1.   Problems in analyzing economic development[1]

1.   INTRODUCTION

Why are some countries rich and others poor? This is has been one of the grand questions in economic and historical research over the last five decades. The question was explicitly asked when many former colonies became independent after World War II (Easterlin 2001). These newly independent countries tried to develop policies that were intended to promote an economic development that would bring them at par with the Western countries. With this in mind, it was not more than natural that researchers started a quest for factors of economic growth. However, the routes they were taking depended strongly on their own scientific background. Economists started to work on growth theory (see for example Solow 1956; Swann 1956) which resulted in quantifiable models from which policy measures could be distilled. Yet, an important drawback of their models was that, in the absence of increasingly improving technology, economic growth should tend to zero. As economic growth did not tend toward zero, this means that technological development had to be present which, however, could not be measured directly. Despite this deficiency, these models were empirically used in growth accounting exercises in which economic growth was divided in several factors, most notably labour and physical capital. The residual, Total Factor Productivity (TFP), was interpreted as the growth of efficiency (containing among others the effect of technology) causing long-run GDP growth (examples are Denison 1962; Mankiw, Romer, and Weil 1992).

These growth accounting analyses were often done for a set of heterogeneous countries for which they calculated the effect of some variables, like physical capital, the labour force, natural resources, and TFP, on economic growth. As a consequence, (institutional) differences among countries could have a serious impact on the estimated parameters. For example, it is hardly imaginable that capital accumulation was equally efficient in Sudan as in the USA. This may lead to different coefficients. However, cross-country regressions assume the same coefficients among countries. This led other economists to put more emphasis on cross-country differences. A famous example is Kuznets (1966) who tried to quantitatively compare the economic development of several developed (and developing) countries. Yet, his analysis remained largely confined to within-country development. His main conclusion was that there was a shift from unskilled labour to (skilled)

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[1] This chapter is intended as an introduction to the topic of human capital and growth and is in no way intended to provide a comprehensive overview of Solowian growth, factor accumulation, or other research.

blue-collar and, especially, white-collar employees. This went hand in hand with a shift from agriculture to industry and services. This development was by some growth accounting economists translated in a shift in the importance of the factors of production for economic growth. For example, Abramovitz (1993), argued that in the USA the importance of physical capital for economic growth declined in favour of TFP in the mid-nineteenth century. Consequently, although scholars were aware of the importance of cross-country differences in economic growth, it was not often accounted for in empirical research. This was largely caused by lack of data, especially for developing countries.

This situation changed in the 1960s when scholars stopped seeing development solely in terms of physical capital and GDP. This increased the importance that was placed on factors as consumption, life expectancy, health, and human capital (see for example Schultz 1961; Seers 1969). Side by side with the broadening interpretation of 'development', also more data became available. It had already been acknowledged in the 1940s and 1950s that the availability of more internationally comparable data was needed. Therefore, international organisations such as the International Monetary Fund (IMF), the International Labour Organization (ILO), and the United Nations Economic and Social Committee (UNESCO) started to collect data on their member states on a large scale. It was a matter of time before these data became available in more or less coherent datasets. The most famous example is the Heston-Summers dataset, which consists of a large set of national time series on aspects such as GDP, physical capital, interest rates, and population.

The situation in the 1980s was thus that all ingredients were available to move up the growth analysis ladder: a growth theory that explained everything except long-run growth, the awareness that it takes more than just physical capital to have economic growth, and the increased availability of data to facilitate empirical analysis. This made it possible to bring human capital in growth theory with the view to endogenise economic growth: long-run growth is determined *within* the model rather than being exogenously determined as in the neo-classical Solow growth model.

In this chapter, following the path from growth accounting with solely physical capital, to the inclusion of social indicators, and to the new growth theories, we will try to determine to what extent these methods can explain the causes of long-run growth. To this end, we start in section 2 by outlining the geographical and time scope of our research. Then, we move on in section 3 to a brief description of growth accounting. In section 4, we also look at other factors, besides physical capital, influencing GDP. Here we extend our view on economic growth by including social factors such as literacy and life expectancy. Combining

physical capital and the social factors, we arrive at a brief description of the new growth theories in section 5. This brief tour through the recent history of development economics once more confirms the importance of country-specific research into human capital as an important factor in economic growth. In section 6 this results in the main question: to what extent recent development economics can explain the economic success and failure of countries.

2.   GEOGRAPHICAL AND TIME SCOPE OF THE STUDY

As outlined in the introduction, it is important that the analysis why some countries experience strong economic growth while others do not, has both country-specific and quantitative components. The quantitative aspects are well treated in the many available cross-country growth analyses. These generally analyze economic growth over one or two decades for a large sample of countries. However, we will also focus on the country-specific aspects which require a historical analysis of the growth path and the underlying causes of growth in the different countries. As this sort of analysis takes more variables into account and stretches over a longer time, it requires us to set limits to our study both in time and place.

Our focus will be on India, Indonesia and Japan in the twentieth century. This is the period when the largest divergence in income took place. Or, to speak with Pritchett (1997, 9): 'Divergence, Big Time'. In addition, data limitations make it often hard to go further back in time than the late nineteenth century. The choice of these Asian countries is, first, because all three took over exogenous educational institutions. This could be either by adopting foreign technology or by creating a new education system. They thus represent the small (technology) or the broad (technology, capital, social factors) vision on economic development. Second, where Japan is considered a successful developer, India and Indonesia lagged behind. Did these (exogenous) factors have a different effect in Japan than in India and Indonesia? Indeed, a third reason to choose these three countries is that the educational institutional development, even in the latter two developing countries, was different, which might explain a part of the economic divergence. Fourth, in those studies stressing the importance of physical (and human) capital accumulation as well as the studies pointing at the importance of technology for economic growth, the Asian countries are often cited as proof. Therefore, a more historically oriented study in the factors of economic growth might provide alternative insights in the development of these countries.

