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The sources of long-term economic growth in Indonesia, 1880-2007

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Abstract

This paper initiates discussion about the contribution of Total Factor Productivity (TFP) growth to Indonesia's long-term economic growth. It presents new time series estimates of GDP, capital stock and education-adjusted employment, and offers a growth accounting approach that estimates the contribution of conventional factor inputs to GDP growth during 1880-2007. For most of the period, the growth of employment, educational attainment and particularly capital stock explained almost all of long-term output growth, and TFP growth was marginal. During the key growth periods 1900-29 and 1967-97, TFP growth was on balance negative, respectively marginally positive. However, the contribution of TFP growth was substantial during some sub-periods, particularly 1933-41, 1951-61, 1967-73 and 2000-07. Each of these followed a major economic downturn that slowed capital stock growth and required a more efficient use of productive resources, assisted by changes in economic policy and institutions that enhanced productivity and efficiency.

Keywords: economic growth, growth accounting, factor accumulation, productivity, Indonesia
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The sources of long-term economic growth in Indonesia, 1880-2007

1. Introduction

The broad dimensions of growth and structural change in Indonesia have been established in other publications (Van der Eng 1992, 2002a). This paper builds on those results in order to outline possibilities for further research and discussion about Indonesia's growth experience. In particular, this paper initiates discussion about the contribution of Total Factor Productivity (TFP) growth to Indonesia's long-term economic growth. It presents new time series estimates of GDP, and tentatively explores and employs the data available to gauge long-term changes in capital stock, education-adjusted employment, and factor income shares. Some of these data are tentative, but offer an opportunity to explore the feasibility of growth accounting analysis. After accounting for the contribution of conventional factor inputs to GDP growth, the paper identifies the contribution of TFP.

Identification of the contribution of TFP allows an elaboration of Indonesia's long-term growth experience in the context of literature on the sources of long-term economic growth. In comparison, the data availability for Indonesia only allows a growth accounting approach that yields relatively crude TFP estimates. These cannot necessarily be taken as indications of the contribution made by technological change to long-term economic growth without refinement, as was possible for other countries (see *e.g.* Abramovitz and David 2001; Prados and Rosés 2007). Summarising the historical growth accounting literature for particularly the UK, US and other Western countries, Crafts (2004) found consensus that TFP growth since the late 18th century has actually been quite modest. These findings underline the so-called 'Solow Productivity Paradox', as they contrast sharply with notable evidence of technological change and its impact in these countries, *e.g.* in the form of steam power in the early-19th century and information technology in the late-20th century. The answer to the paradox may lie in the embodiment of new technology in measures of capital stock.

The TFP estimates presented in this study will allow reflection on the results of multi-country growth studies that employed similar crude estimates. In the Asian context, a large part of the literature on the economics of macroeconomic growth is dominated by discussion about the degree to which TFP growth explains the 'Asian economic miracle' of high economic growth since the 1960s. Young (1994) argued, on the basis of a 4-country study, that this 'miracle' was more the result of the mobilisation of factors of production (labour and capital) than productivity growth – *i.e.* 'perspiration' rather than 'inspiration', as Krugman (1994) summarised the findings, inciting a series of studies that often used readily available multi-country data sets in order to estimate TFP growth, extending beyond Asia to cover different

parts of the world.[2] The multi-country studies that estimated TFP growth all found different, sometimes contradictory results. One of the reasons was that they had to make rather crude estimates of capital input on the basis of available national accounts data.

As a major Asian country Indonesia has, of course, been part of the multi-country studies referred to above. Most found positive TFP growth, albeit to varying degrees (see section 4 of this paper). However, there are no reasons to regard the results of these studies as conclusive, as they failed to consider the quality and availability of Indonesian statistical data explicitly. Close scrutiny of the data from these multi-country studies also reveals inexplicable discrepancies with the original data produced at the Statistics Indonesia (*Badan Pusat Statistik*, BPS), Indonesia's statistical agency, and its predecessors. Moreover, studies using multi-country data sets took national accounts data for granted. They did not account for revisions in these data over time, while their capital stock estimates often depended on rough assumptions, such as depreciation or lifetime of different categories of productive assets. Consequently, estimates of gross fixed capital formation and capital stock, for example, deviate significantly from estimates that take close account of the idiosyncrasies in Indonesia's statistical data and the composition of investment and capital stock (Van der Eng 2008b).

Indonesia's long-term economic growth has been the subject of several studies (*e.g.* Booth 1998; Dick 2002) and its recent growth experience in recent decades has been the subject of even closer scrutiny (*e.g.* Hill 1999). However, these studies did not employ growth accounting as a tool of analysis and focused on the ultimate reasons for Indonesia's development in terms of changes in institutions and economic policies conducive to economic growth. Consequently, the proximate causes remain unclear, even though they underlie the country's economic growth experience and offer pointers to the periodisation of the long-term growth experience as well as the relative relevance of ultimate explanations.

This paper seeks to resolve these inconsistent findings in the literature. It follows an approach used by Sigit (2004), but enhances it on the basis of new long-term estimates of GDP in 2000 prices, new long-term estimates of capital stock in Indonesia in 2000 constant prices, estimates of the share of labour income, new estimates of education-adjusted employment, and an extension of the timeframe of analysis. The next section outlines the methodology and data used in the paper, while section 3 discusses the data. Section 4 estimates the 'proximate' sources of economic growth in Indonesia. Section 5 concludes.

[2] See *e.g.* Baier et al. (2006: 45), who concluded that TFP growth contributed only 14% to the growth of output per worker throughout the 20th century, but -37% in Indonesia. Other studies, such as Chen (1997), Felipe (1999) and Weerasinghe and Fane (2005) offer critical discussions of the results of these multi-country studies for Asian countries.

2. Methodology of estimating TFP

This paper uses a simple, direct accounting method to estimate the contribution of TFP growth to economic growth. The production function in equation (1) indicates that output during a given year is a function of the productive employment of the total stocks of capital and labour.

$$Q_t = A_t\ f(K_t\ L_t) \qquad \text{(Equation 1)}$$

Where Q_t = real output, K_t = capital stock and L_t = employment in year t, and A_t is the efficiency term. Differentiating with respect to time yields equation 2.

$$\frac{dQ}{dt} = \frac{dA}{dt} f(K_t\ L_t) + A_t \frac{\partial f}{\partial K}\frac{dK}{dt} + A_t \frac{\partial f}{\partial L}\frac{dL}{dt} \qquad \text{(Equation 2)}$$

Dividing both sides by Q_t yields equation 3.

$$\frac{dQ}{dt} / Q_t = \frac{dA}{dt} / A_t + \frac{\partial f}{\partial K}\frac{dK}{dt} / f(K_t\ L_t) + \frac{\partial f}{\partial L}\frac{dL}{dt} / f(K_t\ L_t) \qquad \text{(Equation 3)}$$

Replacing the marginal productivities by factor prices then gives equation 4.

$$g_t^Q = g_t^{TFP} + (rK_t / Q_t) g_t^K + (wL_t / Q_t) g_t^L = g_t^{TFP} + s_k g_t^K + s_l g_t^L \qquad \text{(Equation 4)}$$

Where g_t^Q g_t^{TFP} g_t^K and g_t^L are the annual growth rates of output, TFP, capital and employment, respectively, r = per unit service prices of capital (interest) and w = per unit service price of labour (wage rate), and s_k and s_l are the shares of income from capital and labour in national income respectively. Assuming constant returns to scale, or perfect elasticity of substitution between capital and labour, yields equation 5:

$$s_k + s_l = 1 \text{ or } s_k = 1 - s_l \qquad \text{(Equation 5)}$$

Any effort to incorporate a measure of quality changes in the stock of capital goods, akin to *e.g.* Maddison (1987: 663-664), is arbitrary, particularly given the paucity of detailed long-term investment data for Indonesia. However, it is possible to incorporate a measure of quality changes in the stock of employment by adjusting it for educational attainment in a way shown by equation 6.

$$L_t^* = L_t e^{\alpha Y_t} \qquad \text{(Equation 6)}$$

Where L_t^* = education-adjusted employment, L_t = number of gainfully employed, α_t = the elasticity of output for each additional year of education and Y_t = the number of years of education per person employed. Substituting L_t for L_t^* in equation 1 and differentiation with respect to time yields a modified equation 4. Inserting equation 5 into the modified equation 4, yields equation 7.

$$g_t^{TFP} = g_t^Q - (1 - s_l) g_t^K - s_l g_t^{L^*} \qquad \text{(Equation 7)}$$

Thus, the key data required to estimate the contribution of TFP to economic growth are annual data on GDP and capital stock in constant prices, education-adjusted employment, and the labour income share in GDP. Since this paper is concerned with the national economy of Indonesia, it uses nation-wide data.

