where the view that “low equipment prices operate to promote growth by increasing the quantity of equipment investment” has gained some credence (DeLong and Summers 1991: p. 474).<sup>3</sup> Some have used this idea to explain important historical cases. For example, Argentina’s import-substitution policy in the 1940s and 1950s has been used to demonstrate how protection-induced high equipment prices can lead to low accumulation rates and slow growth (De Long 1992; Taylor 1992, 1998). Nonetheless, the exploration of Argentina’s experience is more the exception than the rule: quantitative studies of pre-1950 growth have been nearly silent on the issue.

By combining capital goods and equipment price time series from national accounts with data from the Penn World Tables (PWT), this paper explores levels and trends in capital goods prices relative to consumption goods prices from 1870 to 1950 for eleven countries, nine from the Atlantic economy, plus Australia and Japan. After discussing the limitations and imperfections of the data, the paper describes the evolution of the relative price of capital goods over these eight decades. It then establishes which countries had cheap capital goods and when. From that point, the paper goes on to show how the conventional wisdom

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<sup>2</sup> There are exceptions that will be noted in a moment, Simon Kuznets (1961) certainly being one.

<sup>3</sup> See Auerbach et al. (1994) for a comment on the empirical fragility of the link that De Long and Summers make between machinery investment and growth.

regarding “world capital market integration” must be revised with the rightful presence of capital goods prices. The paper also offers some tentative assessments of the capital goods price impact on accumulation and growth, and explores some possible demand-side and supply-side determinants of the relative price of capital goods. We conclude with an agenda for the future.

### The Data

Capital goods price indices underlie the real investment series of all national accounts, and in some cases machinery or equipment price indices are available separately. We have drawn on these national accounts price series for eleven countries to construct a database covering Australia, Canada, Denmark, Finland, Germany, Italy, Japan, Norway, Sweden, Great Britain, and the United States.<sup>4</sup> For each country a relative price index can be formed by dividing the capital goods price index by the consumption goods price index.<sup>5</sup> The resulting series tell us how this relative price ( $P_k/P_c$ ) has changed over time within each country, but they do not tell us anything about differences between countries: we can say with certainty that the relative price of capital goods fell in Japan and rose in the US from the 1870s to the 1950s, but so far we cannot say whether the relative price of capital goods in the US was higher or lower than it was in Japan at any time over the eight decades. To establish a cross-country benchmark for 1950, we use the price level variables for investment and consumption reported by the Penn World Tables for each country.<sup>6</sup> The

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<sup>4</sup> We would like to expand the sample, but most countries do not have long and detailed national accounts stretching back to the 19th century.

<sup>5</sup> Consumption goods are chosen for the comparison rather than the overall GDP deflator because the investment goods index is included in the GDP deflator. Using Gordon’s (1990) postwar data for the US, Greenwood, Hercowitz and Krusell (1997) as well as Greenwood and Jovanovic (1998) also relate capital goods prices to consumption goods prices. Jones (1994, p. 361) shows that the choice does not matter for the 1960-1985 period. Later in this paper, we also relate capital goods prices to wage rates, a relative price of men versus machines that motivates capital deepening.

<sup>6</sup> The 1950 figures are themselves linked to benchmarks constructed by the United Nations’ International Comparison Program which was initiated in 1970 and extended in 1975, 1980, and 1985 (Summers and Heston 1991).

benchmark permits a double comparison similar to that made by Charles Jones (1994): we observe whether the price of capital goods relative to the price of consumption goods in a particular country is high or low compared to the same ratio in other countries. Thus, we can say something about the relative cost of capital goods between countries as well as over time.

Unfortunately, the Penn World Tables do not provide price series for the sub-components of capital goods, and at the same time it is evident that producer durables prices may differ substantially from the overall capital goods price. This implies that the 1950 PWT figures for overall investment goods prices are probably not reliable approximations of equipment or machinery prices. Instead, we take the producer durables and consumer goods price data from the U.N.'s International Comparison Program (ICP) for 1980 and extend these prices back to 1950 by using the producer durables and consumer goods price indices implicit in the OECD national accounts.

Admittedly, this is not an ideal measure of relative capital goods prices over time or across countries, as Simon Kuznets pointed out long ago (Kuznets 1961, p. 15). The national accounts capital goods price series are often combinations of input prices rather than actual observations of capital goods prices – that is, they often ignore productivity advance within the capital goods sector. Furthermore, the methods of price estimation are not identical across countries, and so we cannot even hope that the biases work the same way and to the same extent in every country. Finally, using a single benchmark to anchor time series running back to 1870 could, of course, produce misleading comparisons.<sup>7</sup> The farther we travel from the benchmarks, the less certain our estimates become. Nevertheless, Robert J. Gordon, after employing similar national accounts price series almost forty years ago, observed that “To deny the existence of these differential price trends is to deny the validity of the deflated estimates of the components of GNP on which we all so heavily rely” (1961, p. 937). It is no surprise that historical national accounts data are quite imperfect, and so it is clear that we

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<sup>7</sup> See Nuxoll (1994) and Dowrick and Quiggin (1997) for considerations of the problems associated with intertemporal and international price data.

must proceed with caution. At the same time, it seems foolish to postpone the exploration of potentially important determinants of long-term economic growth simply because the data are not ideal. Until the next round of revision of historical national accounts (and their underlying price series) and the appearance of comprehensive cross-country capital goods price data for the 19th century, the comparisons we make here rely on the best available characterizations of each economy's evolution.

### **The Evolution of the Relative Price of Capital Goods 1870-1950**

Tables 1a and 1b document the movements in capital goods prices relative to consumption goods prices over eighty years, country by country, with each series set equal to 100 in 1900. Table 1a reports the quinquennially-averaged relative price of all capital goods (equipment plus structures) for each country from 1870 to 1950, whereas Table 1b reports the relative price of equipment alone for a somewhat smaller sample of countries (data are not available for Australia and Finland).

The first notable fact is the time series variety across countries. Australia, Canada, Denmark, Sweden, and the United States all exhibit a rising relative cost of capital goods between the 1870s and just prior to World War I. Some of these increases are quite marked: the Swedish relative price rose 17.5 percent, the Danish by 14.4 percent, the Canadian by 11.7 percent, and the US by 10.6 percent. If the price elasticity of investment demand was about unity, these relative price changes would, by themselves, have served to choke off real investment in these economies anywhere between a tenth and a sixth by the end of the period. Had those relative prices been constant, annual investment in those four decades just prior to World War I would have been quite a bit higher.

Other countries underwent a decline in the relative price of capital goods. Japan experienced a spectacular fall of 46 percent, much of which took place during the 1870s and 1880s, an event which must

certainly have stimulated accumulation there.<sup>8</sup> Although not as spectacular as Japan, other countries underwent a decline up to 1910-1914 too: Germany by 19.2 percent, Italy by 8.3 percent and the United Kingdom by 7.9 percent. That these four countries recorded a significant decline in relative capital goods prices is all the more surprising given that the late 19th century investment boom was raising investment shares in GDP almost everywhere in the world economy. These demand-side forces should have tended to raise relative capital goods prices, suggesting that strong cost-reducing supply side forces must have been at work in the capital goods sector in each of these four countries. The decline in the relative price of equipment (Table 1b) was even more dramatic in all four countries: between 1870/74 and 1910/14 the relative price of machines in Japan fell by more than 66 percent; in Germany by 36 percent; in Italy by almost 12 percent; and in the UK by more than 17 percent. Indeed, every country in our sample experienced a decline in the relative price of equipment over the period, even though in some cases the aggregate capital goods price was on the rise.

The second notable fact is the regime switch around World War I. That is, the ubiquitous and strong downward drift in the relative price of equipment leveled out in all but one case and even started rising in some. Between the early 1920s and 1950, the relative price of equipment rose in Denmark, Norway, the UK and the US. In Canada, Japan and Sweden, the late 19th century fall in the relative price of equipment slowed down markedly, and in Germany the decline ceased entirely. Only in Italy did the pre-WWI decline resume its rapid rate of fall after the 1920s.

The third notable fact is that the Great Depression and the two World Wars, which one might expect to have had quantitatively different demand-side effects on the prices of capital goods and consumer goods, appear not to have had a large impact on the relative price of capital goods or equipment.<sup>9</sup> Since investment

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<sup>8</sup> This theme for late Meiji and early Taisho Japan was stressed some time ago by DeBever and Williamson (1977). The Japanese machine industry is discussed in some detail later in the paper.

<sup>9</sup> Of course, this stylized fact is somewhat qualified since some countries drop from the sample during war years. Wars generally led to inflation of both consumer and investment goods prices, but the relative price of the two did not change by much.



contracted so much more than did consumption during the Great Depression, one would have expected those demand effects to have lowered the relative price of capital goods. Although the relative price of capital goods fell slightly in a number of countries from the late 1920s to the early 1930s (and more than slightly in Germany), only in Italy and Germany did this relative decline persist into the late 1930s. Similarly, only in Italy did the relative price of equipment fall from the late 1920s into the late 1930s. This result cannot be explained by some exceptional stickiness of capital goods prices since they dropped enormously into the Great Depression, but less so than did the price of consumption goods. The examination of price trends during wartime is a bit obscured because some countries drop out of the sample during the wars. As the demand for military hardware rose, presumably the prices of factors and materials used intensively in the production of capital goods (especially private producers durables) also increased. This should have raised the prices of capital goods relative to others in the economy. This appears to have been true everywhere during World War I except for Finnish and British capital goods, and British equipment. However, it was not everywhere true during World War II. Capital goods prices in Denmark, Italy and Sweden appear to have fallen relative to consumption goods prices; and relative equipment prices in Italy and Sweden also appear to have fallen. Even where the relative price of capital rose during these wars, it rarely rose by much because consumption goods prices kept pace with the inflation of capital goods prices.<sup>10</sup>

Tables 1a and 1b simply report time series over the eight decades 1870-1950. What can be said about the variance in relative prices across countries? Where were capital goods cheap and where were they expensive? Tables 2a and 2b employ the benchmark from 1950 to make the comparisons, and all figures are expressed relative to the United States in 1950.

In the benchmark year of 1950, only Germany and Finland had lower relative capital goods prices than the United States (Table 2a) and only Canada had lower relative equipment prices (Table 2b). Despite

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<sup>10</sup> The exception being Australia in World War II when the relative price of capital goods rose from 107.85 in 1935-39 to 122.78 in 1940-44.