3.   FACTOR ACCUMULATION AND ECONOMIC GROWTH

Based on the initial model of Solow (1956) and Swan (1956), growth accounting analyses became increasingly popular from the 1960s onwards. Even after the construction of the new growth theories it is still used extensively today due to its relative simplicity. Initially mainly physical capital was inserted to obtain the residual, TFP, which was an indication of all factors causing long-run growth. Later, additional variables were inserted. Yet, the basic equation was, and is, with physical capital.

Generally, this literature decomposes economic growth in the effect of physical capital (K) and a residual, the Total Factor Productivity (*TFP*). This is often done in per capita or per labourer terms where economic growth ($\dot{y}/y$) is decomposed in the growth of physical capital ($\dot{k}/k$) and the growth of *TFP*. A factor share of each factor of production is determined, which is often set at 0.3 for physical capital. The residual ($\hat{g}$) is interpreted as the growth of TFP. We then arrive, under the assumption of constant returns to scale, at the equation:

$$\hat{g} = \dot{y}/y - s_K\left(\dot{k}/k\right) \qquad\qquad (1.1)$$

Equation (1.1) says that the growth of TFP, $\hat{g}$, is equal to the growth of per capita/labourer GDP minus the factor share of physical capital multiplied by the growth of per capita/ (or per labourer) physical capital.

Although many studies have used growth accounting for the period after World War II[2], this method is much less applied to earlier periods. For India, however, Mukerjee (1973) did a growth accounting exercise for the period prior to 1947. This was based on earlier GDP estimates which since then have considerably been revised resulting in an overestimate of the GDP growth rates. Using an updated series, Sivisubramonian (2000, 484) shows that TFP growth in the first half of the twentieth century explained about 56% of GDP growth. For Indonesia, even less data are available. However, based on our approximation of the physical capital stock (see appendix A.2.), we can carry out a growth accounting exercise for the period 1900-1940 (see table 1.1). Using GDP and gross fixed non-residential capital stock per labourer as inputs (the share of physical capital is set at 0.3), we arrive at a share of TFP growth in GDP growth of around 24%. This indicates that in the first half of the twentieth century Indonesia experienced mainly growth through physical capital accumulation. In Japan pre-World War II data are available from Hayami and Ogasawara (1999). They find TFP

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[2] See for example Ikemoto (1986), and Young (1995) on several Asian economies.

Table 1.1: Per labourer growth accounting exercise for India, Indonesia, and Japan 1900-2000

		Literature				Our estimates			
		Per labourer growth *GDP*	Per labourer Growth *K*	Share *K* in per labourer *GDP* growth	Share *TFP* in per labourer *GDP* growth	Per labourer growth *GDP*	Per labourer Growth *K*	Share *K* in per labourer *GDP* growth	Share *TFP* in per labourer *GDP* growth
1900-1940	India	0.92%*	1.98%*	41%*	56%*	0.6%	1.0%	47.8%	52.2%
	Indonesia	n.a.	n.a.	n.a.	n.a.	1.2%	3.1%	76.0%	24.0%
	Japan	2.57%**	3.26%**	56%**	44%**	2.8%	3.7%	39.7%	60.3%
1950-2000	India	2.92%***	1.62%***	22%***	78%***	2.6%	3.7%	43.3%	56.7%
	Indonesia	4.12%***	2.88%***	28%***	72%***	3.0%	4.1%	40.8%	59.2%
	Japan	5.97%**	7.95%**	43%***	57%**	4.8%	6.0%	37.9%	62.1%

* Not in per capita terms, the share of L in GDP growth is 33%
** Private gross non-primary product.
*** 1960-1992.
Note: The factor share of physical capital is set at 0.3.
Source: India: Sivisubramonian (2000, 484) and Bosworth *et al.* (1995); Indonesia: Bosworth *et al.* (1995); Japan: Hayami and Ogasawara (1999, 9). The remaining estimates are on the basis of the data in appendix A.2.

growth to explain 44% of GDP growth.

Based on the estimates from the literature and our own estimates in table 1.1, we may draw two tentative conclusions. First, in confirmation of the work of Abramovitz (1993) and Hayami and Ogasawara (1999), we find that the share of TFP growth in economic growth appears to increase over time.[3] Although this is true for all estimates in table 1.1, the increase in India and Japan was much smaller than in Indonesia. Second, in the second half of the century the differences in the effect of TFP growth on economic growth are much more equal. Indeed, our estimates show that Indonesia, with a share of TFP growth in GDP growth of only 24% until 1940, came with 59% at par with Japan and India after World War II.

The main implication is thus that physical capital growth declined in importance to TFP growth in explaining economic growth. However, it remains unclear what TFP is. Should we interpret it as technological growth as is often done in the neo-classical Solow model or in some branches of the new growth theories? Or should we interpret it as the effect of human capital accumulation as is argued by some other branches of the new growth theories?