3. Estimation of output and inputs

3.1 Output data

Indonesia's official national accounts data underwent at least six major revisions since the 1950s. These were in part due to the adoption of new estimation procedures, improved estimation procedures, improved coverage of estimation, and changes in the base-year for constant price estimates (see Van der Eng 1999, 2005). Since the 1983 revision, Indonesia's national accounts have been anchored on the quinquennial Input-Output (I-O) Tables. Consequently, the output approach still offers the main substantiation of the country's national accounts. The last of these revisions was anchored on the 2000 I-O Table.

For the purpose of this paper, the new national accounts data for 2000-07 were extrapolated back in time with 1983-2000 national accounts data and with broad indicators of economic activity for 1880-1983, following a methodology established in Van der Eng (1992, 2002a). This yields a GDP series in constant 2000 prices that is shown in per capita terms in Figure 1. The chart confirms that the 1951-82 national accounts data were underestimated. The chart shows that Indonesia experienced periods of economic expansion, particularly sustained periods of growth during 1900-29 and 1967-97. In the latter period, average GDP growth was a significant 6.9% per year and annual GDP per capita growth was 4.8%. Indonesia's economy contracted drastically in 1998, but growth resumed in 1999 and the 1997 level of GDP per capita was re-achieved in 2004.

3.2 Capital stock data

Closely scrutinised estimates of capital stock in Indonesia are rare. Recent estimates disaggregate the growth of Gross Fixed Capital Formation (GFCF) on the basis of the quinquennial I-O Tables (Van der Eng 2008b). A perpetual inventory method was applied to 28 categories of productive assets since 1951, with the longest asset lifetime of 40 years, to estimate Gross Fixed Capital Stock (GFCS). The first 'complete' estimate is for 1990. GFCS was then re-estimated back to 1950 with the annual data on GFCF and assumed rates of asset retirement that were based on average implicit rates of asset retirement in the early 1990s. Only non-residential GFCS was used here.

For the purpose of this paper, estimates of non-residential GFCS were made for 1880-1941. These were based on estimates of total GFCF during these years, which were obtained as follows. In 1938, the value of GFCF was ƒ272 million, or 8.1% of GDP (CBS 1948).[3] GFCF in 1938 was extrapolated for 1880-1941 with total imports of all capital goods and cement in current prices.[4] The underlying assumption is that imported goods used for investment purposes had the same share in GFCF, or 32.5%.[5] GDP in current prices was calculated from Polak (1943) as NDP plus an assumed annual 6.5% depreciation rate for 1921-39, which is close to the 5.9% rate for 1938 (CBS 1948). This series was extrapolated for 1880-1941 by linking the 1921-39 series to a 'reflated GDP' series, using constant price GDP estimates in Table A.1 and a 'reflator' from Van der Eng (2002a: 168-73). Total GDP in 2000 prices in Table A.1 was then multiplied by the resulting ratio of GFCF and GDP in current prices to yield GFCF in constant prices during 1880-1941.

To estimate non-residential GFCS, a perpetual inventory approach was used, assuming the average productive life of all capital goods to have been 26 years, which is the implicit weighted annual average age of 27 items of non-residential capital goods in GFCS during the 1950s (Van der Eng 2008b). It is also assumed that repairs and maintenance allowed successive vintages of a capital good to deliver the same services and that scrapping only took place at the end of the service life of a capital good. Hence, the first complete estimate of capital stock was for 1906. For 1880-1905, a

[3] That is, ƒ42 million investment by Indonesian firms and f225 million by foreign-owned firms (CBS 1948). ƒ5 million was added as government investment in public infrastructure in 1938 (CEI3 1977). The total of ƒ272 million was considerably higher than the ƒ89 million total investment by Dutch-owned companies and by the central government in fixed assets included in the annual investment series mentioned in CEI3 (1977) for 1938. The discrepancy is due to the fact that the CEI3 data do not include investment by non-Dutch-owned firms, particularly by registered and unregistered ventures that by 1957 were Indonesian-owned, including important investments in farm agriculture.

[4] In particular, wood and timber, cement, building glass, industrial and commercial machinery, engines, electrical equipment, railway equipment, ships, and motor vehicles. It may be possible to refine this approach on the basis of more detailed and consistent trade data (values and quantities).

[5] The same method was used in the national accounts during the 1950s. *E.g.* for 1951-55 imported capital goods were on average 25-30% of GFCF (NPB 1957: 622).

constant capital-output ratio (COR) of 0.6 was assumed. This is a low but credible ratio for a still largely agrarian economy as Indonesia's prior to 1906.[6]

Figure 2 shows the results of the estimation of GFCS as a Capital-Output Ratio (COR). The COR increased significantly from 0.6 in 1905 to 1.3 in 1929, increasing further to 1.6 in 1932 due to negative GDP growth while GFCF decreased. The COR decreased significantly from 1.3 in 1941 to 1.6 in 1950, the first year after Indonesia's full independence. This reflects the decrease in GFCS during the 1940s, as a consequence of Dutch 'scorched earth' tactics during the Japanese advance into Indonesia in early 1942, the dismantling of industrial assets and railways during the Japanese occupation of 1942-45, and damage sustained during the war of independence 1945-49 (Keppy 2006: 61-67).[7] The increase in the COR across the 1940s also reflects the fact that the 1941 level of GDP was not re-achieved until 1954.

During 1950-67, new GFCF of on average 8% of GDP was just sufficient to recover capital stock, but for several years insufficient to compensate for the retirement of capital goods and prevent a decrease in the COR, as Figure 2 shows. The decline continued until the rate of GFCF increased significantly in the 1970s and stopped the decrease in the COR, and accelerated further during the 1980s and 1990s, yielding an increase in the COR. The stagnation of the COR during the 1970s until the early-1980s, despite an acceleration of GDP growth during the same years, suggests that the main sources of high economic growth during these years were capital-extensive. This may be related to the fact that natural resource exploitation, particularly the rapid growth of oil production for export, underlies much of the economic expansion during these years, in combination with the mobilisation of labour for new jobs in agriculture and industry. The ratio increased significantly during 1980-97, indicating that economic growth during 1980-97 was of a more capital-absorbing nature and depended, at least partly, on the mobilisation of productive capital. This is related to the significant growth of export-oriented manufacturing industry since the early-1980s.

3.3 Employment data

Consistent long-term estimates of employment in Indonesia are hampered by the fact that only the population censuses of 1930, 1961, 1971, 1980, 1990 and 2000 are key sources of data, even though the definitions of employment in each are slightly different. These census results have been used to extrapolate the data of the National Labour Force Survey (*Survei Angkatan Kerja Nasional*, Sakernas), which was

[6] The COR was on average 0.66 in the UK in 1820-30, and 0.68 in Japan in 1890, calculated from capital stock estimates in Maddison (1995) and GDP data in Maddison (2003).

7. The implicit estimate of the loss is 5% of capital stock in 1941. This is modest compared with e.g. 26% in Japan and 16% in Germany 16%, 10% in The Netherlands and 8% in France of prewar capital stock (Maddison 1995: 146-147).

conducted for 1976-80, 1982 and 1985-2007. The Sakernas definitions of employment also differ slightly over the years (Sigit 2000a: 28-29).

Figure 3 shows the interpolated employment data from the population censuses and also the Sakernas data. The interpolations and the Sakernas data track each other closely until 2000. The deviation in total employment in 2000 is possibly caused by the change in the definition of employment in Sakernas to exclude 10-14 year old workers, starting in 1998 (Sigit 2000a: 8). Many 10-14 year olds remained gainfully employed in Indonesia, comprising 3.7%, 2.9% and 2.9% of employment in 1980, 1990 and 2000 respectively, according to population census data. The interpolated census data are extrapolated backwards from 1930, taking account of population growth 10 years previously, reflecting the assumption that people long started gainful – but most likely part-time – employment at the age of 10.