Japan's spectacular capital goods price decline up to World War II, it still had a much higher relative price than the US in 1950, 75.3 percent higher. Ceteris paribus (and ignoring international capital mobility for a moment), Japan would have required a savings rate 75 percent higher than the US to make the same real investment in its productive capacity. Thus, Japan's historically high savings rate has had to compensate for the relative high price of capital goods there compared to other countries. Over the eighty years as a whole, Australia, Canada, Denmark, Italy, Japan, Sweden and the UK appear to have had relatively expensive capital goods implying, ceteris paribus, a relatively disadvantageous price structure for capital accumulation. Japan, Sweden and the UK in particular carried the heaviest burdens. Finland, Germany, Norway and the US appear to have had relatively cheap capital goods implying, ceteris paribus, a favorable price structure for capital accumulation.

The relative price of equipment declined in each of the nine sampled countries up to World War I, but the decline was much steeper in some than others. Those with the most expensive equipment in the 1870s enjoyed the steepest relative price decline up to World War I, just as one would expect for tradable goods in an increasingly global economy. The between-country spread in relative prices in the late 1870s was far larger than just prior to World War I. In the 1870s, the relative price of equipment in Japan and Italy was 7.9 and 3.0 times that of the United States, but those ratios had fallen to 3.0 and 2.8 by World War I. Throughout the eight decades, the United States and Canada maintained the lowest relative prices of machinery.

### **The Evolution of a Global Capital Market?**

In measuring the evolution of a global financial market over the past century, Maurice Obstfeld and Alan Taylor (1998) point out that the dispersion of real interest rates for ten countries fell slightly between 1885 and 1914, jumped up during World War I, declined somewhat during the 1920s, increased again during

the 1930s achieving a secular peak in the mid-1940s, and then declined sharply from that peak to 1960. Despite the ballyhooed financial “globalization” of the 1980s and 1990s, the dispersion of interest rates across these countries has not changed much since the 1960s (Obstfeld and Taylor 1998, p. 366).<sup>11</sup> The dispersion of real interest rates after 1960 was similar in magnitude to its level prior to 1914, despite the dislocation of the interwar years. Hence the now standard view about the timing and extent of international (financial) capital market integration asserts that global capital markets were as well integrated in 1914 as they are now and that what had been gained up to 1914 was lost during the de-globalization episode up to the 1940s. So much for interest rates and financial markets. Did the dispersion of capital good prices, and ultimately the user cost of capital, follow the same pattern?

Table 3 reports the coefficient of variation of relative capital goods and equipment prices from 1875 to 1990, both with and without Japan,<sup>12</sup> and in many ways the time path of the capital goods price dispersion is quite different from that of real interest rates.<sup>13</sup> Obstfeld and Taylor find that the dispersion of real interest rates in the 1950s was larger than in the 1870s and 1880s. But even when Japan is excluded from the samples, the dispersion of both relative capital goods prices and relative equipment prices were about half as large in 1950 as in 1870: excluding Japan, the epochs of big decline in the dispersion of capital goods prices are 1885-1895, 1945-1950, and 1965-1985. It could be that our measure of relative capital price dispersion becomes less reliable the further we travel from the benchmark year, so what happens when we chop off some of the more distant 19th century decades? Obstfeld and Taylor find that the dispersion of interest rates was

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<sup>11</sup> Obstfeld and Taylor’s sample includes Australia, Belgium, Canada, France, Germany, Italy, the Netherlands, Sweden, Great Britain, and the United States.

<sup>12</sup> The magnitude of the relative price change in Japan tends to dominate the change in the overall dispersion, and so we calculate the dispersion statistics both with and without Japan to provide a clearer picture of the Atlantic economy’s experience. Yet, no matter how global capital goods market integration is calculated in Table 3, there is clear evidence of an unambiguous decline in price dispersion over the century or so between 1875 and today.

<sup>13</sup> Our sample is somewhat different from that of Obstfeld and Taylor (1998), and our measure of dispersion is different as well. Obstfeld and Taylor measure the dispersion as the standard deviation of the absolute interest rate differential relative to the US.

about the same in 1974-1989 as in 1890-1913, but, once again, the dispersion of relative capital goods and equipment prices was markedly lower in the post-war period than at the turn of the century. Capital goods prices underwent a secular decline in dispersion over the full century since the 1890s, while real interest rates did not. Given that Obstfeld and Taylor have found evidence confirming that financial capital markets were as well integrated in the 1890s as in the 1980s, our findings suggest that capital markets (i.e., when capital goods prices are included) are much better integrated today than they were prior to 1914, at least if we are willing to use price dispersion as a measure of integration.<sup>14</sup>

What about 1914-1950, decades of autarky and de-globalization? During the two world wars, the dispersion figures rise in six out of eight cases in Table 3, the puzzling exception being for equipment between 1940 and 1945. Between 1910 and 1915 the equipment price dispersion rises from 0.44 to 0.54 and the capital goods price dispersion rises from 0.29 to 0.31 before jumping to 0.43 in 1917. During WWII, the dispersion measure for relative capital goods prices rises from 0.25 to 0.43 between 1940 and 1945.<sup>15</sup> This wartime leap in the dispersion of international capital goods prices is also present in the real interest rate evidence (Obstfeld and Taylor 1998), and they both might be related to the breakdown in global markets, one in the goods market and one in the financial market.

An important distinction between our version of global capital market integration and that of the financial historian emerges from Table 3. The widening in the dispersion of real interest rates (Obstfeld and Taylor 1998, Figure 11.3) took place during wartime and interwar episodes which were associated with government interventions that destroyed well-integrated global financial markets. That is, policy had a clear

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<sup>14</sup> One could take the view that a decline in the price dispersion does not necessarily imply that market integration has increased if declining transport costs are doing all the work rather than the appearance of better institutions and more liberal policy. Clearly, one's definition of integration matters to one's interpretation of the evidence. However, there should be no debate about epochs of disintegration.

<sup>15</sup> These comparisons are inexact because some countries leave the sample during the wars. However, we constructed coefficient of variation time series for samples that always exclude these subsets of countries and found that the rise in the dispersion is not merely the result of these countries leaving the sample.

impact on the functioning of global financial markets. In capital goods markets, however, it appears that the globalization backlash during the interwar years had very little to do with the evolution of relative capital goods prices. The years 1910-1940 show very little change in the dispersion of relative capital goods prices; in fact, these years show a decline in the dispersion of relative equipment prices.

This strikes us as an important finding. While government intervention had a predictable impact in first destroying and then reconstructing global financial capital markets, it did not have the same impact on relative capital goods prices. If changes in capital goods prices dominated changes in the user cost of capital, then we have a revisionist finding of some note and the literature on financial history can be said to have missed a crucial point.

Tables 4a and 4b make an effort to identify changes in the two components of the user cost of capital over time (Table 4a) and differences across countries (Table 4b).<sup>16</sup> In Table 4a for the period 1870-1914, there are six countries for which the data can say something about the components of user costs. Both components of the user cost of capital fell in the United Kingdom, and so the observed decline in the interest rate understates the decline in the user cost of capital, the latter nearly twice the former. In the other five cases, the fall in one component of the user cost was at least partially offset by a rise in the other. The relatively large changes in the  $(i + \delta - \Delta Pk/Pk)$  component of user costs reflects the relatively large swings in nominal interest rates and inflation rates compared to changes in the relative cost of capital to consumer goods. For the period 1910-1949 there are eight countries for which the data can say something about user costs. Changes in the components of the user cost reinforce one another in Australia, Canada, Italy and Sweden, but move in opposite directions in Germany, Norway, the UK, and the US. The rise in relative capital goods prices more than offsets the fall in  $(i + \delta - \Delta Pk/Pk)$  for Germany and very nearly so for Norway. The offsetting effect of the relative price of capital goods was more modest but not insignificant for the UK

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<sup>16</sup> To facilitate the calculation of percentage changes in the  $(i + \delta - \Delta Pk/Pk)$  component of user costs, we simply assume that  $\delta = 0.10$  for all countries and periods.

and the US.

Table 4b measures at various points in time differences across countries in the two components of the user cost of capital (all expressed relative to the US). In the 1870s, the US appears to have had a relatively high effective interest rate, but a relatively low relative price of capital goods.<sup>17</sup> Thus, the high financial cost of capital in the US was partially offset by the relatively low cost of the capital goods being purchased. Note that the total user cost of capital appears to have been very similar in the US and UK in the 1870s despite the US having relatively high interest rates, a revisionist finding given the established tradition which characterizes the US as capital-scarce compared to Britain at that time. As pointed out in the discussion of Table 2a, the US maintained this relatively low price of capital goods throughout the period under consideration, and by the late 1940s, it also had a relatively low real interest rate. Low interest rates and cheap capital goods imply low user costs of capital, and that fact should have made investment in the US very attractive.

### **Capital Goods Prices, Investment and Growth**

The relative price of capital goods has been featured prominently in a number of recent cross-section studies of economic growth (De Long and Summers 1991; Easterly 1993; Jones 1994; Lee 1995; Greenwood, Hercowitz, Krusell 1997; Greenwood and Jovanovic 1998). Charles Jones, for example, uses data underlying the Penn World Tables to argue that “an increase in the relative price of machinery reduces capital accumulation and therefore reduces the growth rate of the economy” (Jones 1994, p. 372). But have capital goods prices always had this influence on investment and growth, or is it only a late 20th century phenomenon? We will use the capital goods relative price data 1870-1950 to test the durability of this link.

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<sup>17</sup> The high interest rate finding may arise from differences in the assets whose nominal rates are used in the calculation. The US series is based on corporate bond yields whereas other countries' rates are usually based on government bonds (Bordo and Jonung, p. 159).