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[3] This differs from the results in the literature (see table 1.1). The figures for India from Sivasubramonian give a larger share of TFP growth. However, he included labour in TFP, thus artificially increasing the share of TFP growth.

4.   ECONOMIC DEVELOPMENT: A CHANGING FOCUS

4.1 Introduction

The large impact of TFP growth on economic growth (on average 56.5%) found in the previous section provides a sign that there were also other factors, besides physical capital, which were important for economic growth. However, because TFP growth is calculated as a residual, it is unclear which factors are captured by TFP growth. Whether this was technology, as was often assumed, or whatever other factor, could not be decided based on this evidence. This was less a problem in early development economics when development was looked upon as (lack of) physical capital accumulation (see for example Lewis 1955). As physical capital accumulation was inserted in the growth accounting exercise, the TFP growth could simply be interpreted as technological growth. Yet, with the rising importance of other, social, indicators such as health, literacy, and human capital, the growth of TFP could reflect the growth of these social indicators as well.

4.2 A classic view: GDP and physical capital

On the basis of per capita GDP data provided by Maddison (2003), we may conclude that the

Figure 1.1

Logarithm of per capita GDP in Japan, India, Indonesia, and the Asian average in 1990 International USD, converted at PPP, 1870-2000
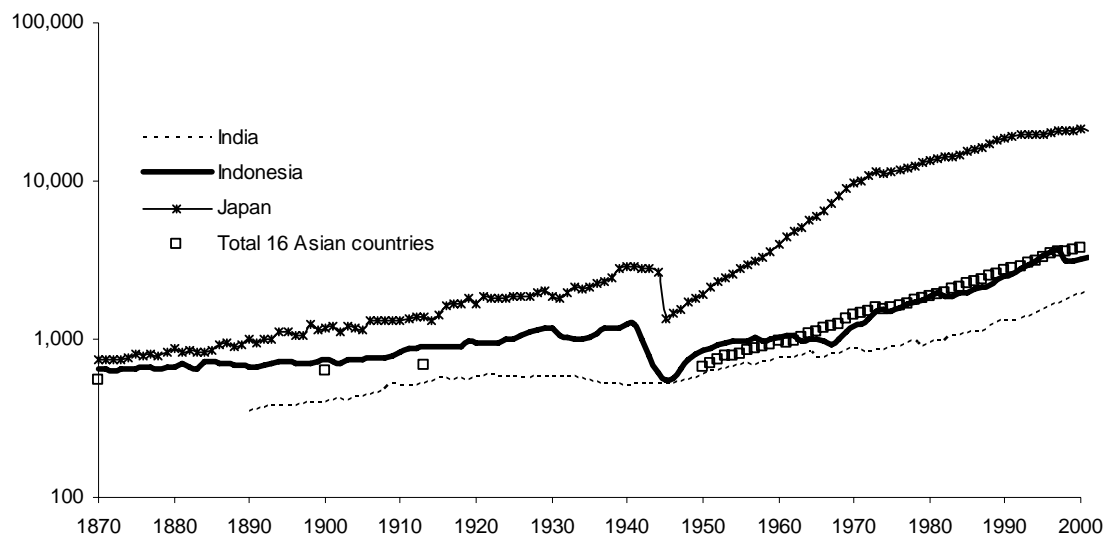
*Note:* the Indian GDP is for the Indian Union only (thus excluding Pakistan and Bangladesh)

Source: appendix A.2 and Maddison (2003)

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levels of per capita GDP were about equal in India, Indonesia, and Japan around 1800. However, in the course of the nineteenth century they started to diverge. In 1890 Japan was already clearly ahead, having a gap in per capita GDP of 35% with Indonesia and 65% with India (see figure 1.1). Indeed, figure 1.1 shows that from 1870 onward there was a strong divergence in per capita GDP between on the one hand Japan and on the other hand India and Indonesia.[4] This divergence accelerated after World War II. A second finding from figure 1.1 is that the Indian GDP is somewhat below the Asian average since as early as 1890. Although this gap closed slightly during the 1940s, mainly because India was far less hit by the War than most other Asian countries, it widened again in the second half of the twentieth century. Indonesian GDP was near the Asian average.

But what are the underlying reasons of these developments? In the previous section we already pointed out that in essence there are two sources of growth, i.e. (physical) capital accumulation and TFP. In addition the share of TFP growth in economic growth increased over time thus decreasing the effect of physical capital. In this sub-section we start with a brief look at physical capital accumulation. Figure 1.2 plots the development of the per capita

Figure 1.2

Log of per capita gross fixed non-residential physical capital stock in Japan, India, Indonesia, 1890-2000, in 1990 Int. USD converted at PPP
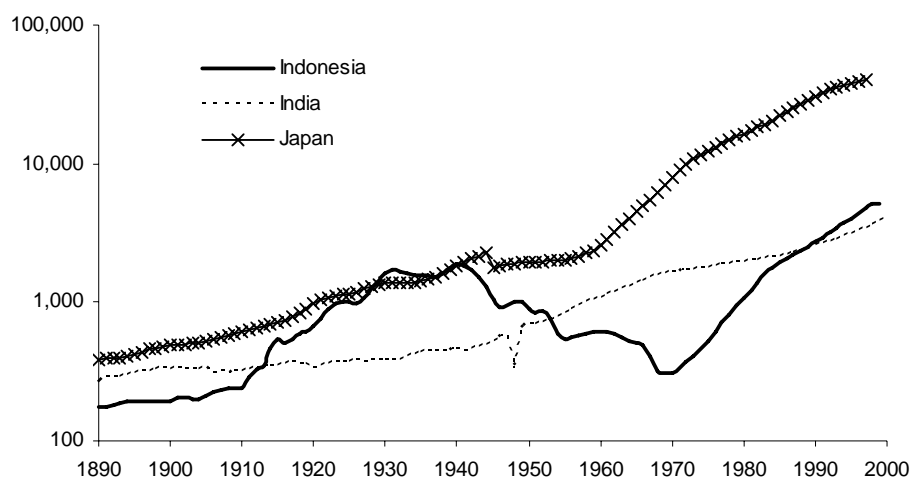
Source: Appendix A.2.