3.4 Educational attainment data

To augment the labour force data, this paper uses an indicator of per capita educational attainment in Indonesia, shown in Figure 4. It is an approximation of long-term changes based on annual enrolments in institutions for primary, secondary and tertiary education. Figure 4 shows that the results closely track similar data from the postwar population censuses and inter-census estimates, which suggests that they approximate the trend.

Improvement in human capital was obviously a gradual process. Educational attainment grew at a very significant rate of 3.9 per cent per year during 1929-67 and 3.2 per cent during 1967-2005, but of course from low levels. Until the 1940s, the gains were mainly due to the expansion of primary education. The share of secondary education increased after 1970, possibly in reaction to labour market changes that increased where the demand for educated workers. As the method used to estimate educational attainment in Figure 4 does not allow a disaggregation of educational attainment by age groups, the paper uses per capita educational attainment as a proxy for the educational attainment per person gainfully employed.

Data on the output elasticity of educational attainment are not available. However, Sakernas contains wage income data that are disaggregated by the highest form of education that employees completed. As the number of years for each form of education is known, it is possible to estimate the income elasticity of each additional year of education. For the years 1989-99, the income elasticity of educational attainment was a fairly constant 0.11, meaning that each additional year of education on average yields an 11% increase of income. This number is taken as a proxy for the elasticity of output with respect to education for the entire period. This is in line with Collins and Bosworth (1996: 152) who found an East-Asia average of 10.7%.

3.5 Factor income share data

Although efforts are underway to estimate national income in Indonesia from the income side of the economy (Saleh and Jammal 2002), Indonesia's national accounts do not yet offer such estimates. The main sources on labour and non-labour income are the quinquennial I-O Tables and Indonesia's System of Economic and Social Accounting Matrices and Extension (SESAME) that use the I-O tables as their 'anchor' (Keuning and Saleh 2000).[8] Unlike the I-O Tables, SESAME does identify non-cash labour income, as well as total wages and salaries.

Table 1 indicates significant changes over time in the labour income share, particularly from 51% in 1995 to a very low minimum of 28% in 1998, when wage rates had been eroded by a drastic inflation spike. Leaving 1998 aside as a one-off aberration, these shares were interpolated for 1975-2003, while the 2003 share was used for 2003-07. No indications of the income shares of labour and capital in GDP are available before 1975. Table 1 suggests that the income share may have been 40% before 1975, but this low share is unlikely to have applied to the entire period 1880-1974.[9] In addition, historical data for other countries suggest that these shares are likely to have been subject to significant annual fluctuations over time. The best possible solution here is to test the sensitivity of the results by assuming plausible factor income shares. In the next section, the paper uses labour income shares of 50% and 70%.[10]

All data presented in this section are necessarily rough, given the difficulties in the compilation of statistical data in Indonesia in both past and present. These difficulties increase further back in time. Still, the data are based on the best possible available information and are reasonably robust.

4. The proximate sources of economic growth

[8] The income data in the I-O Tables only comprise the sum of wages and salaries received, which is generally estimated on the basis of Sakernas. They do not include in-kind incomes, particularly the incomes of unpaid household workers. The income of the self-employed and of household-based ventures is included in the total operating surplus of all companies, which is not disaggregated. Sigit (2004: 103-104) solved this by multiplying average income of waged employees from Sakernas with the total number of gainfully employed, and expressing the total as a percentage of GDP. However, this yields lower labour income shares than in the SESAME tables. In addition, there is no correction for the fact that the definitions of income varied in the different Sakernas years (Sigit 2000b: 7-9 and 17-18).

[9] The 1975 share of 39% seems very low, but capital income comprised the imputed income from the productive use of land, most of which was owned by small farming households. In an economy where agriculture was the most important single sector in terms of employment and income, as was the case in Indonesia before the 1970s, income from land may have been relatively significant.

[10] Which is roughly the band in which the labour income share in Spain fluctuated over time (Prados and Rosés 2007: Figure 8). In the US, the labour income share was 65% during 1800-55 and 55% during 1855-90 (Abramovitz and David 2001: 20), roughly the same as the UK and France in the late-19th century (Prados and Rosés 2003: 50).

The data in section 3 allow the disaggregation of GDP growth and the identification of the key proximate explanations of growth. Table 2 reveals the contribution of TFP growth to economic growth for key growth periods identified on the basis of Figure 1. The table shows that TFP growth has on average been low during 1880-2007, explaining only 7 to 13% of the annual average 3.6% GDP growth. Most economic growth can be explained on the basis of the mobilisation of capital and labour, and improvements in the quality of labour, although the relative share of both key production factors in explaining growth depends on what their respective actual income shares were.

Notably, during 1900-29, TFP growth was negative to marginal, despite the fact that this was a period during which the country must have experienced the impact of a range of potentially productivity-enhancing imported and home-grown technologies, as well as institutional changes. Arguably the most important technological changes were in transport and communications and in the production of key export commodities (Van der Eng 2002a: 153-54). Together with the only 10 to 13% contribution of TFP growth during the high-growth era of 1967-97, this finding may be further evidence of the 'Solow Productivity Paradox'.

It should be noted, however, that these are averages for considerable periods, each of which may contain significant fluctuations in TFP growth. For that purpose, Figure 5 summarises the findings of this study in a different way. It expresses both measures of TFP growth as an annual index number. Given the break in the series during the 1940s, the chart uses two reference years (1880 and 1950). Better than Table 2, Figure 5 shows clearly that there were significant variations in annual TFP growth, particularly during 1900-29 and 1967-97. During 1900-29, TFP growth was positive 1923-28, but negative during most other years. Likewise during 1967-97, TFP growth was very high during 1967-73, but close to zero or negative during other years.

Table 2 and Figure 5 revealed remarkably significant contributions of TFP growth to GDP growth during particularly four periods: 1933-41 (55-59% of 3.9% average annual growth), 1951-61 (58-59% of 4.3%), 1967-73 (66-67% of 9.4%) and 2000-07 (34% of 5.0%). What do the periods have in common? TFP and GDP growth during 1941-49 are not known, but it can be assumed that they were negative. If so, all four periods came after significant set-backs in Indonesia's economic development: the 1930-32 crisis, the 1942-49 Japanese occupation followed by the war of independence, the mounting political and economic chaos of the early 1960s, and the 1997-98 crisis. All four set-backs caused a slow-down in GFCF and in GFCS growth. Consequently, subsequent economic recovery was in first instance based on a more efficient use of productive resources, particularly capital stock, assisted by economic policy and institutional changes that enhanced productivity and efficiency.

Following 1930-32, the change took the form of import-replacing development strategies to off-set the consequences of falling commodity export earnings and later to prepare for the impact of World War II on Indonesia's foreign trade. This policy stance was interrupted during 1942-49, but intensified after the country's independence period, particularly in the face of falling commodity export earnings after the 1951-52 Korea boom. This period of expansion ended, however, when an accumulation of erratic policies under President Sukarno paralysed the economy during 1959-66. The regime change of 1966 eventually resulted in economic stabilisation and a phase of rapid economic growth during 1967-97 under President Soeharto, and significant TFP growth until GFCF took over as the main factor spurring economic growth during 1974-97. In each case, policy reforms took a few years to crystallise before their full impact was felt, and GFCF increased.

Table 3 compares this paper's estimates of TFP growth and its contribution to economic growth in Indonesia with those of other studies. The table shows significant differences in the results of all studies, but particularly between those of studies 2-3 and 5-9 and those of Baier *et al.* (2006), Sigit (2004), Firdausy (2005) and this study. Studies 1-9 hardly paid attention to the intricacies of Indonesia's statistical data and their consequences for growth accounting. It may therefore be appropriate to use their results with caution.