The effect of capital goods prices on growth is indirect, while its effect on accumulation is direct. Thus, we should find more convincing evidence of the importance of relative capital goods prices by focusing first on the quantity of investment undertaken. An empirical assessment of the link between capital goods prices and investment rates is offered in Tables 5 and 6. Each observation in the regression represents a particular country over one of the following six periods: 1870-85, 1885-1900, 1900-13, 1913-29, 1929-39, and 1939-50. Across columns, the sample size changes depending on the availability of data.<sup>18</sup> The investment share in GDP is regressed on the log of GDP per capita, the relative price of capital goods (or machinery), and the real interest rate on long term assets at the beginning of each period.<sup>19</sup> We also include time period dummies. Table 5 calculates the investment share in current prices whereas Table 6 calculates it in constant prices.<sup>20</sup>

The relative price of capital goods is not exogenous, and so this kind of estimation procedure does not offer a clean identification of the effect of relative capital goods prices on investment and accumulation, an issue we will consider in the next section. Non-price forces which shift the demand curve for investment goods to the right will also raise the relative price of capital goods, a fact which will be true even for tradable equipment if the investment boom is world-wide. This will tend to generate a positive relationship between investment rates and relative capital goods prices, and thus a downward bias on the true influence of capital goods prices on accumulation and growth. The same will be true for real interest rates. We attempt to minimize this bias by observing prices and interest rates at the beginning of the period rather than in the middle, as would be implied by an average over the period. Furthermore, the specification fails to introduce

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<sup>18</sup> For example, of the eleven countries which have sufficient national accounts for the construction of relative capital goods price series, real interest rate data exist only for seven (Canada, Germany, Italy, Norway, Sweden, Britain, and the United States).

<sup>19</sup> The real interest rate figures are derived from unpublished data supplied by Michael Bordo and Alan Taylor. Of course, cross-country comparisons of such rates are necessarily inexact.

<sup>20</sup> The constant price investment and GDP series from each country are used to form a series representing the constant price investment share over time, and then internationally comparable figures for investment and GDP from the PWT for 1950 are used to benchmark each country's constant price investment share in that year.

demographic variables (Bloom and Williamson 1998; Williamson 1998), measures of protection (O'Rourke 1997a), economic geography (Krugman 1991; Gallup, Sachs and Mellinger 1998) and other variables that have been shown to influence growth and ought to affect investment and accumulation as well. Nevertheless, we press bravely ahead with the simple OLS specification, expecting to improve it in future versions of this paper.

The correlation of the investment rate with capital goods or equipment prices is in all cases negative and in all cases but one statistically significant. According to Table 6, column 1, a one-standard-deviation increase in the relative price of capital goods is associated with a decline in the investment share of about 3.6 percentage points, a significant figure in an era when the investment rate was around 17 percent, and it implies an elasticity of -0.68. According to column 2, a one standard deviation increase in the relative price of equipment is associated with a decline in the (total) investment share of 3.4 percentage points (an elasticity of -0.45). If in 1870 the US had had the relative price of capital goods of the other countries (not including Japan), the regression suggests that the US investment share would have been about 2.4 percentage points lower than it was between 1870 and 1885. Since the US always had cheap capital goods, one may conclude that its investment rate, its rate of accumulation, and ultimately its rate of growth were always favored by this characteristic of its price structure. Thus, we have found that relative capital goods prices were an important determinant of investment, and, by extension, that they were also important to growth.

Columns 3 and 4 add the real interest rate at each period's beginning to the regressions.<sup>21</sup> This changes the sample composition considerably because interest rate data are not available for every country. The real interest rate is negatively related to investment rate, but the coefficient estimate is very imprecise. This might be due to demand side forces that tend to raise investment and interest rates simultaneously or to problems with the international comparability of the interest rates, or both.

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<sup>21</sup> The real interest rate is calculated as the difference between the nominal interest rate and in the inflation rate for all goods.



So far, we have suggested that because capital goods prices appear to affect investment, they must also affect growth. Table 7 looks for direct evidence of this link between capital goods prices and growth. In the manner of Robert Barro (1991), we regress average annual per capita GDP growth over each period on the log of GDP per capita, the relative price of capital goods (or machinery), and time period dummies. As with the investment equations, this version of the paper excludes from the growth equation other conditioning variables like geography, demography, and policy. Both columns in Table 7 yield the expected negative coefficient on initial GDP per capita, that is, poor countries grow faster than rich, *ceteris paribus*. Most importantly for the theme of this paper, the relative price of capital goods (or machinery) has a consistent negative impact on growth. True, the estimate for total capital goods prices is far from statistically significant, but this is hardly surprising given the confounding demand side effects on the relative price of capital goods, the limited number of conditioning variables present in the specification, and the indirect nature of the link between capital goods price and growth.

According to column 2, a one-standard-deviation increase in the relative price of equipment lowered annual growth by almost 0.37 percentage points (an elasticity of -0.55). According to the column 1, a one-standard-deviation increase in the relative price of all capital goods lowered annual growth by almost 0.19 percentage points (an elasticity of -0.30). If the United States had had a relative price of equipment equal to the average price in the other countries (excluding Japan), then the regression coefficient from column 2 predicts that the per capita annual growth rate would have been 1.55 percent between 1870 and 1885 rather than 1.9 percent. Compounded over those fifteen years, this counterfactual suggests that per capita income would have been 5 percent lower in 1885 than it actually was. While that number may seem small, it would have contributed significantly to greater convergence over the period. We constructed another simple counterfactual by regressing average annual per capita growth from 1870 to 1950 on (log) initial GDP per

capita and the relative price of all capital goods at the beginning of the period (around 1870).<sup>22</sup> Using the coefficient on capital goods prices from this regression and replacing the US actual capital goods price with the average price of the other ten countries in the sample, we estimate that US per capita growth would have been about 1.55 percent per year rather than 1.7. When compounded over an 80 year period, this implies that real income per capita might have been about 12 percent lower in 1950 than it actually was (\$8500 versus \$9573 in 1990 Geary-Khamis dollars). The US would still have been among the world's richest countries, but it would not have been the unrivaled world leader in income per capita since it would have ranked about on par with the New Zealand and somewhat below Switzerland.

Previous studies of international income convergence have found that the United States' growth rate outpaced the predictions of convergence regressions estimated with long run data (Wright 1990; Williamson 1996). The US was a rich country which continued to grow quickly relative to the rest of the world despite the implications of neoclassical convergence models. We have now identified one reason why: the US was favored by cheap capital goods throughout the period.

### **Explaining the Relative Price of Capital Goods**

Thus far, capital goods prices have been taken as given and used as if they were exogenous in the growth and investment regressions reported above. Now we consider some of the factors that might explain differences in relative capital goods prices across countries and their changes over time. After discussing Japan and the United States in some detail, we explore the determinants of the relative price of capital goods

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<sup>22</sup> Unlike the previous growth regressions this one does not break up each country's performance into six periods, rather the dependent variable is average annual growth over the full 80 years and the independent variables are initial GDP per capita and initial relative price of capital goods. The coefficient on the relative price variable is 0.0000318 (t-statistic = 4.97). Similar counterfactual results are attained if Japan is excluded from the regression and from the calculation of the average price of capital in countries other than the US.

econometrically.

One of the outstanding characteristics of Tables 2a and 2b is the high ratio of capital goods prices to consumer goods prices in Japan, especially in the 1870s and 1880s and especially for producer durables. The small size of the domestic machine tool industry at the time of the Meiji Restoration, and its evolution thereafter, is discussed at length by Toshiaki Chokki (1986). Imported machines were crucial to the establishment of Japanese arsenals in the 1870s, and subsequently the process of military modernization appears to have provided an important impetus to the development of domestic machine production (Yamamura 1977). During World War I, domestic production of machinery expanded rapidly to fill the growing demand which (for the time being) could not be satisfied by imports from Britain, the US, or Germany. Tables 1a through 2b all show that the relative price of capital goods rose substantially in Japan during these years reflecting the increase in domestic demand coupled with an inelastic wartime import supply. Imports bounced back after the war, however, and the relative price of capital goods fell. The invasion of Manchuria in 1931 and the years of war that followed again cut off foreign supplies of machinery, and it is reflected in the rise of the relative price of machinery.

These temporary shocks drove the expansion and evolution of the domestic capital goods industry and in doing so may have contributed to the long-run permanent decline in Japanese capital goods prices. When looking at United States 19th century experience, Nathan Rosenberg (1963b, p. 223) linked the emergence and development of the domestic capital goods industry with the size of the market for such goods. He argued that “with the growth in the demand for machinery the capital-goods industry became gradually more and more highly specialized and subdivided in order to undertake the production of machines, the cost of producing machines was thereby sharply reduced . . .” Presumably, the Rosenberg hypothesis is more likely to survive the more is machinery non-tradable. With the hypothesis in mind, we will test econometrically whether the size of the domestic economy, *ceteris paribus*, had a noticeable impact on the relative price of capital goods between 1870 and 1950.

When studying 19<sup>th</sup> century American capital accumulation, Jeffrey Williamson (1979) argued that it was important to distinguish between those capital goods which were labor-intensive, non-tradable and undergoing slow rates of productivity advance (structures and infrastructure) and those capital goods which were skill-intensive, tradable and undergoing fast rates of productivity growth (equipment and machinery). Given those attributes, we would expect the relative price of machines to decline faster than the price of structures and thus of all capital goods combined, as Tables 1a and 1b confirm. American economic historians have always argued that the rate of productivity advance in the producer durables sector was relatively fast (Rosenberg 1963a, 1963b, 1969; David 1975; Williamson 1979). If what was true of the US was also true at the global level, then we should see a declining price of producers durables relative to consumer goods world-wide, and in fact this is also confirmed in Table 1b. Furthermore, in a world of imperfect commodity market integration, we would expect the relative price of capital goods to be higher in poor agrarian countries which have not yet experienced the unbalanced productivity growth associated with industrialization.

Williamson (1974, 1979) also argued that part of the decline in the US relative price of capital goods between the 1840s and the 1870s was due to Civil War tariffs that raised the price of manufactured goods relative to investment goods, tariffs which persisted for almost a century after the Civil War ended. It may appear that Argentine import substitution experience in the 1940s and 1950s is inconsistent with the American Civil War tariff experience almost a century earlier, the former contributing to slow growth and the latter to fast growth. The inconsistency is resolved, however, if capital goods in the 1860s were for the most part nontradable structures and homemade machines, while over the course of the next century, the tradable machine component became much more important. In the American case, tariffs would have decreased the relative price of then nontradable capital goods, while in the Argentine case they would have increased the relative price of now tradable (and imported) capital goods.

On the other hand, US demand shifted away from structures and infrastructure and towards machines

as settlement and town-building slowed down, and as agriculture contracted (relatively) while manufacturing expanded (Kuznets 1961: p. 40). These events should have contributed to the shift in capital from structures to equipment, thus raising the relative price of equipment from the demand side. In the long run, however, these demand forces should have been overwhelmed by changing cost conditions on the supply side.