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[4] The data for India only start in 1890.

gross fixed non-residential physical capital stock. We notice that the amount of per capita physical capital in Indonesia and Japan peaks in the 1930s and early 1940s. Because these countries were hit hard by the Second World War, we see a strong decline thereafter. However, whereas in Japan per capita physical capital started to recover almost immediately after the War, in Indonesia it declined until around 1970. This suggests that in Indonesia also other factors played a role such as, for instance, the Dutch police actions after the War and the initially unfavourable investment climate. This was different for India, which had not suffered from Japanese occupation. Therefore, we see a steady increase of the per capita physical capital stock with a minor increase in the growth rate as from the 1940s. Thus, whereas Japan and Indonesia experienced a relatively strong growth in per capita physical capital until the 1940s and an even faster growth after 1950 and 1970 respectively, India had a relatively small growth until the 1940s and a somewhat faster, but still relatively slow, growth after 1940.

Comparing figure 1.2 with figure 1.1 suggests that the per capita gross fixed non-residential physical capital stock moves up and down with the development of per capita GDP. In other words, the development of per capita GDP strongly resembles that of per capita physical capital. This suggests a relationship between both variables.

4.3 Broadening the scope: other factors influencing economic development

The findings in section 3 and 4.2 confirm that physical capital plays an important role in economic growth. However, this does not explain the large share of TFP. In Indonesia, physical capital increased strongly in the post-War period as did TFP growth. In Japan, which showed a similar large increase in physical capital, the share of TFP growth in economic growth rose far less. The situation that Indonesia lagged behind to India and Japan in terms of TFP cannot explain this difference completely.

Other factors thus may explain (part of) the differences. These other factors are captured with social data, often shared under the common term 'human capital'.[5] Unfortunately, these data are even harder to collect than those on physical capital. Therefore,

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[5] This siding of variables such as literacy and life expectancy under a common denominator 'human capital' is obvious when considering studies of human capital. For example, many studies use adult literacy rates (often defined as the ability to read and write) as proxies for human capital (Azariadis and Drazen 1990; Romer 1990). Admittedly, this variable only captures the effect of human capital on economic growth up to a certain threshold. The reason is that, when everyone is literate, secondary and higher education may still expand without being visible in the literacy rate. Nevertheless, certainly in the nineteenth and start of the twentieth century and in the less developed countries, literacy is a relatively good indicator of human capital. The same can be said for life expectancy. There are numerous papers in which the decision to invest is based on life expectancy (Castelló-Climent and Doménech 2006). Equally, a higher life expectancy is associated with better health and some papers associate health with human capital. Hence life expectancy, just as health in general, is directly interpreted as human capital (Newland and San Segundo 1996; Sachs and Warner 1997; Arora 2001).

a whole range of social indicators has been used to reflect human capital. Mostly these are literacy rates and life expectancy. The results for these variables are presented in figures 1.3 and 1.4. Although the data are of limited quality, especially for the first half of the twentieth century, they do show the familiar logistic pattern that can be found in many developing (and developed) economies. These figures show that the fastest growth of these social indicators reflecting human capital took place between 1920 and 1960 (Japan) or 1980 (India and Indonesia). It is interesting that, contrary to physical capital, the gap in the human capital indicators between, on the one hand, Japan, and, on the other, India and Indonesia, declined.

The development of the human capital indicators in figures 1.3 and 1.4 reflects that of per capita GDP in figure 1.1. Just as for physical capital, this suggests a relation between these variables and GDP. If we now combine the economic and the social indicators, we get