One of the reasons for the different results in Table 3 is the fact that authors often used different data sets and/or different ways to process the data, generally without regard for the inherent problems in the underlying data sets. For example, several of the multi-country studies obtained output data from the Penn World Tables (PWT), which in turn obtained them from the World Bank's *World Development Indicators*. However, there are many unexplained anomalies between the PWT data and the official data from BPS, Indonesia's statistical agency. For example, PWT gives total population estimates for Indonesia as 124.7 million in 1971, 154.4 million in 1980, 188.0 million in 1990 and 224.1 million in 2000, while Indonesia's population censuses give totals of respectively 118.4, 147.0, 178.5 and 206.2 million. PWT also offers GDP in international prices, even though Indonesia only featured twice – in 1980 and 1996 – in the six benchmarks of the International Comparisons Project. Hence, PWT estimated the key expenditure components of GDP for most years in its Indonesian time series on the basis of its multilateral 'shortcut approach', but without consideration of the degree of underestimation in Indonesia's national accounts data. In addition, several multi-country studies took capital stock data from Nehru and Dhareshwar (1993), which were based on aggregated investment data obtained from the World Bank that took no account of underestimation, and on highly arbitrary assumptions, such as that of a single 'decay rate' of 4% for all countries. Baier *et al.* (2006) used Mitchell's handbooks of historical statistics as key sources, but without accounting for inconsistencies in *e.g.* the national accounts data, and

simply interpolating years for which data were missing, without due account of the availability of other data for Indonesia.

Hence, it is difficult to check whether the different estimates of TFP growth from the multi-country studies are true differences or the consequences of measurement errors and/or the assumptions underlying data processing. For the same reason it is not possible to explain with detail the differences in the results of studies 1-9 and the findings of this paper. Only in the case of Sigit (2004) is it possible to explain the discrepancy, because Sigit clearly over-estimated capital stock growth, which was based on an incomplete and unpublished BPS estimate, while he also underestimated the share of labour income in total income by counting only wage income from Sakernas and excluding income in kind.

Several studies have estimated TFP on the basis of the firm-level data from the annual survey among industrial firms in Indonesia employing 20 or more people. The results are shown in Table 4. They all suggest that in manufacturing industry TFP growth has been modest, but significant and positive.

To put the results of this paper in context, it has to be noted that the results in Table 2 do not necessarily indicate that there was no technological change in Indonesia that contributed to long-term economic growth. One of the key reasons for the different results shown in Table 3 is, as Chen (1997: 23-26) noted, the fundamental difficulty of measuring capital input, and the fact that TFP is consequently a fairly arbitrary concept. There are at least two fundamental problems with this paper's calculation of TFP growth: (1) it is estimated as a residual, and (2) the paper's calculation assumes perfect elasticity of substitution of labour and capital.

The measurement of TFP growth as a residual means that TFP does not account for the fact that some aspects of technological change may already have been captured in the measurement of capital stock and education-adjusted employment. As capital accumulation tends to be the main vehicle of technological change, much of the technology is embodied in the stock of capital goods. This fundamental issue is likely to be significant for Indonesia in recent decades, given the high rate of capital accumulation since the early 1980s, as Figure 2 showed. Hence, most of the current non-residential capital stock is of recent vintage, and is likely to embody recent technologies. In addition, in manufacturing industry, investment in machinery and equipment was predominant and sustained most of the rapid growth of output in that sector (Timmer 1999: 83 and 89). While some technological change and efficiency gains were captured in the rates of TFP growth in manufacturing industry in Table 4, other gains were most likely captured in the measured industrial capital stock, and cannot be disentangled. [11] On the other hand, as most investment outside manufacturing industry may have been in the form of non-residential structures,

11. See *e.g.* Maddison (1987: 663-664) for a discussion of the problem of technology embodiment in capital stock and the difficulty of accounting for it.

particularly investment in public infrastructure, the embodied efficiency gains may not have been as significant as was the case in manufacturing industry.

Likewise, the measurement of education-augmented employment may have captured some technological change that would otherwise be measured as part of TFP. After all, the significant improvement in educational attainment explains one-third of the 28 to 31% contribution of employment to economic growth during 1967-97, shown in Table. Several of the studies in Table 3 did not adjust for changes in educational attainment. Hence, without the education adjustment, TFP growth in Table 2 would have been higher.

For those reasons, this paper's measure of TFP growth – and that of other studies as well – may be less a measure of technological change and increased efficiency of production than simply an unexplained residual that comprises a wide range of factors related to Indonesia's business environment as they impacted on the efficiency of production. Hence, low or negative TFP growth may rather reflect a multitude of inefficiencies in Indonesia's economy at large that impacted negatively on the productivity of firms rather than the general performance of firms. If TFP growth was indeed positive in manufacturing industry in recent decades, as Table 4 suggests, such inefficiencies may have existed in the non-manufacturing sectors of the economy. They may for example have taken the form of imperfections in particularly non-tradable sectors in non-manufacturing industry and services, such as transport and communications, and/or in labour, capital and commodity markets, possibly related to inhibiting regulations, the lack of exposure to foreign competition, the dominance of state-owned enterprises, and/or the presence of opportunities for anti-competitive behaviour.

A possible indication that TFP growth measures the residual is the fact that during 2000-07 the residual became positive, explaining a significant 34% of GDP growth. Of course, GFCF was relatively low during these years, while the growth of employment was steady. In addition, there may have been productive overcapacity by 1999 that became more efficiently used during 2000-07. Still, this change may be understood as an improvement in efficiency caused by the many growth-enhancing, or rather inefficiency-decreasing institutional changes that recent governments introduced in Indonesia (Van der Eng 2004). For example, deregulation and re-regulation in various ways enhanced competition in previously non-tradable sectors. Likewise, new capital market regulation imposed greater discipline on listed firms. While these changes may have increased uncertainty among foreign investors about investing in Indonesia, they may at the same time have been an encouragement for firms in Indonesia with a more intimate knowledge of past and current idiosyncrasies and risk in Indonesia's business environment, and ways to hedge it.

Secondly, and related to the first point, available growth accounting studies implicitly assume that there is perfect elasticity of substitution between labour and

capital. This paper did the same in equation (5). However, as Rodrik (1998: 84-8) has argued, it cannot be automatically assumed that this is the case. If, for example, economic growth and technological change had either a labour-saving or a capital-saving nature, the elasticity of substitution would be more than, respectively less than 1.[12] Hence, if technological change in Indonesia was to a degree labour-saving and capital-absorbing, the process will have yielded a downward bias of the estimated rate of TFP growth. The bias may be in proportion to the capital-labour ratio, which indeed increased very significantly in Indonesia, as Figure 7 shows, particularly during 1988-97, and to a lesser degree during 1906-29 and 1970-87. Although this point can be readily made, it is not easy to quantify its implications for efforts to account for economic growth.

4. Conclusion

This paper estimated that the contribution of TFP growth to GDP growth, after accounting for the growth of non-residential capital stock and education-adjusted employment, was on average a low 7 to 13% during 1880-2007. It also estimated that a large part of GDP growth during 127 years – 44 to 61% – was explained by the growth of capital stock. During the 1967-97 period of rapid growth the growth of the capital stock still explained 56 to 61% of economic growth. As such, the case of Indonesia appears to offer support for Krugman's thesis that economic growth in East Asia in recent decades was 'perspiration', rather than 'inspiration'-based.

However, the paper noted that capital stock in Indonesia is likely to have contained embodied technology, while the education-adjustment of employment is also likely to have captured part of the productivity growth that must have occurred, particularly during the key growth periods 1900-29 and 1967-97. Hence, the measure of residual TFP growth offered in the paper is more likely a reflection of a wide range of factors that impact on economic growth, but that the paper could not account for in ways done in other growth accounting studies. Such studies were generally able to draw on a much wider range of historical statistical data than are available for Indonesia (*e.g.* Maddison 1987; Crafts 2004).

The negative residual TFP growth during 1900-29 and the marginally positive TFP growth during 1967-97 may be taken as reflections of a range of inefficiencies that existed in the Indonesian economy at the time, despite a range of other efficiency-enhancing technological and institutional changes that occurred at the same time. Support for that suggestion was found in the fact that TFP growth was significantly

12. An econometric approximation of factor shares during 1880-2007 supports the suggestion that the elasticity of substitution between capital and labour is imperfect. Linear multiple regression to estimate the coefficients in Equation (4) yielded 0.33 for s^k and 0.83 for s^{l*} ($F(2, 116) = 55.9$, adjusted $R^2 = 0.48$), adding up to 1.16 rather than 1. But of course the degree of imperfection in the substitution of capital and labour may have varied during different periods.

positive during 1933-41, 1951-61, 1967-73 and 2000-07 that each followed periods of economic recession or stagnation. During each of these periods, economic recovery may have been based in first instance on a more productive use of available resources, particularly capital stock. In second instance, recovery may have been based on the fact that preceding periods of recession or stagnation had magnified the economic inefficiencies that were then assessed, addressed and reduced, leading to economic policy and institutional changes that enhanced efficiency, leading successively to growth of GFCF that reduced measured TFP growth.