Endowments of labor and skills may also matter to the relative price of capital goods. The construction of structures is very labor intensive, while the construction of machines is very skill intensive. In countries and epochs where labor is cheap and skills are expensive, and where world commodity markets are only imperfectly integrated, the relative price of machines should be high. In countries and epochs where labor is expensive and skills are cheap, the relative price of machines should be low. In the Anglo-American debate over ante bellum dual scarcity, it emerged that the relative price of skills and machines were low in America (Rosenberg 1967; Brito and Williamson 1973). More generally, this fact offers another reason to expect a positive correlation between level of development and cheap capital goods.

We explore these hypotheses econometrically in Table 8 where the log relative capital goods price (or equipment price) is regressed on the log of initial GDP per capita, the log of total GDP, and a measure of tariff rates. There are three key findings reported there. First, GDP per capita has a negative impact on the relative price of capital goods (especially equipment), a result Charles Jones (1994) also reports for the late 20th century. This finding is consistent with our discussion of unbalanced factor productivity growth as well as with the suggestion that rich countries with relatively abundant skills will also be characterized by relatively cheap capital goods. Furthermore, the coefficient on GDP per capita is larger and more significant for equipment than for all capital goods, just as we would have predicted. Second, columns 2 and 5 show that for a given level of GDP per capita, the overall size of the domestic economy is positively, not negatively, correlated with relative capital goods prices, a clear rejection of the Rosenberg hypothesis. This suggests that cost reductions due to scale were more far important for consumption goods than for capital goods. Third, higher tariffs were associated with lower relative capital goods prices. In column 3 a 10 percentage point

increase in the tariff rate (say, from 0.10 to 0.20) lowers the relative price of capital goods by 7.6 percent, and in column 6 a 10 percentage point increase in the tariff rate lowers the relative price of equipment by 25.6 percent. To the extent that tariffs distorted prices prior to 1950, they did so in a way that lowered the price of capital goods relative to consumer goods, a price twist consistent with what Williamson (1974, 1977) has argued for US Civil War tariffs. The fact that tariffs appear to be negatively associated with capital goods prices might help explain the otherwise puzzling positive correlation between late 19th century growth and tariffs, the “Bairoch effect” (Bairoch 1989) recently confirmed by O’Rourke (1997b).<sup>23</sup>

### **The Relative Price of Men and Machines**

The price of capital goods is most often expressed relative to the price of other goods, but capital goods are, after all, factors of production too, and so it may be useful to compare the price of capital goods with the price of another factor of production, unskilled labor. Table 9 reports five-year averages of the price of capital goods relative to the price of labor for ten countries between 1870 and 1950. Every country experienced a rise in the price of men relative to the capital goods with which they worked between 1870 and 1914. Alternatively, the price of capital goods fell relative to the unskilled worker’s wage, and the decline in Denmark, Germany, Italy, and Norway was especially large. The wage gains driven by mass European emigration would help account for the fact that the downward trend was more dramatic in Europe than in the New World. The US, Canada, and Australia all underwent comparatively small declines in the  $P_k/W$  ratio up to 1914, and Japan’s ratio increased substantially before declining after 1890. After 1915, and with the end of mass migration, there was a regime switch: the US and Canada now joined Italy, Japan, Norway and

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<sup>23</sup> We call this 19th century growth-tariff or growth-openness positive correlation puzzling since it is negative for the late 20th century (Sachs and Warner 1995; Vamvakidis 1997). For the equipment price, the coefficient on the tariff variable remains negative and statistically significant even when the US (a high tariff, low  $P_k/P_c$  country) is omitted from the regression. The tariff coefficient becomes positive but statistically insignificant in the regression with all capital goods prices when the US is omitted.

Sweden in recording substantial declines in the  $Pk/W$  ratio. Over the full 80 year period, only Australia had no lasting decline in its  $Pk/W$  ratio.

International comparisons of the capital goods price/wage ratio can be made by using price data from the PWT and internationally comparable wage data from Williamson (1995) to form a benchmark in 1950.<sup>24</sup> The series underlying Table 9 can then be used to extend the international comparisons back to 1870 as we do in Table 10. In the benchmark year of 1950, the US had the lowest  $Pk/W$  ratio by far, and it appears to have held that position throughout the period under consideration (though Norway occasionally challenged). Denmark, Sweden, and Italy had the highest ratios in 1870, but all three experienced a rapid decline in  $Pk/W$  over the subsequent 80 years.

### The Agenda

The user cost of capital has two components, the cost of finance and the cost of the capital good. Thus, any attempt to understand the integration and disintegration of world capital markets over time should pay attention to both components. The same should be true of any comparative assessment across epochs or across countries of investment behavior, accumulation performance and growth. Oddly enough, however, the relative price of capital goods has not been incorporated into studies of capital market integration and long-term growth. To rectify this omission, we developed a panel data base for eleven OECD countries over the eight decades between 1870 and 1950.

While this paper must be viewed as only a start on a long term historical assessment of these issues, and while the underlying capital goods price data base is fragile, some stylized facts seem to be robust. First,

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<sup>24</sup> The benchmark relies on the ratio of  $Pk/Pc$  from the PWT to the real wage from Williamson (1995) where both  $Pk/Pc$  and the real wage are expressed relative to the US in 1950. The series are extended back from this benchmark on the basis of changes in the nominal price of capital goods relative to nominal wages within each country.

there was enormous variance in trends in the relative price of capital goods across countries before 1950. Some, like Japan, underwent a spectacular decline in the aggregate capital goods price from 1870 to 1914, while others, like Scandinavia, underwent a rise. This divergence was possible even during a period of globalization in trade since only equipment was traded, while structures, of course, were not. Second, the relative price of equipment fell everywhere, an event which appears to support the view that productivity growth was faster in the producer goods sector world-wide. Yet, and third, there was a notable regime switch around World War I, after which the downward drift in the relative price of equipment stopped and in some cases reversed. Finally, there was also enormous variance in the relative price of capital goods and the user cost of capital across countries. Some, like Japan and Sweden, were disadvantaged by relatively expensive capital goods, and thus needed higher savings rates to achieve the same growth as their competitors. Some, like Germany and the United States, were favored by relatively cheap capital goods, and thus could achieve the same rates of growth with lower savings rates.

Do these capital goods price facts change our conventional views of the evolution of a global capital market? They do indeed. Using the more comprehensive user cost criteria, capital markets were far better integrated in the 1980s than they were in the 1890s, not equally well-integrated as the financial historian usually argues. Furthermore, the time path of the capital goods price dispersion is very different than that of real interest rates, and thus will require different explanations. The dispersion of real interest rates increases between 1910 and 1940, decades which were associated with government interventions that destroyed well-integrated world financial markets. Yet, globalization backlash after 1914 seems to have had very little to do with the evolution of capital goods prices.

The remainder of the paper takes a stab at three difficult questions: First, did the relative price of capital goods have a statistically significant and big impact on investment? The answer is yes: expensive capital goods choked off investment. The impact was statistically significant and powerful, so that on average the investment share responded to the relative price of capital goods with an elasticity of about -0.7.



Did the relative price of capital goods also have a statistically significant and big impact on GDP per capita growth? Here the answer is more tentative. Yes, the annual growth rate of GDP per capita was dampened by high capital goods prices with an elasticity of almost -0.6. But significance tests suggest that caution be attached to that conclusion, perhaps confirming that while the impact of capital goods prices on investment and accumulation was direct, its impact on growth was indirect. Finally, what explains the relative price of capital goods? Here we find that prior to 1950 rich countries had lower relative capital goods prices compared with poor countries, large economies had higher relative prices compared with small ones (holding constant GDP per capita), and economies with tariffs had lower relative prices compared with those which went for free trade.

The agenda for future research has four parts. First, we would like to extend and improve the capital goods price data base. Second, the investment and growth equations must be augmented by more conditional variables to better isolate the impact of capital goods prices. Third, while we know that capital deepening raises the relative price of labor and lowers the relative price of machines, we need to learn more about the causal direction that goes from the relative price of labor or machines to capital deepening. History shows that countries trace out very different trends in the relative price of men versus machines, and we need to know the reasons why. Fourth, the determinants of the price of capital goods relative to consumption goods must be better understood. This last agenda item is especially important since only by so doing can we isolate the roles of policy and institutions in accounting for the evolution of world capital markets and their impact.

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## Appendix: Capital Goods Price and Investment Data 1870-1950

### Australia

#### Price Index for Capital Goods:

1870-1939: N. G. Butlin (1962), *Australian Domestic Product, Investment and Foreign Borrowing 1861-1938/39*, p. 33. The series is for gross domestic capital formation.

1939-1950: M. W. Butlin (1977), "A Preliminary Annual Database 1900/01 to 1973/74." The series is for private non-dwelling investment.

#### Price Index for Machinery and Equipment:

Not available.

#### Price Index for Consumption Goods:

1870-1950: B. R. Mitchell (1995), *International Historical Statistics: Africa, Asia & Oceania* (hereafter *IHSAAO*). A consumer price index is used because none for the consumption goods component of GDP has been found.

#### Current Price Value of Investment:

1870-1939: N. G. Butlin (1962), pp. 6-7.

1940-1950: B. R. Mitchell (1995), pp. 1017-18.

#### Current Price Value of GDP:

1870-1939: N. G. Butlin (1962) pp. 6-7.

1940-1950: B. R. Mitchell (1995), pp. 1017-18.

#### Constant Price Value of Investment:

1870-1939, 1949-50: B. R. Mitchell (1995), pp. 1017-18.

1939-1949: M. W. Butlin (1977).

#### Constant Price of GDP:

1870-1939, 1949-50: B. R. Mitchell (1995), 1017-18.

1939-1949: M. W. Butlin (1977).

### Canada

#### Price Index for Capital Goods:

1870-1929: O. J. Firestone (1958), "Canada's Economic Development 1867-1953," *Income and Wealth Series VII*, p. 178. Missing data (except 1916-1919 which are left blank) are interpolated.

1929-1950: M. C. Urquhart (1965), *Historical Statistics of Canada*, p. 305.

#### Price Index for Machinery and Equipment:

1870-1929: O. J. Firestone (1958), p. 178. Missing data (except 1916-1919) are interpolated.

1929-1950: F. H. Leacy (1983), *Historical Statistics of Canada*, series K160-171.