Figure 1.3

Percentage literacy in Japan, India, Indonesia, 1890-2000
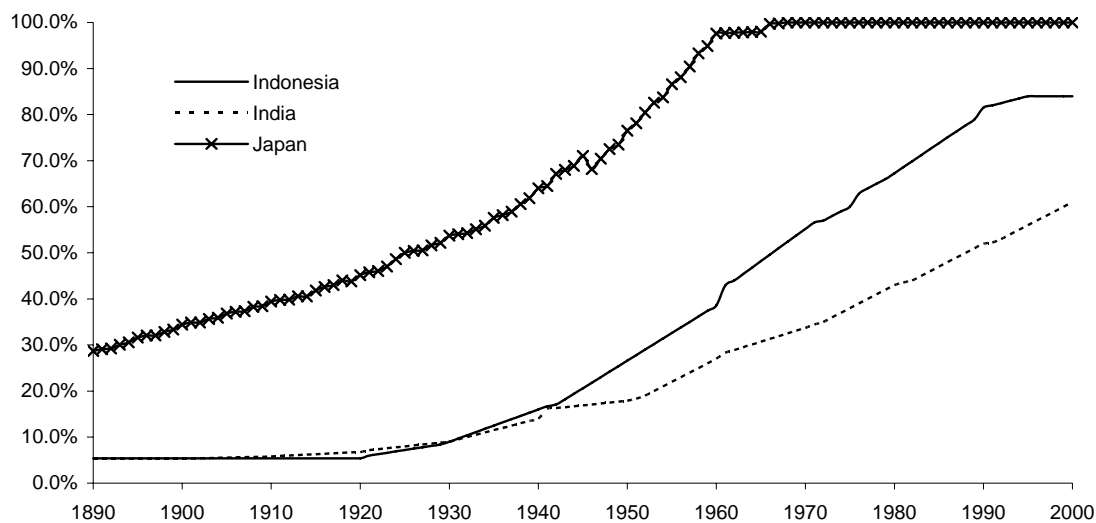
*Source: US Census Bureau (International Programs Centre) (*www.census.gov*); Statistical Abstract of British India (various issues), Volkstelling 1930 and Colonial Reports (various issues). For Japan, literacy data were harder to obtain. Because Japan was further developed we used our estimates of educational attainment (chapter 3 and appendix A.7) to proxy for literacy.*

the Historical Living Standard Index (HLSI) used by Crafts (2002) and Astoraga, Berges, and Fitzgerald (2005). The human development index is a weighed index of literacy (E), life expectancy (L) and per capita GDP (Y). We use a theoretical benchmark country with a per

capita income of 40,000 USD in 1990 prices[6], a life expectancy of 85 years[7], and a literacy rate of 100%. If a country would satisfy these requirements, the index value would become unity:

$$H_{it} = \frac{1}{3}\left[\left(\frac{\log Y_{it} - \log 100}{\log 40,000 - \log 100}\right) + \left(\frac{L_{it} - 25}{85 - 25}\right) + \left(\frac{E_{it} - 0}{100 - 0}\right)\right] \qquad (1.2)$$

The results are presented in figure 1.5.[8] Where we saw in figure 1.3 and 1.4 that the gap between on the one hand India and Indonesia and on the other hand Japan started to decline as

Figure 1.4

Life expectancy at birth (years) in Japan, India, Indonesia, 1890-2000
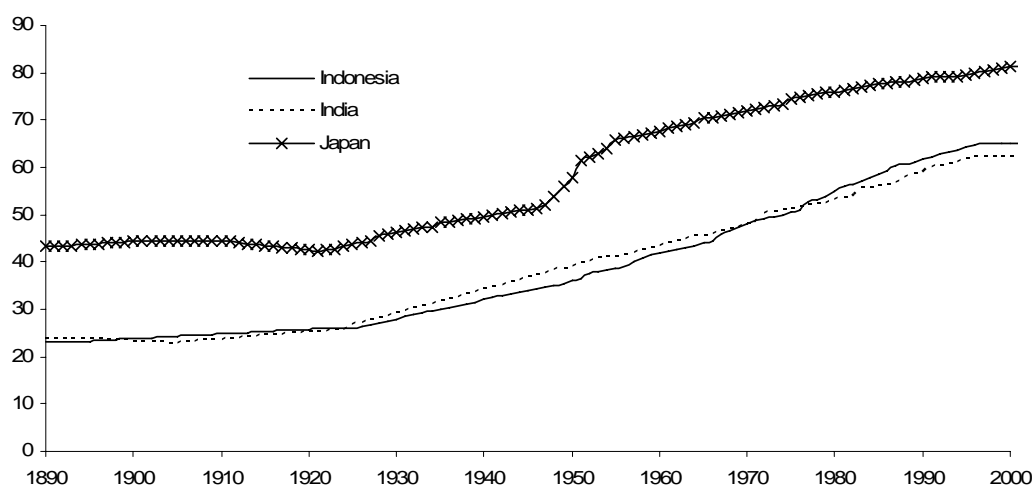
Source: UN, Demographic Yearbook: Historical Supplement; Demographic Yearbook 1948.

from the 1960s, we notice the same in figure 1.5. Between 1960 and 1995, the gap between Japan and India declined with 20% and that between Japan and Indonesia with 50%.

The analysis of this section leads to the conclusion that, besides physical capital, social indicators are also important for economic development. As the gap in the historical living standard index diminished while that in physical capital (proxied by GDP)[9] remained,

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[6] Crafts (2002) and Astoraga, Berges, and Fitzgerald (2005) used 1970 prices.
[7] We are aware that a life expectancy of 85 years is rather high, epecially for the early twentieth century. However, this makes the result more comparable to the Historical Living Standard Index for other countries.
[8] An interesting feature is that both in Japan and in Indonesia we see a dip around the War in the HLSI. This is, however, not the case in India. The reason is of course that India did not participate in the War directly.