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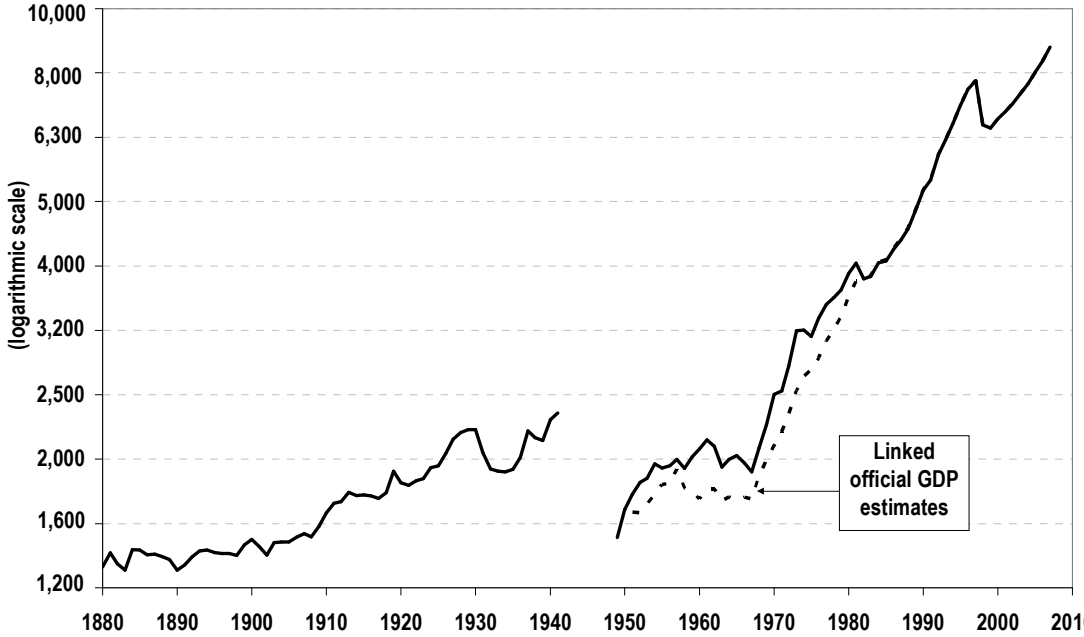
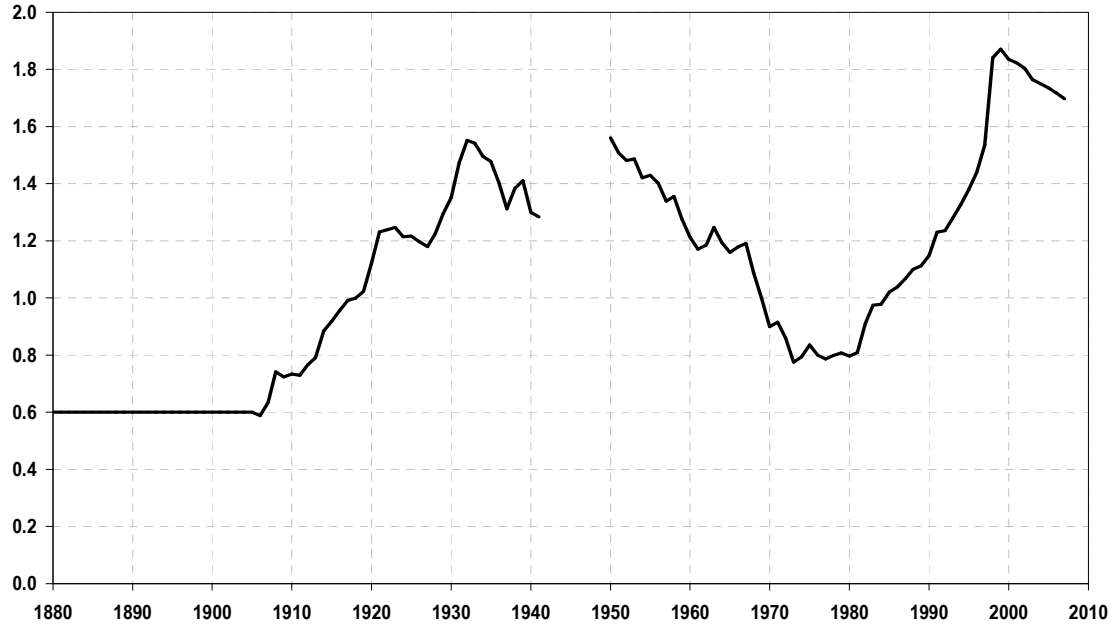
Figure 1: GDP per Capita in Indonesia, 1880-2005 (thousand 2000 Rupiah)



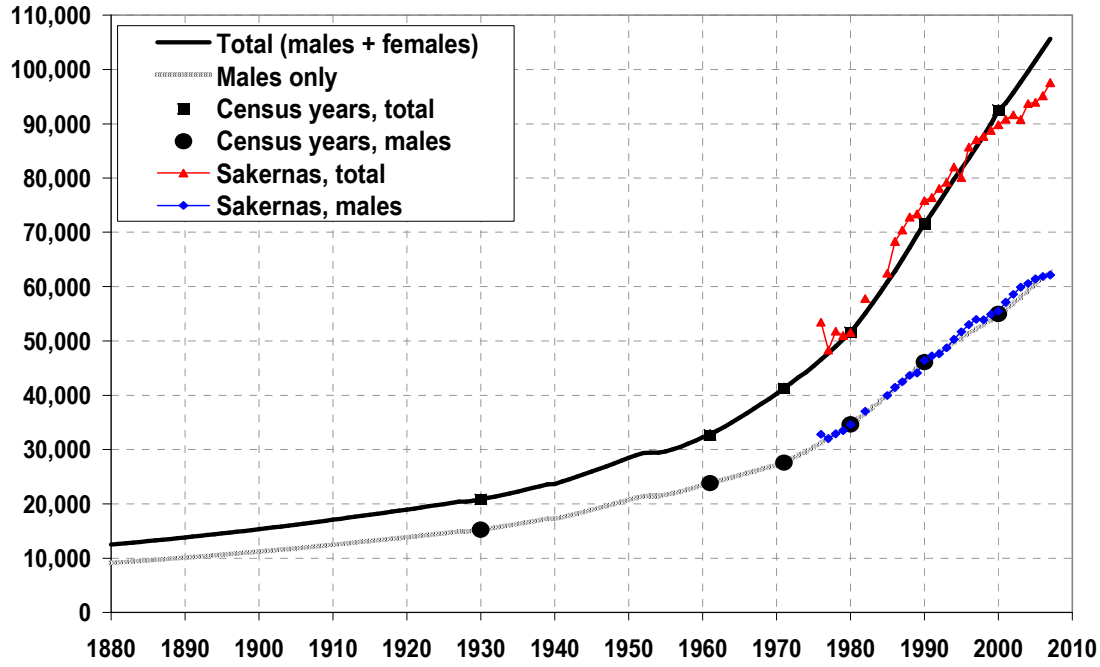
Sources: Table A.1; population 1930-61 from Van der Eng (2002b), 1961-2007 interpolations and extrapolation of census data, 1880-1929 unpublished estimates.