#### Price Index for Consumption Goods:

1870-1929: O. J. Firestone (1958), p. 178. Missing data (except 1916-1919) are interpolated.

1929-1950: M. C. Urquhart (1965), p. 305.

#### Current Price Value of Investment:

1870-1900: Investment shares are from S. Kuznets (1961) who based figures on O. J. Firestone (1958) for 1870, 1890, and 1900. Missing data are interpolated.

1901-1930: Leacy (1983), series F179-182. Leacy provides quinquennial sums. Investment shares are calculated for five year periods by dividing by the quinquennial sum of GNP.

1930-1950: B. R. Mitchell (1993), *International Historical Statistics: The Americas* (hereafter *IHSA*), pp. 750, 754.

#### Current Price Value of GNP:

1901-1930: Derived from M. Altman (1992), "Revised Canadian GNP Estimates and Canadian Economic Growth, 1870-1926," *Review of Income and Wealth*.

- 1930-1950: B. R. Mitchell (1993), *IHSA*, pp. 750, 754.
- Constant Price Value of Investment:  
1870-1929: O. J. Firestone (1958), p. 275. Using series for gross investment in new residential and non-residential construction and new machinery and equipment.  
1929-1950: B. R. Mitchell (1993), *IHSA*, pp. 750, 754.
- Constant Price Value of GNP:  
1870-1929: O. J. Firestone (1958), p. 275.  
1929-1950: B. R. Mitchell (1993), *IHSA*, pp. 750, 754.

### Denmark

- Price Index for Capital Goods:  
1870-1950: Derived from current and constant price investment series in *Økonomisk vækst i Danmark* (1974).
- Price Index for Machinery and Equipment:  
1870-1950: Derived from K. Bjerke (1955), "The National Product of Denmark, 1870-1952," in *Income and Wealth Series V*, edited by S. Kuznets.
- Price Index for Consumption Goods:  
1870-1950: Derived from *Økonomisk vækst i Danmark* (1974).
- Current and Constant Price Value of Investment:  
1870-1950: B. R. Mitchell (1992), *International Historical Statistics: Europe* (hereafter IHSE), pp. 890, 893, 899.
- Current and Constant Price Value of GDP:  
1870-1950: B. R. Mitchell (1992), *IHSE*, pp. 890, 893, 899.

### Finland

- Price Index for Capital Goods:  
1870-1950: Derived from current and constant price investment series in R. Hjerppe (1989), *The Finnish Economy, 1860-1985*, pp. 201-204, 211-213.
- Price Index for Machinery and Equipment:  
Not available.
- Price Index for Consumption Goods:  
1870-1950: Derived from R. Hjerppe (1989), pp. 201-204, 211-213. Using series for private consumption.
- Current and Constant Price Value of Investment:  
1870-1950: R. Hjerppe (1989), pp. 201-204, 211-213.
- Current and Constant Price Value of GDP:  
1870-1950: R. Hjerppe (1989), pp. 201-204, 211-213.

### Germany

- Price Index for Capital Goods:  
1870-1950: W. Hoffmann (1965), *Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*, pp. 598-600.
- Price Index for Machinery and Equipment:  
1870-1950: Index for agricultural machinery from W. Hoffmann (1965), pp. 569-70.
- Price Index for Consumption Goods:  
1870-1950: W. Hoffmann (1965), pp. 598-600.
- Current and Constant Price Value of Investment:  
1870-1950: Series for net investment from W. Hoffmann (1965), pp. 825-28.



Current and Constant Price Value of GDP:

1870-1950: Series for net national product from W. Hoffmann (1965), pp. 825-28.

### Italy

Price Index for Capital Goods:

1870-1950: P. Ercolani (1978), "Documentazione statistica di base," in *Lo Sviluppo Economico in Italia III*, edited by G. Fuà, pp. 434-35.

Price Index for Machinery and Equipment:

1870-1950: O. Vitali (1978), "La stima del valore aggiunto a prezzi costanti per rami di attività," in *Lo Sviluppo Economico in Italia III*, edited by G. Fuà, pp. 511-12.

Price Index for Consumption Goods:

1870-1950: P. Ercolani (1978), pp. 434-35.

Current and Constant Price Value of Investment:

1870-1950: B. R. Mitchell (1992), *IHSE*, pp. 891, 895, 901.

Current and Constant Price Value of GDP:

1870-1950: B. R. Mitchell (1992), *IHSE*, pp. 891, 895, 901.

### Japan

Price Index for Capital Goods:

1870-1940: K. Ohkawa et al. (1967), *Estimates of Long-Term Economic Statistics of Japan since 1868*, Vol. 8, p. 134.

1952: K. Ohkawa et al. (1979), *Patterns of Japanese Economic Development*, p. 389.

Price Index for Machinery and Equipment:

1870-1950: K. Ohkawa et al. (1967), Vol. 8, p. 161.

Price Index for Consumption Goods:

1870-1940: K. Ohkawa et al. (1967), Vol. 6, p. 106.

1952: K. Ohkawa et al. (1979), p. 389.

Current and Constant Price Value of Investment:

1870-1950: B. R. Mitchell (1995), *IHSAAO*, pp. 1002-08.

Current and Constant Price Value of GDP:

1870-1950: B. R. Mitchell (1995), *IHSAAO*, pp. 1002-08.

### Norway

Price Index for Capital Goods:

1870-1930: *Langtidslinjer I Norsk Økonomi* (1966), pp. 142, 148, 150.

1930-1950: *Nasjonalregnskap* (1952), pp. 316-17.

Price Index for Machinery and Equipment:

1870-1930: *Langtidslinjer I Norsk Økonomi* (1966), pp. 142, 148, 150.

1930-1950: *Nasjonalregnskap* (1952), pp. 318-19.

Price Index for Consumption Goods:

1870-1930: Private consumption goods prices from *Langtidslinjer I Norsk Økonomi* (1966), pp. 142, 148, 150.

1930-1950: Private consumption goods prices from *Nasjonalregnskap* (1952), pp. 316-17.

Current and Constant Price Value of Investment:

1870-1950: Mitchell (1992), *IHSE*, pp. 891, 896, 902.

Current and Constant Price Value of GDP:

1870-1950: Mitchell (1992), *IHSE*, pp. 891, 896, 902.

## Sweden

### Price Index for Capital Goods:

1870-1950: Implicit price index from Ö. Johansson (1967), *The Gross Domestic Product of Sweden and its Composition*, pp. 134-37.

### Price Index for Machinery and Equipment:

1870-1950: Implicit price index from Johansson (1967), pp. 134-37.

### Price Index for Consumption Goods:

1870-1950: Implicit price index for total consumption from Johansson (1967), pp. 122-29.

### Current and Constant Price Value of Investment:

1870-1950: Johansson (1967), p. 134-37.

### Current and Constant Price Value of GDP:

1870-1950: Johansson (1967), p. 150-53.

## United Kingdom

### Price Index for Capital Goods:

1870-1920: C. H. Feinstein and S. Pollard (1988), *Studies in Capital Formation in the United Kingdom, 1750-1920*, pp. 470-71.

1920-1950: C. H. Feinstein (1972), *National Income, Expenditure and Output of the United Kingdom, 1855-1965*, Table 61.

### Price Index for Machinery and Equipment:

1870-1920: C. H. Feinstein and S. Pollard (1988), pp. 470-71.

1920-1950: C. H. Feinstein (1972), Table 63.

### Price Index for Consumption Goods:

1870-1950: C. H. Feinstein (1972), Table 61.

### Current and Constant Price Value of Investment:

1870-1950: B. R. Mitchell (1992), *IHSE*, pp. 891, 897, 905.

### Current and Constant Price Value of GDP:

1870-1950: B. R. Mitchell (1992), *IHSE*, pp. 891, 897, 905.

## United States

### Price Index for Capital Goods:

1870-1950: Implicit price index for gross capital formation from S. Kuznets (1961), *Capital in the American Economy*, pp. 572-74. All of his data are reported as five-year moving averages.

### Price Index for Machinery and Equipment:

1870-1950: Implicit price index for gross producers' durables from S. Kuznets (1961), pp. 596-97.

### Price Index for Consumption Goods:

1870-1950: Implicit price index from S. Kuznets (1961), pp. 561-564.

### Current and Constant Price Value of Investment:

1870-1950: S. Kuznets (1961), p. 572.

### Current and Constant Price Value of GDP:

1870-1950: S. Kuznets (1961), p. 561.

**Table 1a: Relative Capital Good Prices 1870-1950 (1900=100)**

	AUS	CAN	DEN	FIN	GER	ITA	JAP	NOR	SWE	UK	US
1870-74	79.08	84.98	88.16	87.70	105.59	100.30	-----	96.35	79.04	100.93	89.33
1875-79	76.90	87.80	84.48	84.06	85.84	103.53	141.99	100.24	82.86	97.06	90.41
1880-84	65.56	89.70	78.02	83.62	78.87	100.79	98.70	91.11	84.44	93.88	93.06
1885-89	61.28	90.22	87.85	94.21	84.97	97.82	118.35	92.61	86.18	90.90	93.20
1890-94	69.51	92.42	89.12	85.05	81.49	94.23	108.27	95.29	83.79	91.39	90.30
1895-99	80.34	97.16	97.77	97.81	86.47	87.02	107.33	96.42	90.64	93.02	95.44
1900-04	86.71	98.09	96.69	95.14	90.91	98.79	93.77	98.04	93.09	94.48	99.26
1905-09	82.80	93.32	98.49	93.93	89.14	98.30	85.87	99.62	91.94	90.72	99.91
1910-14	85.96	94.91	100.84	85.39	85.32	92.00	76.04	95.19	92.86	92.95	98.81
1915-19	107.92	-----	-----	83.78	-----	127.10	94.65	128.65	114.56	92.07	105.34
1920-24	109.10	108.74	108.48	97.63	-----	104.35	89.77	110.50	108.58	83.04	109.85
1925-29	106.91	98.81	98.65	106.16	91.41	94.28	75.89	82.62	100.21	73.35	106.19
1930-34	99.00	98.52	113.09	104.69	76.85	92.85	73.99	83.82	109.07	73.84	118.87
1935-39	107.85	103.82	110.60	118.47	88.62	87.17	79.78	91.26	113.51	78.26	120.01
1940-44	122.78	108.67	84.93	121.46	-----	51.68	85.82	-----	103.89	81.30	121.14
1945-49	142.92	111.05	106.77	131.10	-----	77.73	-----	119.97	104.62	97.30	119.41
1950	133.85	116.05	120.66	148.58	95.45	91.22	87.99	127.09	101.88	100.14	130.57

**Notes:** The figures show changes in the price of capital goods relative to consumption goods over time in each country. These prices are drawn from each country's national accounts. Each series is scaled to equal 100 in 1900.