Figure 1.5

Historical Living Standard Index (HLSI) for Japan, India, Indonesia, 1890-2000
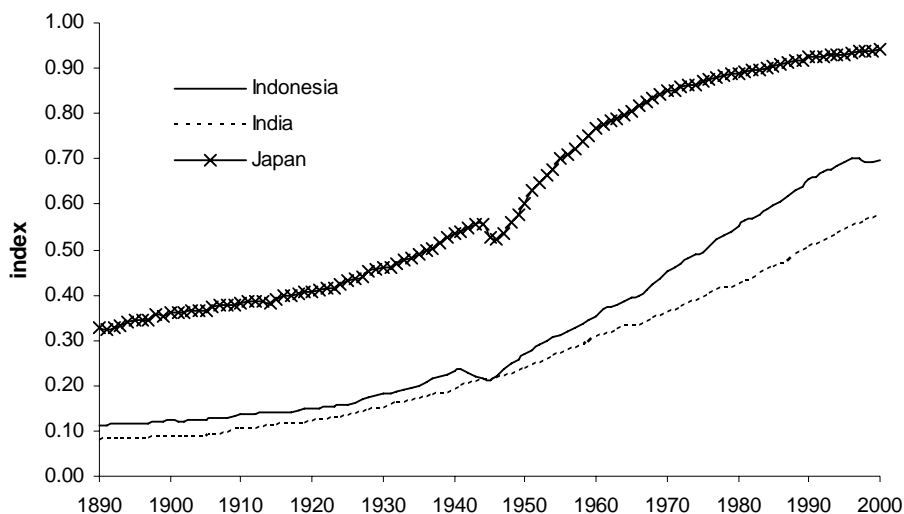
Source: see under figure 1.1, 1.3 and 1.4. Construction as described in the text.

the social indicators must have had an important effect on the standard of living. However, it is unclear what the importance of each factor is for economic growth. Both literacy and life expectancy, or more general: human capital, do have an impact on economic growth. However, whether this is in the form of capital accumulation as is the case for physical capital, or by way of facilitating technological growth, remains unclear.

5.   THEORY BEFORE EMPIRICS: THE NEW GROWTH THEORIES

5.1 Introduction

The role of the social factors was thus important. However, it was unclear whether they had an impact on economic growth through capital accumulation or through facilitating the adoption of technologies. The first step in solving this puzzle was to search for a comparable indicator of social developments. Following Theodore W. Schultz (1961) and Gary Becker (1964), the obvious candidate was human capital. As they defined human capital as a kind of 'capital' it was obvious to use this non-physical capital to extend capital in growth accounting exercises. In this way, it was hoped that the residual TFP could be reduced.

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[9] We used GDP to keep the Historical Living Standard Index comparable to the one used in the literature. As GDP also includes the social factors, we are somewhat biasing our results toward the social factors. However, in our opinion this does not drastically alter the result.

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Many growth accounting studies that inserted human besides physical capital, used proxies of human capital such as 'average years of schooling of the population'. Some examples are Bosworth, Collins, and Chen (1996), Young (1995), and Dougherty and Jorgenson (1996). All authors arrive at human capital shares in GDP growth of around 20% while TFP shares in economic growth are around 30%.[10] Compared with regressions without human capital, this is a strong reduction in the effect of TFP.

Yet, although reduced by the inclusion of human capital indicators, the share of TFP growth in economic growth remained large. We cannot interpret this as evidence that human capital as a factor of production is of little importance.[11] For this to be the case, too many problems plague this sort of growth accounting approaches. For example, the quality of the human capital data is generally low, thus reducing[12] the effect of human capital if directly inserted as a factor of production. In addition, there are some strong assumptions underlying this model, most importantly constant returns to scale. However, if there are decreasing returns, TFP growth would be underestimated. Finally, no matter how correct TFP growth is estimated, it still comes like some sort of manna from heaven, i.e. is exogenous. In other words, even measured perfectly, it is unclear what TFP growth is and how it influences GDP growth.

These problems make the results difficult to interpret and therefore the discussion goes on whether capital growth (physical, human or both) or technology causes economic growth.[13] A clear example is that the assimilists[14] (arguing that economic growth is mainly caused by the assimilation of technology) and the accumulists (those arguing that economic growth is largely caused by the accumulation of capital) both point at the Asian countries to strengthen their point. The assimilists argue that TFP increased over time. As TFP is an indicator of technological assimilation, and because after World War II most Asian countries experienced strong economic growth, this growth should primarily be driven by the

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[10] Obviously, there are many cross-country differences in the shares of each of the factors. However, on average we may conclude that the inclusion of 'human capital' or 'the quality of labour' decreases TFP. See Bosworth, Collins, and Chen (1995, table 6), Young (1995), tables VVIII), Dougherty and Jorgenson (1996, table 2).

[11] As a facilitator of technology, human capital can still work through TFP.

[12] Random measurement error in the independent variable causes a bias towards zero in the coefficient in a bivariate regression.

[13] Another problem is that it is possible that capital investment is correlated to economic growth. In other words, it is endogenous. Some examples of this are the large increases in physical capital growth after World War II. Indeed, Alwyn Young (1994) argues that after World War II capital accumulation in Asian countries was the cause of growth and not TFP. As a consequence, there seems to be a clear endogenous relation between economic development and investment in physical capital. This is also remarked by Krueger and Lindahl (2001) who estimated that this creates an overestimation of the share of physical capital in growth of about 50% when using a regression analysis.

[14] See for example Easterly and Levine (2002).

assimilation of technology. Equally, the accumulists argue that TFP shares in Asian countries are large, but they are by no means much larger than in other countries (Young 1995; Bosworth, Collins, and Chen 1995). As Asian countries after World War II nevertheless did experience strong growth, this suggests that rapid capital accumulation is the main reason for Asian economic development.[15]

The only way to give definite proof for either the accumulists or the assimilists is to endogenise long run growth. That is, either technological growth or (human) capital accumulation has to be inserted in the growth model in order to explain long-run growth. This is done by the new growth theories. In this way the validity of both arguments can be tested directly.[16]

5.2 The new growth theories

It was in the 1980s, with the creation of large cross section datasets and the dissatisfaction with the unexplained long-run growth that the new growth theories came into existence. As indicated, the main difference with the Solowian, neo-classical, growth model was that growth rates were now determined within the model, i.e. were endogenous. Two strands of new growth theories arose. Both made use of this additional 'capital' to relax the diminishing returns in the neo-classical model and thus create endogenous growth. Yet, they viewed human capital in a very different way.