Figure 2: Capital-Output Ratio for Indonesia, 1880-2007



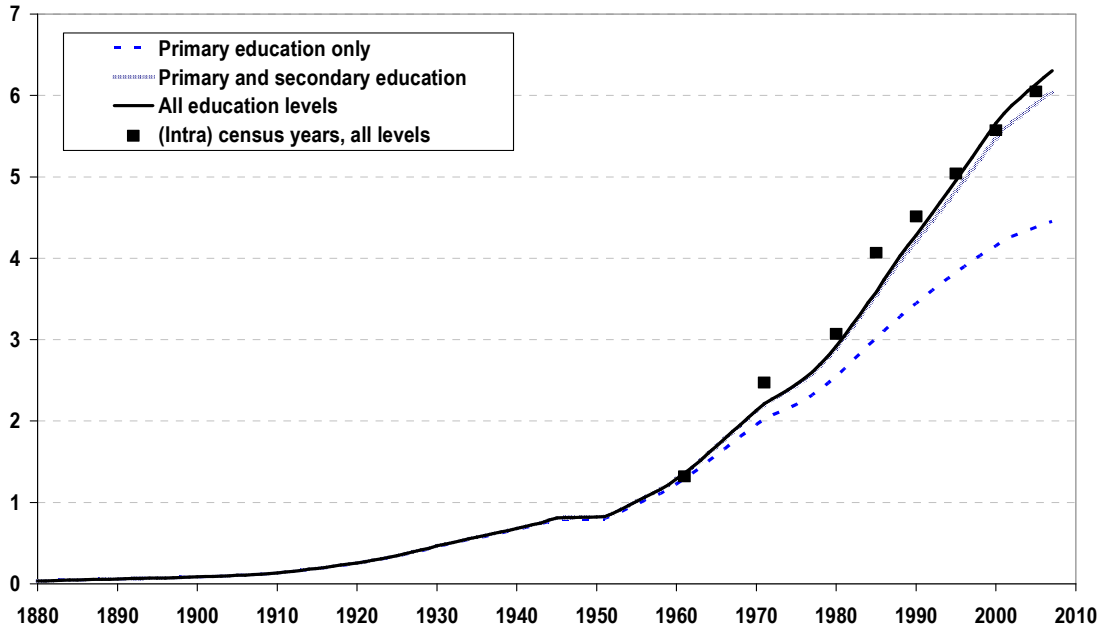
Note: Capital stock excludes residential structures.
Sources: Van der Eng (2008b); main text and Tables A1 and A2.

Figure 3: Employment in Indonesia, 1880-2007 (1,000)



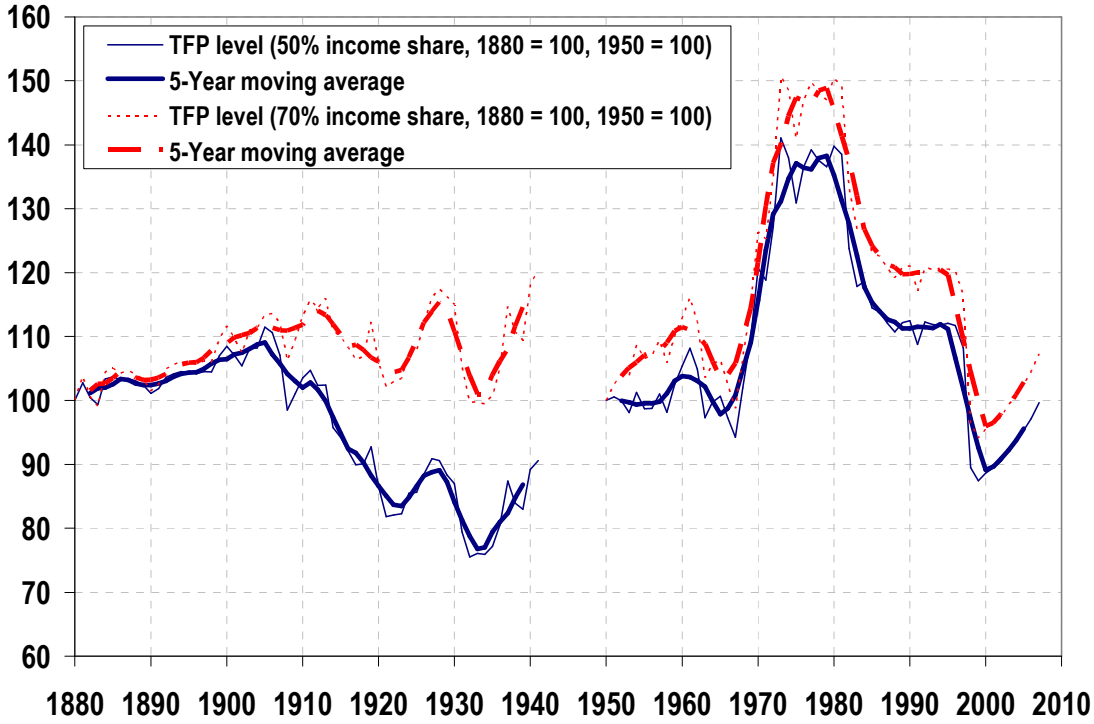
Sources: Extrapolation and interpolations of the population census data for 1930, 1961, 1971, 1980, 1990 and 2000, taking account of population growth 10 years previously; population 1930-61 from Van der Eng (2002b), 1870-1929 unpublished estimates; 1976-80, 1982 and 1985-2007 Sakernas data.

Figure 4: Educational Attainment in Indonesia (average years of schooling per person), 1880-2007



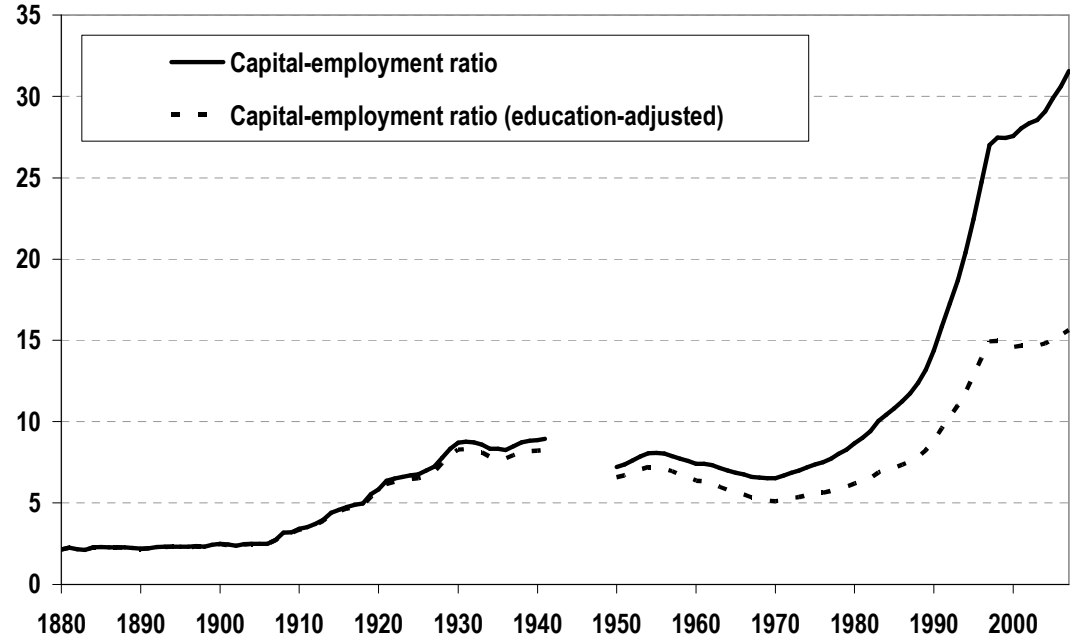
Notes: (Intra) census years calculated by assuming that those reported as having 'incomplete primary education' had an average of 2 years of schooling, those with primary education 6 years of schooling, completed junior secondary education 9 years (6 years + 3 years for junior high school), senior secondary 11 years (6 + 3 + 2 years for senior high school) and tertiary education 15 years (6 + 3 + 2 + 4 years at university). Other estimates are derived from data on primary, secondary and tertiary education enrolments during 1870-2007. Student years were accumulated on the assumption that the working life of a primary school graduate was 50 years, that of a secondary school graduate 45 years, and of a university graduate 40 years. The series of accumulated education in terms of student years were divided by population. This procedure assumes that all enrolled students actually went to school during the year. It makes no adjustment for quality differences between the types of schooling or between public and private universities, nor does it take account of overseas education of Indonesian residents, or the education that migrants brought or took with them.
Sources: 1961-80 census benchmarks Hugo *et al.* (1987: 282), 1985 BPS (1987: 123), 1990 BPS (1992: 132), 1995 BPS (1996b: 138), 2000 BPS (2002: 151), 2005 BPS (2006: 93); enrolments 1880-2007 from annual statistical publications for Indonesia and the website of the Department of Education in Indonesia, http://www.depdiknas.go.id/statistik/

Figure 5: Change in Total Factor Productivity in Indonesia, 1880-2007(1880 =100, 1950 =100)



Sources: Calculated from Tables A1 and A2, see main text.