**Sources:** National accounts sources are cited in the appendix.

**Table 1b: Relative Price of Equipment 1870-1950 (1900=100)**

	CAN	DEN	GER	ITA	JAP	NOR	SWE	UK	US
1870-74	117.17	85.31	105.74	99.37	-----	112.83	118.47	118.74	111.29
1875-79	120.80	69.07	70.25	109.04	216.82	115.90	88.77	122.52	101.95
1880-84	117.79	66.86	65.97	90.69	132.62	99.45	84.24	110.06	96.58
1885-89	104.82	69.65	61.83	84.16	131.66	100.68	81.16	101.66	92.72
1890-94	97.63	72.54	69.15	85.99	120.67	95.52	78.35	99.94	87.06
1895-99	99.11	80.99	71.71	91.38	105.96	95.97	82.25	96.60	92.27
1900-04	93.12	85.42	78.16	95.31	94.78	96.82	83.17	100.37	96.87
1905-09	75.93	82.87	73.07	98.81	86.02	91.30	80.50	97.03	92.40
1910-14	70.76	81.01	67.65	87.85	72.47	86.61	82.71	98.10	94.61
1915-19	-----	-----	-----	126.34	99.41	109.11	129.86	95.29	103.13
1920-24	85.39	105.98	-----	110.37	60.71	89.78	80.77	75.88	101.91
1925-29	70.54	85.74	67.50	93.79	48.53	75.14	63.39	71.16	98.47
1930-34	69.76	104.72	70.69	86.57	53.48	70.88	61.54	70.25	106.35
1935-39	78.00	99.14	66.88	83.59	58.54	76.60	75.14	82.48	112.56
1940-44	80.52	-----	-----	54.93	50.96	-----	73.70	86.98	116.82
1945-49	71.14	112.65	-----	69.75	-----	91.49	70.40	96.91	103.66
1950	75.14	115.28	69.40	78.32	56.73	102.25	71.81	101.46	111.76

**Notes:** The figures show changes in the price of equipment relative to consumption goods over time in each country. These prices are drawn from each country's national accounts. Each series is scaled to equal 100 in 1900. Due to data limitations, Japan's reported figure in the 1950 row is actually for 1952.

**Sources:** National accounts sources are cited in the appendix.

**Table 2a: Relative Capital Goods Prices 1870-1950 (US = 100 in 1950)**

	AUS	CAN	DEN	FIN	GER	ITA	JAP	NOR	SWE	UK	US
1870-74	81.44	84.76	89.82	49.88	94.44	119.03	-----	78.54	94.56	125.34	68.42
1875-79	79.19	87.58	86.08	47.81	76.77	122.86	282.95	81.71	99.13	120.54	69.24
1880-84	67.51	89.48	79.50	47.56	70.54	119.61	196.69	74.27	101.02	116.59	71.27
1885-89	63.10	90.00	89.51	53.58	76.00	116.09	235.85	75.50	103.10	112.89	71.38
1890-94	71.58	92.19	90.80	48.37	72.88	111.82	215.77	77.68	100.24	113.49	69.16
1895-99	82.73	96.92	99.62	55.63	77.34	103.27	213.89	78.60	108.44	115.52	73.09
1900-04	89.30	97.85	98.51	54.11	81.32	117.23	186.87	79.92	111.36	117.34	76.02
1905-09	85.27	93.09	100.35	53.42	79.73	116.65	171.12	81.21	109.99	112.66	76.52
1910-04	88.53	94.68	102.74	48.56	76.31	109.17	151.53	77.60	111.09	115.44	75.68
1915-19	111.13	-----	-----	47.65	-----	150.83	188.62	104.87	137.05	114.34	80.67
1920-24	112.36	108.47	110.53	55.53	-----	123.83	178.90	90.08	129.89	103.13	84.13
1925-29	110.10	98.56	100.52	60.38	81.76	111.88	151.24	67.35	119.88	91.09	81.33
1930-34	101.95	98.28	115.23	59.54	68.74	110.18	147.45	68.33	130.49	91.70	91.04
1935-39	111.07	103.56	112.69	67.38	79.26	103.44	158.98	74.40	135.80	97.19	91.91
1940-44	126.44	108.40	86.54	69.08	-----	61.33	171.01	-----	124.28	100.96	92.77
1945-49	147.18	110.77	108.78	74.56	-----	92.24	-----	97.80	125.16	120.83	91.45
1950	137.84	115.76	122.94	84.50	85.37	108.25	175.34	103.60	121.88	124.37	100.00

**Notes:** The figures show the relative price of capital goods in each country compared to the relative price of capital goods in the United States in 1950. The movement of each series over time is determined by the price series of that country's national accounts. Internationally comparable price data from the Penn World Tables are used to benchmark these national account series relative to the United States in 1950.

**Sources:** Summers, et al., *Penn World Tables Mark 5.6* (1995). National accounts sources are cited in the appendix.

**Table 2b: Relative Price of Equipment 1870-1950 (US = 100 in 1950)**

	CAN	DEN	GER	ITA	JAP	NOR	SWE	UK	US
1870-74	119.38	133.22	184.45	286.90	-----	137.68	242.18	178.92	99.58
1875-79	123.08	107.86	122.55	314.83	717.17	141.42	181.48	184.62	91.23
1880-84	120.01	104.40	115.07	261.85	438.68	121.35	172.20	165.84	86.41
1885-89	106.80	108.77	107.86	243.00	435.48	122.85	165.90	153.19	82.96
1890-94	99.48	113.28	120.62	248.28	399.14	116.55	160.17	150.59	77.90
1895-99	100.98	126.48	125.09	263.83	350.50	117.10	168.13	145.55	82.56
1900-04	94.88	133.39	136.34	275.18	313.49	118.14	170.03	151.24	86.68
1905-09	77.36	129.41	127.46	285.29	284.53	111.40	164.57	146.20	82.67
1910-14	72.09	126.50	118.01	253.65	239.69	105.68	169.08	147.83	84.65
1915-19	-----	-----	-----	364.76	328.83	133.14	265.46	143.59	92.28
1920-24	87.01	165.50	-----	318.67	200.82	109.55	165.10	114.35	91.19
1925-29	71.88	133.90	117.75	270.78	160.53	91.69	129.59	107.23	88.11
1930-34	71.08	163.53	123.31	249.94	176.88	86.48	125.80	105.86	95.16
1935-39	79.47	154.83	116.67	241.35	193.63	93.47	153.60	124.28	100.71
1940-44	82.04	-----	-----	158.61	-----	-----	150.66	131.07	104.52
1945-49	72.49	175.91	-----	201.38	-----	111.63	143.92	146.03	92.75
1950	76.56	180.02	121.06	226.12	189.81	124.77	146.79	152.88	100.00

**Notes:** The Penn World Tables do not include separate price information for equipment. The 1950 figures are derived using the benchmark for producers durables and consumption prices from the 1980 report of the U.N.'s International Comparison Project (ICP) in combination with the OECD national accounts in current and constant prices from 1980 back to 1950. Due to data limitations, Japan's reported figure for 1950 is actually calculated for 1952 (relative to U.S. in 1950). Sweden did not participate in the ICP in 1980, and so its 1950 relative price of equipment is estimated by multiplying Norway's figure by the ratio of the relative price of investment goods in Sweden and Norway in 1950 (reported in Table 2a).

**Sources:** United Nations, *World Comparison of Purchasing Power and Real Product for 1980* (Phase IV of the International Comparison Project, Part 2). National accounts sources are cited in the appendix.

**Table 3: Dispersion of the Relative Price of Capital Goods 1875-1950  
(Coefficient of Variation = CV)**

	Capital Goods CV of Full Sample	Capital Goods CV w/o Japan	Equipment CV of Full Sample	Equipment CV w/o Japan
1875	0.60(11)	0.26(10)	0.88 (9)	0.45 (8)
1880	0.35(11)	0.26 (10)	0.56 (9)	0.35 (8)
1885	0.45 (11)	0.35 (10)	0.52 (9)	0.36 (8)
1890	0.41 (11)	0.22 (10)	0.56 (9)	0.33 (8)
1895	0.46 (11)	0.19 (10)	0.56 (9)	0.37 (8)
1900	0.33 (11)	0.21 (10)	0.43 (9)	0.37 (8)
1905	0.30 (11)	0.19 (10)	0.48 (9)	0.40 (8)
1910	0.29 (11)	0.21 (10)	0.44 (9)	0.42 (8)
1915	0.31(9)	0.23 (8)	0.54 (7)	0.52 (6)
1920	0.31 (9)	0.23 (8)	0.40 (7)	0.43 (6)
1925	0.25 (11)	0.21 (10)	0.45 (9)	0.48 (8)
1930	0.27 (11)	0.25 (10)	0.38 (9)	0.40 (8)
1935	0.23 (11)	0.20 (10)	0.36 (9)	0.38 (8)
1940	0.25 (9)	0.17 (8)	0.32 (6)	0.36 (5)
1945	0.43 (8)	0.43 (7)	0.24 (5)	0.24 (5)
1950	0.21 (11)	0.15 (10)	0.31 (8)	0.31 (8)
1955	0.20 (11)	0.16 (10)	---	---
1960	0.22 (11)	0.16 (10)	---	---
1965	0.17 (11)	0.16 (10)	---	---
1970	0.12 (11)	0.12 (10)	---	---
1975	0.13 (11)	0.13 (10)	---	---
1980	0.11 (11)	0.11 (10)	0.19 (9)	0.18 (8)
1985	0.09 (11)	0.09 (10)	---	---
1990	0.10 (11)	0.10 (10)	---	---

**Notes:** The full sample includes Australia, Canada, Denmark, Finland, Germany, Italy, Japan, Norway, Sweden, the United Kingdom, and the United States. Equipment price series for Australia and Finland are not available for the 1870 to 1950 period. The Penn World Tables do not include separate price information for equipment, and so a 1950 benchmark for relative equipment prices was constructed by using the 1980 ICP data for producer durables and OECD national accounts price series. See the text and appendix for details. Sweden and Australia did not participate in the 1980 ICP and are not included in the equipment CV calculation for that year.