In the first model, pioneered by Lucas (1988), human capital was inserted as a factor of production. This had three consequences. First, the empirical equation remained similar to the Solow model, augmented with human capital. However, in contrast, he argued that the formation of human capital was subject to constant, or increasing, marginal returns in human capital accumulation. This means that, even without the existence of positive external effects, endogenous growth was possible. Second, a logical consequence of this extension of the Solow growth model with human capital was that the growth of human capital positively

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[15] For an excellent discussion of the debate between the accumulist and the assimilist theories, see Timmer (2002).

[16] Human capital, for example proxied by variables such as life expectancy and literacy, can pick up a large part of long-run growth as we will point out in the description of the new growth theories in chapter 2. This also means that human capital is to a large extent correlated with TFP growth which is, as indicated, the source of long-run growth in the neoclassical Solow model. Indeed, if we perform a simple canonical correlation between, on the one hand, TFP growth and, on the other hand, the growth rate of indicators of human capital such as life expectancy, literacy, and the share of females in total educational enrolments, we get a relatively high correlation of 0.25 for Indonesia, 0.19 for India, and 0.21 for Japan, all highly significant. Given the fact that we are correlating growth rates (which generally result in lower correlation coefficients), the correlation coefficients found are relatively high. This is especially true because, as we will argue in chapter 2, these variables are only limited proxies of human capital.

influenced the growth of GDP. The third consequence of inserting human capital as a factor of production was its definition. Human capital used in this way exemplifies skills embodied in a worker. Consequently, human capital is a rival good (its use in one job precludes the use in another job) and it is excludable (people have property rights over their own labour) (Barro and Sala-i-Martin 2004, 239-240).

In the second model, pioneered by Romer (1990), the neo-classical growth model is followed in the sense that technological change (and possibly some other, less explicitly stated, factors) causes long-run growth. This effect of technological growth works on GDP growth through the level of human capital, either because human capital produces new technologies directly or because it is used as an input in R&D related activities (Sianesi and Van Reenen 2003, 163). This has two consequences. First, it is the level of human capital that has an effect on GDP growth.[17] Second, whereas in the theory of Lucas human capital is seen as the skills embodied in a worker, in the theory of Romer it is seen as knowledge and ideas. Consequently, in the latter case human capital is non-rival and partly-excludable.

Both new growth theories, each in several forms, have been estimated extensively. A few important studies are Barro (1991); Hanushek and Kim (1995); Gundlach (1995); De la Fuente and Doménech (2000). A clear finding is that the effect of the level of human capital on economic growth is small with around 3% on average while the effect of the growth of human capital is rarely significant. Partly, this can be attributed to the use of unsuitable human capital proxies because they only to a limited extend reflect the definitions of human capital as used by Lucas and/or Romer. In addition, these variables are often constructed with considerable error which is exacerbated when using growth rates. This might be an important reason why often an insignificant effect of the growth of human capital on economic growth is found as we will argue in the next chapter.

However, probably the most important problem is that these estimates are often done using cross-section or panel analyses. These analyses are less suited to answer our research questions. For example, often very dissimilar countries are pooled together in order to arrive at a sufficiently large sample (Tallman and Wang 1992, 9). As these models often assume the impact of human capital to be homogenous across countries, they hide large parameter heterogeneity. Equally, the relation between human capital and economic growth may be non-linear, i.e. for example depending on the level of human capital already attained. In addition,

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[17] Because the level of human capital influences GDP growth, this implies that a one-time rise in the level of human capital has a permanent influence on GDP growth.

it is likely that other, institutional factors influencing human capital formation change over time causing a change in coefficient over time.

These problems make it difficult to analyze the results. Are they reliable or are they caused by bad data, parameter heterogeneity, non-linearities, or country-specific changes over time? This is the reason why, for example Pack (1994, 70) argues that '[t]he challenge for empirical work is to test the implications of the new theory more directly. In practice, this means testing its insights against the economic evolution of individual countries using time series data.' Equally, Temple (1999, 119-120) argues that 'it is important to remember that growth regressions will never offer a complete account of the growth process, and that historical analyses must have an important complementary role.'

6.   RESEARCH QUESTIONS

The main advantage of the new growth theories is that they incorporate explanations for long-run growth (human capital and technological growth) into the model. In this way it became theoretically possible to determine the importance for growth of technology and human capital accumulation. Yet, the empirical estimates suffer from two important drawbacks. First, there is the problem of the human capital data. Both branches of the new growth theories use human capital in their empirical work. However, while in the Lucas (1988) model human capital is inserted as a factor of production, in the Romer (1990) model it is used as a facilitator of technological growth. The definitions of human capital are different in the two theories, making a comparison using the same data difficult. In addition, most human capital proxies suffer from large measurement errors. Second, even if we had the correct data, we still have to interpret our findings and find out how the country-specific educational institutions affect the growth path.