Figure 6: Capital Stock per Person Employed in Indonesia, 1880-2007 (million 2000 Rp)



Source: Appendix A2.

Table 1: Share of Labour Income in GDP in Indonesia, 1975-2000 (bln Rupiah)

	Labour income			Capital income	Total GDP (factor cost)	Total GDP (market prices)	Labour income share
	Wages, salaries	Income in kind	Total				
1975	2,853	2,393	5,245	8,097	13,342	13,686	39.3%
1980	9,491	9,044	18,535	29,976	48,511	48,913	38.2%
1985	22,904	19,537	42,441	53,176	95,617	98,407	44.4%
1990	55,738	37,049	92,787	104,570	197,357	210,867	47.0%
1993	91,479	59,484	150,963	156,458	307,420	329,776	49.1%
1995	163,376	98,983	262,359	248,633	510,993	542,755	51.3%
1998	168,585	109,731	278,316	700,126	978,442	989,573	28.4%
2000	397,579	244,495	642,074	725,941	1,368,015	1,379,770	46.9%
2003	690,975	430,548	1,121,523	849,657	1,971,180	2,045,854	56.9%

Note: Data in italics are estimated values, non-italic data are from the sources below.
Sources: BPS (1996a: 72), BPS (1999: 27), BPS (2003: 35), BPS (2005: 11).

Table 2: Decomposition of Economic Growth in Indonesia, 1881-2007

	s_I	g_t^Q	g_t^K	g_t^L	$g_t^{L^*}$	g_t^{TFP}
A. Annual average growth						
1881-99		1.8	1.8	1.0	1.1	0.4
1900-29		2.6	5.3	1.0	1.2	-0.6
1930-32		-3.2	2.8	1.2	1.5	-5.1
1933-41		3.9	1.6	1.3	1.6	2.1
1951-61		4.3	1.6	1.3	1.9	2.5
1962-66		0.4	0.5	2.3	3.3	-1.5
1967-97		6.7	7.6	2.8	4.1	0.7
1998-99		-6.5	2.9	2.1	3.6	-9.7
2000-07		5.0	3.8	2.0	3.0	1.7
1881-07		**3.6**	**4.3**	**1.7**	**2.3**	**0.3**
B. Contribution to growth, assuming s_I = 50% in 1880-1974						
1881-99	50.0%		50%		30%	20%
1900-29	50.0%		102%		22%	-24%
1933-41	50.0%		21%		20%	58%
1951-61	50.0%		18%		22%	59%
1967-97	45.8%		61%		28%	10%
2000-07	54.4%		34%		32%	34%
1881-07	**49.0%**		**61%**		**31%**	**7%**
C. Contribution to growth, assuming s_I = 70% in 1880-1974						
1881-99	70.0%		30%		42%	28%
1900-29	70.0%		61%		31%	8%
1933-41	70.0%		13%		29%	59%
1951-61	70.0%		11%		31%	58%
1967-97	50.9%		56%		31%	13%
2000-07	54.4%		34%		32%	34%
1881-07	**63.8%**		**44%**		**41%**	**13%**

Note: The annual averages are calculated as simple averages for each period. The percentages contribution may not add up to 100% due to rounding.
Sources: Calculated from Tables A1 and A2, see main text.

Table 3: FTP Contribution to Economic Growth in Indonesia in Various Studies

	Source	Period	Annual average TFP growth (%)	% TFP contribution to output growth
1.	Baier *et al*. (2006: 45)	1951-2000	-0.7	-37
2.	Bosworth *et al.* (1995: Table A2)	1960-92	0.5	17
3.	Collins and Bosworth (1996: 157)	1960-94	0.8	23
4.	Firdausy (2005: 12)	1961-2000	-1.5	-27
5.	Drysdale and Huang (1997: 208)	1962-90	2.1	31
6.	Lindauer and Roemer (1994: 3)	1965-90	2.7	42
7.	Young (1994: 243)	1970-85	1.2	24
8.	Kawai (1994: 384)	1970-90	1.5	24
9.	Sarel (1997: 29)	1978-96	1.2	25
10.	Sigit (2004: 104-5)	1980-2000	-0.8	-15
11.	This study[a]	1951-2007	0.6	12

a. Assuming 60% labour income share 1951-74, unlike the 50% and 70% in Table 2.
Note: The different results are due to differences in (a) the period considered, (b) the basic data used, (c) the ways in which the key variables for growth accounting were constructed, (d) variables used to account for growth.

Table 4: TFP Growth in Manufacturing Industry in Indonesia in Various Studies

	Study	Period	Annual average TFP growth (%)	% TFP contribution to output growth
1.	Aswicayhono and Hill (2002: 148)	1975-93	2.7	21
2.	Timmer (1999: 87-89)	1975-95	2.8	22
3.	Vial (2006: 367)	1976-96	3.5	35*
4.	Hayashi (2005: 99, 107)	1986-96	1.9 (SMEs) 2.3 (LEs)	22 17
5.	Ikhsan (2006: 3 and 12)	1988-2000	1.6	16

* This source does not specify output growth, which for this table is calculated from national accounts data.

Table A.1: Gross Value Added in 17 Output Sectors in Indonesia, 1880-2007 (billion 2000 Rupiah)

	Food crops	Animal. husbandry	Farm cash crops	Estate crops	Fishe-Ries	Fores-try	Mining	Manu-factu-ring	Utili-ties	Con-struc-tion	Trade	Transport, communi-cations	Financial services	Hou-sing	Public adminis-tration	Other servi-ces	Oil, Gas	Total
1880	12,814	4,311	693	131	1,313	376	1,806	4,443	1	273	6,210	373	936	5,489	982	4,443	0	44,596
81	14,315	4,367	817	181	1,327	455	1,676	4,488	1	278	6,527	390	1,398	5,564	1,023	4,604	0	47,410
82	13,162	4,419	716	180	1,334	409	1,536	4,513	1	347	6,372	415	1,397	5,417	1,065	4,542	0	45,825
83	12,506	4,479	715	197	1,351	416	1,449	4,570	2	305	6,342	491	1,437	5,348	1,178	4,549	0	45,334
84	14,471	4,539	782	222	1,364	458	1,661	4,616	2	333	6,793	546	1,641	5,641	1,446	4,765	0	49,280
1885	15,035	4,608	784	197	1,390	448	1,453	4,701	2	309	6,900	626	1,707	5,705	1,426	4,852	0	50,144
86	14,547	4,693	917	210	1,414	515	1,451	4,784	1	354	6,954	632	1,732	5,679	1,404	4,899	0	50,187
87	14,560	4,776	847	194	1,434	475	1,951	4,851	1	448	6,986	649	1,785	5,680	1,342	4,973	0	50,952
88	14,194	4,860	898	191	1,452	497	1,963	4,911	1	422	7,051	704	1,847	5,662	1,461	5,015	0	51,126
89	13,901	4,940	888	215	1,464	503	1,754	4,954	1	381	7,145	848	1,896	5,659	1,469	5,036	0	51,055
1890	13,442	5,039	774	212	1,501	450	1,677	5,078	1	418	7,058	951	1,850	5,587	1,285	5,071	0	50,393
91	13,431	5,080	960	232	1,509	544	1,991	5,107	1	456	7,213	1,095	1,903	5,651	1,289	5,148	0	51,609
92	14,982	5,134	1,004	239	1,529	567	2,184	5,174	1	403	7,445	1,154	1,779	5,808	1,161	5,294	0	53,858
93	15,964	5,188	809	226	1,528	472	2,174	5,171	2	386	7,546	1,169	1,817	5,890	1,262	5,349	0	54,952
94	15,390	5,236	1,021	260	1,549	585	2,385	5,241	2	485	7,670	1,218	1,876	5,892	1,481	5,426	169	55,885
1895	15,928	5,302	892	152	1,577	476	2,071	5,335	2	348	7,699	1,310	1,980	5,907	1,659	5,500	254	56,393
96	15,304	5,314	1,033	263	1,595	591	2,193	5,397	2	494	7,795	1,386	1,976	5,904	1,670	5,548	340	56,803
97	15,959	5,335	985	299	1,622	586	2,477	5,489	2	543	7,853	1,485	1,756	5,947	1,234	5,632	593	57,795
98	15,174	5,356	1,046	318	1,650	622	2,659	5,583	2	590	7,915	1,577	2,010	5,917	1,547	5,708	677	58,352
99	16,703	5,377	1,122	361	1,679	677	3,098	5,679	2	593	8,242	1,860	2,260	6,126	1,573	5,932	423	61,707
1900	17,130	5,400	1,184	364	1,707	706	4,024	5,776	3	634	8,422	2,084	2,204	6,191	1,592	6,093	509	64,024
01	16,964	5,401	1,186	351	1,728	702	3,234	5,848	3	641	8,416	2,242	1,969	6,161	1,319	6,074	931	63,171
02	15,521	5,405	1,362	433	1,750	819	2,687	5,920	3	880	8,387	2,515	2,007	6,108	1,528	6,077	593	61,996
03	16,851	5,411	1,340	460	1,771	821	3,511	5,993	4	776	8,564	2,699	2,029	6,231	1,519	6,258	1,357	65,595
04	17,444	5,417	1,286	447	1,793	791	2,818	6,068	4	821	8,727	2,881	2,183	6,307	1,684	6,346	1,528	66,546