**Sources:** Relative price of investment goods is from the Penn World Tables for 1950 to 1990. Relative price of equipment in 1980 is from World Comparisons of Purchasing Power and Real Product for 1980 (Phase IV of ICP, Part 2: Detailed Results for 60 Countries). The 1950 figures from the PWT are used to benchmark relative price series from each country's national accounts. See the appendix for national accounts sources.

**Table 4a: Percentage Changes in the User Cost of Capital Over Time, 1870-1949**

	AUS	CAN	DEN	FIN	GER	ITA	JAP	NOR	SWE	UK	US
1870/74-1945/49											
% $\Delta(i+\delta-\Delta Pk/Pk)$	2.16	-109.24	-----	-----	-----	-----	-----	-16.63	34.81	-32.64	-126.7
% $\Delta Pk$	59.18	26.76	19.15	40.20	-10.09	-25.50	-----	21.92	28.03	-3.66	29.02
Total	61.34	-82.48	-----	-----	-----	-----	-----	5.29	62.84	-36.30	-97.68
1880/84-1945/49											
% $\Delta(i+\delta-\Delta Pk/Pk)$	-28.68	-106.27	-----	-----	-28.46	-88.55	-----	-104.46	-39.94	-68.01	-109.1
% $\Delta Pk$	77.94	21.34	31.36	44.96	19.09	-25.98	-11.49	27.52	21.42	3.58	24.93
Total	49.26	-84.93	-----	-----	-9.37	-114.53	-----	-76.94	-18.52	-64.43	-84.17
1870/74-1910/14											
% $\Delta(i+\delta-\Delta Pk/Pk)$	-36.81	-184.67	-----	-----	-----	-----	-----	10.07	-3.14	-14.79	-65.55
% $\Delta Pk$	8.35	11.06	13.44	-2.67	-21.31	-8.64	-----	-1.22	16.11	-8.23	10.09
Total	-28.46	-173.61	-----	-----	-----	-----	-----	8.85	12.97	-23.02	-55.46
1880/84-1910/14											
% $\Delta(i+\delta-\Delta Pk/Pk)$	-67.66	-181.71	-----	-----	-25.52	10.77	-----	-77.76	-77.90	-50.15	-47.96
% $\Delta Pk$	27.10	5.64	25.65	2.09	7.87	-9.13	-26.08	4.38	9.50	-0.99	6.00
Total	-40.56	-176.07	-----	-----	-17.65	1.64	-----	-73.38	-68.4	-51.14	41.96
1910/14-1945/49											
% $\Delta(i+\delta-\Delta Pk/Pk)$	38.98	75.44	-----	-----	-2.94	-99.32	-----	-26.69	37.95	-17.86	-61.13
% $\Delta Pk$	50.84	15.70	5.71	42.87	11.22	-16.85	14.60	23.14	11.93	4.57	18.93
Total	89.82	91.14	-----	-----	8.28	-116.17	-----	-3.55	49.88	-13.29	-42.20

**Notes:** Depreciation rate is assumed to be 0.10 in all countries and all periods. For the 1945/49 figures, Germany's change in  $(i+\delta-\Delta Pk/Pk)$  is calculated using 1950/54 whereas Italy's is calculated using 1950. Germany and Japan's changes in  $Pk$  and  $Pm$  are calculated using 1950's figures. Percentage changes are calculated as log changes.

**Sources:** Unpublished interest rate data were supplied by Michael Bordo and Alan Taylor. Capital goods relative price changes are from Table 1a.



**Table 4b: Percentage Differences Across Countries in the User Cost of Capital  
(expressed relative to the United States in same years)**

	AUS	CAN	DEN	FIN	GER	ITA	JAP	NOR	SWE	UK
1870/74										
% diff in $(i+\delta-\Delta P_k/P_k)$	-49.54	-23.61	-----	-----	-----	-----	-----	-102.60	-85.82	-57.64
% difference in $P_k$	17.43	21.43	27.22	-31.60	-32.24	55.38	-----	13.81	32.37	60.54
Total	-32.11	-2.18	-----	-----	-----	-----	-----	-88.79	-53.45	2.90
1880/84										
% diff in $(i+\delta-\Delta P_k/P_k)$	-1.10	-8.98	-----	-----	-8.57	-68.05	-----	2.83	6.52	-4.68
% difference in $P_k$	-5.42	22.76	10.93	-40.45	-1.03	51.77	101.51	4.12	34.89	49.22
Total	-6.52	13.78	-----	-----	-9.60	-16.28	-----	6.95	41.41	44.54
1910/14										
% diff in $(i+\delta-\Delta P_k/P_k)$	-20.80	-142.73	-----	-----	13.88	-9.32	-----	-26.98	-23.41	-6.87
% difference in $P_k$	15.68	22.40	30.58	-44.36	0.84	36.64	69.43	2.50	38.39	42.22
Total	-5.12	-120.33	-----	-----	14.72	27.32	-----	-24.48	14.98	35.35
1945/49										
% diff in $(i+\delta-\Delta P_k/P_k)$	79.30	-6.17	-----	-----	10.86	-92.02	-----	7.45	75.67	36.39
% difference in $P_k$	47.59	19.17	17.36	-20.42	-15.82	0.86	56.16	6.71	31.38	27.86
Total	126.89	13.00	-----	-----	-4.96	-91.16	-----	14.16	107.05	64.25

**Notes:** Depreciation rate is assumed to be 0.10 in all countries and all periods. For the "1945/49" figures, Germany's  $(i+\delta-\Delta P_k/P_k)$  differential is calculated using 1950/54 relative to the U.S. for the same period whereas Italy's is calculated using 1950. Germany and Japan's  $P_k$  and  $P_m$  differentials are calculated using 1950's figure relative to the U.S. in that year. Since all country's are being compared to the U.S., there is no separate column for the U.S.

**Sources:** Unpublished interest rate data were supplied by Michael Bordo and Alan Taylor. Relative prices of capital goods are from Table 2a.

**Table 5: Current Price Investment Shares and Capital Goods Prices 1870-1950**  
**(Dependent Variable: average gross investment share in GDP over period)**

	(1)	(2)	(3)	(4)	(5)	(6)
Capital Goods Price	-0.0003046 (1.47)	-----	-0.001141 (3.69)	-----	-0.001098 (3.48)	-----
Equipment Price	-----	-0.0004233 (3.66)	-----	-0.0004869 (3.10)	-----	-0.0004766 (3.51)
GDP per capita	-0.008581 (0.65)	-0.06073 (3.22)	-0.02025 (1.52)	-0.05522 (2.49)	-0.01965 (1.56)	-0.05386 (2.49)
Real Interest Rate	-----	-----	-0.1688 (0.86)	-0.1418 (0.60)	-----	-----
1885-1900	0.01227 (0.79)	0.01644 (1.02)	0.009612 (0.50)	0.006584 (0.29)	0.007568 (0.44)	0.005340 (0.27)
1900-1913	0.03993 (2.22)	0.07052 (3.86)	0.05023 (2.29)	0.06218 (2.31)	0.04671 (2.38)	0.05934 (2.54)
1913-1929	0.03819 (2.08)	0.06287 (4.00)	0.04019 (2.22)	0.05351 (2.19)	0.04230 (2.53)	0.05330 (2.47)
1929-1939	0.02756 (1.40)	0.05467 (2.46)	0.03525 (1.24)	0.04737 (1.26)	0.02509 (1.10)	0.03951 (1.25)
1939-1950	0.06281 (2.11)	0.1072 (3.15)	0.04172 (1.57)	0.05842 (1.58)	0.05070 (2.09)	0.06718 (2.02)
Constant	0.2217 (2.05)	0.6533 (4.23)	0.4021 (3.71)	0.6314 (3.62)	0.3864 (3.89)	0.6136 (3.65)
N	63	51	43	37	43	37
R <sup>2</sup>	0.16	0.34	0.32	0.33	0.30	0.32
Mean	0.1537	0.1571	0.1504	0.1510	0.1504	0.1510
Dependent Variable						

**Notes:** Capital goods price and real interest rate figures are those pertaining at the beginning of each period. The real interest rate is defined as the difference between the nominal rate of interest on long-term assets and the inflation rate.

**Sources:** Current price investment rates are calculated from investment and GDP figures available in the various volumes of Mitchell. See the appendix for details. Capital goods price data are described in the text. The interest rate data were shared with us by Michael Bordo and Alan Taylor.

**Table 6: Constant Price Investment Shares and Capital Goods Prices 1870-1950**  
**(Dependent Variable: average gross investment share in GDP over period)**

	(1)	(2)	(3)	(4)	(5)	(6)
Capital Goods Price	-0.001233 (6.03)	-----	-0.001844 (3.59)	-----	-0.001802 (3.50)	-----
Equipment Price	-----	-0.0005184 (3.20)	-----	-0.0005361 (2.27)	-----	-0.0005272 (2.32)
GDP per capita	0.005147 (0.30)	-0.02384 (0.73)	0.008906 (0.33)	-0.03812 (0.83)	0.009494 (0.36)	-0.03695 (0.83)
Real Interest Rate	-----	-----	-0.1646 (0.59)	-0.1232 (0.30)	-----	-----
1885-1900	0.02192 (0.92)	0.01199 (0.42)	0.02703 (0.77)	0.02209 (0.49)	0.02504 (0.76)	0.02101 (0.51)
1900-1913	0.03312 (1.43)	0.04463 (1.43)	0.04637 (1.33)	0.05548 (1.11)	0.04293 (1.32)	0.05301 (1.17)
1913-1929	0.01549 (0.66)	0.01676 (0.55)	0.01204 (0.34)	0.03060 (0.61)	0.01410 (0.43)	0.03041 (0.64)
1929-1939	0.003668 (0.14)	0.003372 (0.10)	0.005974 (0.13)	0.02644 (0.40)	-0.003933 (0.11)	0.01962 (0.36)
1939-1950	0.03948 (1.27)	0.04272 (0.95)	0.01957 (0.39)	0.03590 (0.53)	0.02832 (0.64)	0.04352 (0.69)
Constant	0.2373 (1.79)	0.4194 (1.59)	0.2707 (1.21)	0.5316 (1.48)	0.2555 (1.16)	0.5162 (1.48)
N	63	51	43	37	43	37
R <sup>2</sup>	0.36	0.23	0.33	0.17	0.32	0.16
Mean	0.1773	0.1703	0.1774	0.1736	0.1774	0.1736
Dependent Variable						

**Notes:** The constant price investment series are calculated by taking the ratio of each country's constant price investment and GDP series, and then benchmarking this series to that implied by the Penn World Tables in 1950.  
**Sources:** See the appendix.