These two problems will be in the centre of this study as they 1) make it possible to quantify the process of economic growth, and 2) determine part of the cross-country differences in growth. In other words, they allow to test whether the different growth experiences of Japan, India, and Indonesia are caused by technology and/or human capital as suggested by the new growth theories. Consequently, the question this book aims to answer is whether the new growth theories explain why Japan was a relatively successful economic developer compared with India and Indonesia.[18] This requires a historical and data-related

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[18] One could see this solely as a study into long-run economic growth. Hence, the focus on the new growth theories would be redundant. However, as our point of departure is the current (new) growth theories and as their empirical application is related to the choice of data and institutions, it is important to first study how the choice

analysis to allow us to estimate and interpret the quantitative findings resulting from the new growth models. We will therefore focus on human capital as this is crucial in empirical estimates of both branches of the new growth theories.

7.   CONCLUSION

Since in the 1950s development economics got a boost with the decolonization wave, research in this field has had problems in bringing theory and practice together. The neo-classical growth model of Solow in the 1950s offered a way to empirically test the role of physical capital in economic growth, but did not explain the sources of long-run growth. Yet, analyses of the effect of the growth of physical capital and TFP on economic growth over the twentieth century have shown that the share of physical capital in economic growth reduces in favour of TFP. The same pattern, although less pronounced, can be observed in developing economies such as India and Indonesia. Indeed, we find that Japan both in physical and human capital related variables exceeded, and continued to exceed, India and Indonesia as from the 1890s.

The finding of a large and increasing effect of TFP growth and the importance of social indicators for growth tells us that there is some other factor besides physical capital that is crucial for understanding growth. Indeed, this was also the conclusion of much research in the 1960s. But, as this research still largely took place within neo-classical boundaries, the best one could say was that these other factors reduced TFP. As TFP growth remained the source of long-run growth, what caused this growth still remained a mystery.

The attempts to bring long-run growth in the model combined with the increasing availability of large international datasets, was partly the reason for the formulation of the new growth theories. Two branches arose, both using human capital. The first branch saw human capital as a factor of production, while the second branch interpreted it as a facilitator of technology. Although it created the possibility to theoretically distinguish between human capital and technology as the main source of growth (the two branches of the new growth theories), the empirical distinction remained difficult. The available human capital data are unsuited to distinguish between the two theories and the lack of country specific studies make it difficult to interpret the empirical results. For example, does a significant country dummy tell us that there are institutional differences or that there is a difference in the level of human capital development?

of data and educational institutions modify the empirical estimates of the growth theories before turning to the final empirical results.

Consequently, we need both new data on human capital and a historical analysis resulting in testable implications for growth regressions. To this end, we start in chapter 2 with an overview of the use of human capital. Both historians and economists have proposed several ways to estimate human capital. The most often used indicator is the panel dataset of Barro and Lee (1993; 2001) which consists of five-yearly country-level data on average years of schooling in the population. These data are used in many empirical applications of the new growth theories, with the growth of per capita GDP as the dependent variable, but generally result in implausibly low human capital coefficients.[19] More interestingly, these analyses generally find that it is the level and not the growth of human capital that yields a slightly positive and significant coefficient. This points to the theory of Romer (1990) in which human capital is seen as a facilitator of technology. Yet, many problems have to be solved before arriving at this conclusion. First, one needs a valid definition of human capital. Second, the data on human capital must be improved. Many of the current proxies are based on educational enrolments and therefore exclude the quality of human capital. As the quality is likely to have increased over the twentieth century, this is crucial in analyzing the effect of the growth of human capital on economic growth. Third, more attention must be given to country specific aspects. Most models are based on the assumption of perfect markets. Therefore, they encounter difficulties in explaining differences in the relation between education and growth between countries. Yet, looking at the country specific development of education, one may find patterns that explain part of these differences.

Consequently, first we must create a set of estimates of the human capital stock that conform to a standard definition and look how it relates to changes over time in the educational structure. This is the topic of chapters 3-5. In chapter 3 we start by collecting the available data on education. These are mostly data on enrolment and educational expenditure. Especially in Indonesia and India these data are often difficult to collect. The resulting time series are interpreted in chapter 4. In chapter 5 we combine these analyses of the educational structure and the data in alternative estimates of the human capital stocks for India, Indonesia, and Japan between 1890 and 2000. We try to use all available data without restricting ourselves in the possibility to bring the series back in time. The results seem fairly consistent, also when compared with physical capital and GDP.

The second step is to use the new human capital estimates and the interpretation of educational development to distinguish between two branches of the new growth theories.

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[19] This is especially true if these results are compared with micro studies on the same topic.

This is done in chapter 6. Although this tells us something about the theoretical and empirical applicability of these growth theories on economic development in India, Indonesia, and Japan, it still does leaves open the question how to interpret the cross-country differences. This is the topic of chapter 7 where we use the hypotheses derived from our analysis of the educational structure in chapter 4 to interpret the estimation results.

In chapter 8, we bring all these facets together. The main conclusion is that the new growth theory is to a large extent capable of analyzing the relation between human capital and economic growth when account is taken of institutional differences among countries, *ceteris paribus*. Equally, it explains a large part of divergence in per capita GDP. Therefore, it is crucial that historical country-specific analyses are performed in order to arrive at hypotheses which can be tested with the use of the new growth theories. Without these analyses, it remains virtually impossible to estimate, let alone interpret, any changes in the relation between human capital and growth, be it over time or among countries.