**Table 7: Growth and Investment Good Prices**  
**(Dependent Variable: average annual GDP per capita growth rate)**

	(1)	(2)
Relative Price Capital Goods	-0.0000576 (0.87)	-----
Relative Price Equipment	-----	-0.0000543 (2.31)
Initial GDP per capita	-0.005242 (1.51)	-0.007844 (1.29)
1885-1900	0.006165 (1.98)	0.007638 (3.06)
1900-1913	0.01064 (3.56)	0.01194 (3.40)
1913-1929	0.005121 (1.67)	0.006849 (1.73)
1929-1939	0.01006 (2.32)	0.009879 (1.58)
1939-1950	0.01085 (1.47)	0.009870 (0.81)
Constant	0.05475 (2.22)	0.07786 (1.62)
N	64	52
R <sup>2</sup>	.10	0.11
Mean Dependent Variable	0.01459	0.01494

**Notes:** See Table 5 notes.

**Sources:** Growth rates over each period and initial GDP per capita are from Maddison (1995).

**Table 8: Explaining Relative Prices**  
**(Dependent Variable: Natural log of relative price of capital goods or equipment)**

	-----Capital Goods-----			-----Equipment-----		
	(1)	(2)	(3)	(4)	(5)	(6)
ln GDP per capita	-0.07751 (0.62)	-0.2003 (1.94)	-0.1003 (0.83)	-0.6040 (4.97)	-0.7593 (6.60)	-0.8614 (5.02)
ln total GDP	-----	0.09033 (3.23)	0.03127 (1.25)	-----	0.1047 (3.15)	0.1594 (4.36)
Tariff	-----	-----	-0.7648 (2.12)	-----	-----	-2.556 (4.51)
1885-1900	0.1088 (0.72)	0.07937 (0.61)	0.02381 (0.21)	0.03661 (0.21)	0.00661 (0.05)	-0.07265 (0.61)
1900-1913	0.1869 (1.58)	0.1495 (1.38)	0.1392 (1.56)	0.3086 (1.76)	0.2758 (1.82)	0.1595 (1.21)
1913-1929	0.1479 (1.00)	0.1026 (0.79)	0.06249 (0.58)	0.2481 (1.36)	0.2099 (1.30)	0.05756 (0.39)
1929-1939	0.1891 (1.24)	0.1359 (1.04)	0.06958 (0.54)	0.2629 (1.35)	0.2203 (1.23)	0.09342 (0.56)
1939-1950	0.3049 (1.92)	0.2583 (1.89)	0.2143 (1.68)	0.4750 (2.33)	0.4410 (2.35)	0.4062 (2.21)
Constant	4.994 (5.23)	5.072 (6.63)	5.043 (6.11)	9.531 (10.29)	9.683 (11.82)	10.34 (9.52)
N	64	64	52	52	52	46
R <sup>2</sup>	0.07	0.24	0.19	0.38	0.49	0.56
Mean Dependent Variable	4.533	4.533	4.543	4.944	4.944	4.881

**Sources:** The text and appendix describe the construction of the price series. Initial GDP per capita and total GDP is from Maddison (1995). The tariff data are used in Collins, O'Rourke, and Williamson (1997).

**Table 9: Price of Capital Goods Relative to Wages 1870-1950 (1900=100)**

	AUS	CAN	DEN	GER	ITA	JAP	NOR	SWE	UK	US
1870-74	94.28	114.15	199.55	170.31	163.23	-----	181.18	131.44	131.98	123.99
1875-79	86.48	111.72	156.16	118.59	139.13	76.29	154.18	132.14	113.61	122.28
1880-84	80.51	111.05	135.75	117.10	118.80	104.89	149.58	124.72	108.96	115.49
1885-89	74.96	103.49	130.09	105.65	105.83	142.58	127.96	110.70	99.81	101.55
1890-94	72.15	95.51	123.57	89.28	100.05	127.15	109.26	99.35	95.53	94.88
1895-99	76.57	99.63	103.93	88.90	88.64	113.88	95.72	95.78	90.80	94.99
1900-04	96.39	95.22	93.48	87.70	91.98	91.10	93.07	91.49	94.92	97.30
1905-09	87.81	81.72	87.24	74.83	81.64	81.99	84.27	83.81	92.71	97.17
1910-14	89.35	86.60	84.19	64.93	70.91	70.14	81.56	77.83	97.85	100.57
1915-19	121.57	106.71	-----	-----	107.35	84.57	107.31	103.07	108.64	96.81
1920-24	101.68	93.71	61.44	-----	72.01	52.84	77.27	67.55	85.47	81.00
1925-29	89.67	81.31	53.24	57.04	68.24	40.87	57.39	58.24	76.56	72.26
1930-34	86.59	72.09	51.28	47.76	58.62	44.64	52.10	51.44	72.71	72.72
1935-39	91.41	71.20	54.62	59.74	64.36	55.42	54.10	53.84	74.81	57.43
1940-44	101.53	69.57	53.58	-----	52.52	-----	-----	51.52	82.87	51.02
1945-49	110.57	62.27	52.95	-----	69.55	-----	69.50	43.47	95.02	46.80
1950	98.24	63.15	54.01	67.20	51.70	48.88	69.67	38.97	94.35	47.73

**Notes:** Figures are quinquennial averages of the ratio of the capital goods price index to a nominal wage index. The Japan 1950 figure is actually for 1952. We do not have wage data for Finland.

**Sources:** The capital goods price data are documented in the appendix. Nominal wage rate data are typically unskilled, male, daily or weekly wage rates in the urban building trades. They are taken from Williamson (1995 revised) with the following exceptions: Sweden (1870-1913) nominal wages are from Mitchell (1998a); Australia (1870 to 1950) wages are from Mitchell (1998b); and for Germany (1870-1940), wages are for unskilled building laborers from Bry (1960) and in 1950 are from the International Labour Office *Yearbook of Labour Statistics* (1953).

**Table 10: Price of Capital Goods Relative to Wages 1870-1950 (US=100 in 1950)**

	AUS	CAN	DEN	GER	ITA	NOR	SWE	UK	US
1870-74	338.76	430.80	851.72	668.19	875.21	487.62	744.11	370.31	259.77
1875-79	310.73	421.61	666.49	465.27	745.96	414.98	748.09	318.78	256.18
1880-84	289.28	419.11	579.40	459.43	636.98	402.60	706.07	305.72	241.95
1885-89	269.34	390.55	555.25	414.50	567.45	344.40	626.71	280.06	212.76
1890-94	259.24	360.47	527.39	350.27	536.42	294.07	562.47	268.05	198.79
1895-99	275.14	376.01	443.60	348.79	475.29	257.61	542.26	254.77	199.02
1900-04	346.36	359.35	399.00	344.08	493.19	250.50	517.94	266.33	203.85
1905-09	315.53	308.40	372.36	293.59	437.75	226.81	474.49	260.12	203.58
1910-14	321.05	326.82	359.34	254.75	380.21	219.51	440.63	274.54	210.70
1915-19	436.83	402.71	-----	-----	575.56	288.82	583.53	304.82	202.82
1920-24	365.35	353.65	262.22	-----	386.12	207.98	382.44	239.82	169.70
1925-29	322.21	306.88	227.23	223.77	365.85	154.45	329.71	214.83	151.38
1930-34	311.12	272.05	218.86	187.36	314.31	140.23	291.23	204.02	152.35
1935-39	328.45	268.71	233.12	234.37	345.06	145.60	304.80	209.91	120.32
1940-44	364.84	262.57	228.67	-----	281.58	-----	291.67	232.52	106.88
1945-49	397.29	235.01	225.99	-----	372.89	186.57	246.09	266.61	98.04
1950	352.98	238.34	230.53	263.65	277.21	187.50	220.64	266.49	100.00

**Notes:** The figures show the price of capital goods relative to wages in each country compared to the relative price in the United States in 1950. The 1950 benchmark is established by taking the ratio of (Pk/Pc) from the Penn World Tables over the internationally comparable real wage data of Williamson (1995 revised). Movement over time in each series is determined by changes in the capital goods price index relative to a nominal wage index as in Table 9. We do not have wage data for Finland, and we do not have a benchmark for Japan in 1950.

**Sources:** The capital goods price data are described in the appendix. The nominal wage rate series are extracted from data underlying Williamson (1995 revised). (See "sources" to Table 9.) The benchmark requires data from Summers, et al. *Penn World Tables Mark 5.6* (1995).

**Table 11: Summary Statistics of Regression Variables**

Regression and Variables	N	Mean	Standard Deviation
<b>Growth &amp; Pk</b>			
Growth	64	0.1459	0.01127
Ln Initial GDP per Capita	64	7.967	0.5143
Initial Pk	64	96.96	29.08
<b>Growth &amp; Pm</b>			
Growth	52	0.01494	0.01158
Ln Initial GDP per Capita	52	7.960	0.5015
Initial Pm	52	152.5	67.26
<b>Investment &amp; Pk</b>			
Current Price Inv. Share	62	0.1773	0.06152
Constant Price Inv. Share	62	0.1537	0.04663
Ln Initial GDP per Capita	62	7.962	0.5172
Initial Pk	62	97.26	29.22
<b>Investment &amp; Pm</b>			
Current Price Inv. Share	51	0.1703	0.06569
Constant Price Inv. Share	51	0.1571	0.05063
Ln Initial GDP per Capita	51	7.954	0.5047
Initial Pm	51	153.0	67.79
<b>Explaining Pk</b>			
Ln Initial Pk	64	4.533	0.2898
Ln Initial GDP per Capita	64	7.967	0.5143
Ln Total GDP	64	10.36	1.539
Tariff	52	0.1304	0.07697
<b>Explaining Pm</b>			
Ln Initial Pm	52	4.944	0.4018
Ln Initial GDP per Capita	52	7.960	0.5015
Ln Total GDP	52	10.64	1.523
Tariff	46	0.1232	0.07472