Table A.1 (continued)

	Food crops	Anim. husbandry	Farm cash crops	Estate crops	Fisheries	Forestry	Mining	Manufacturing	Utilities	Construction	Trade	Transport, communications	Financial services	Housing	Public administration	Other services	Oil, Gas	Total
1905	17,381	5,424	1,552	463	1,816	919	2,280	6,143	5	783	8,934	3,080	2,280	6,364	1,746	6,420	1,863	67,452
06	18,540	5,480	1,478	488	1,837	897	2,284	6,215	6	787	9,134	3,270	2,364	6,482	1,661	6,554	1,863	69,340
07	18,397	5,538	1,762	524	1,859	1,043	2,518	6,288	6	1,003	9,299	3,633	2,248	6,551	1,522	6,663	2,286	71,140
08	17,903	5,596	1,631	526	1,881	985	2,679	6,363	6	968	9,247	3,922	2,284	6,514	1,588	6,712	2,377	71,182
09	19,734	5,656	1,576	505	1,903	949	2,580	6,438	7	970	9,570	4,291	2,543	6,711	1,782	6,941	2,540	74,697
1910	21,087	5,716	1,707	538	1,925	1,025	3,260	6,514	8	1,237	9,997	4,786	2,743	6,928	2,052	7,236	2,540	79,300
11	21,710	5,778	1,665	665	1,948	1,063	4,395	6,592	9	1,363	10,225	5,533	2,835	7,064	2,010	7,479	2,794	83,129
12	21,458	5,906	1,950	624	1,971	1,175	4,869	6,670	10	1,537	10,343	6,087	2,755	7,125	1,876	7,639	2,547	84,543
13	22,225	6,036	1,802	628	1,994	1,109	5,516	6,748	12	2,019	10,611	6,560	2,909	7,261	2,498	7,893	2,625	88,446
14	22,629	6,245	1,788	622	2,018	1,100	4,426	6,827	13	1,772	10,706	6,732	3,037	7,301	2,707	7,913	2,625	88,459
1915	23,303	6,346	1,741	624	2,041	1,080	3,768	6,906	14	1,914	10,831	6,673	3,420	7,380	2,799	8,031	2,794	89,667
16	22,180	6,285	1,708	781	2,065	1,136	5,101	6,987	15	1,825	10,786	7,038	3,434	7,316	2,788	8,135	2,887	90,466
17	23,235	6,231	1,528	811	2,089	1,068	3,849	7,069	16	1,745	10,801	7,167	3,562	7,372	2,932	8,199	3,048	90,722
18	24,536	6,155	1,739	828	2,090	1,172	3,458	7,072	17	2,068	11,132	7,245	3,465	7,522	2,793	8,290	2,963	92,545
19	25,370	6,082	2,903	664	2,118	1,628	5,065	7,166	18	1,581	11,922	8,311	4,470	7,817	3,919	8,738	3,556	101,328
1920	23,414	5,983	2,358	747	2,146	1,417	4,300	7,260	20	2,449	11,490	9,590	3,414	7,664	3,549	8,647	4,066	98,516
21	21,835	6,118	2,445	779	2,171	1,471	4,401	7,347	23	2,233	11,560	10,231	3,605	7,614	4,209	8,779	3,934	98,755
22	23,947	6,184	2,560	859	2,198	1,561	4,728	7,435	24	2,156	11,762	9,601	3,892	7,749	3,899	9,015	3,959	101,527
23	23,591	6,383	2,846	901	2,224	1,710	5,315	7,525	25	2,317	11,953	9,368	4,279	7,790	3,638	9,115	4,609	103,588
24	24,633	6,556	3,365	991	2,251	1,988	5,761	7,615	26	2,220	12,617	9,802	5,192	8,034	3,705	9,463	4,749	108,968
1925	23,498	7,048	3,624	1,165	2,278	2,185	5,330	7,707	27	2,811	13,101	10,476	5,132	8,126	3,986	9,657	4,969	111,121
26	25,511	7,354	3,749	1,093	2,306	2,238	6,589	7,801	30	3,195	13,609	11,265	5,195	8,370	4,396	10,083	4,928	117,710
27	26,725	7,489	4,046	1,271	2,334	2,536	6,810	7,896	33	3,618	14,192	12,570	5,452	8,642	4,699	10,485	6,370	125,168
28	25,790	7,946	4,392	1,464	2,362	2,704	6,981	7,992	37	4,213	14,659	13,800	5,316	8,769	5,212	10,699	7,450	129,784
29	24,184	7,685	4,390	1,486	2,391	3,023	7,082	8,743	42	4,882	14,966	14,802	4,779	8,784	5,601	10,807	9,112	132,757
1930	26,721	7,393	4,081	1,489	2,420	2,259	7,016	9,900	47	4,097	15,105	14,216	4,554	8,813	5,677	10,902	9,680	134,373
31	26,133	7,199	4,072	1,503	2,456	1,763	5,733	9,261	48	3,041	14,232	12,860	4,398	8,475	5,449	10,693	8,244	125,560
32	27,268	6,738	3,985	1,435	2,492	1,374	3,358	8,016	45	2,563	13,329	11,974	4,457	8,264	5,369	10,515	9,045	120,227

Table A.1 (continued)

	Food crops	Anim. husbandry	Farm cash crops	Estate crops	Fishe-Ries	Fores-try	Mining	Manu-factu-ring	Utili-ties	Con-struc-tion	Trade	Transport, communi-cations	Financial services	Hou-sing	Public adminis-tration	Other servi-ces	Oil, Gas	Total
33	27,856	6,567	4,115	1,143	2,529	1,154	3,046	8,860	43	2,173	13,561	11,209	4,645	8,255	5,315	10,587	9,900	120,959
34	25,609	6,699	4,723	1,020	2,566	1,303	3,940	9,954	41	2,129	13,982	10,836	4,627	8,218	5,335	10,681	10,793	122,456
1935	28,141	6,890	4,626	916	2,604	1,428	4,600	9,545	43	2,463	14,175	9,728	4,846	8,309	5,242	10,865	10,942	125,364
36	29,856	6,772	4,868	986	2,642	1,587	6,186	9,602	47	2,738	14,604	10,339	5,400	8,512	5,737	11,270	11,604	132,749
37	29,485	7,927	5,417	1,386	2,681	2,025	7,771	13,262	52	3,108	17,453	11,517	5,673	9,057	6,077	12,046	13,158	148,097
38	31,095	7,090	5,078	1,259	2,721	2,095	5,469	12,531	58	3,464	16,875	12,278	5,607	9,043	6,689	12,078	13,296	146,726
39	31,235	7,326	5,167	1,386	2,762	2,145	5,755	12,357	65	3,942	16,778	12,286	5,023	9,039	5,634	12,170	14,402	147,472
1940	32,931	7,359	5,317	1,457	2,803	2,288	8,838	14,138	90	4,284	18,114	11,920	7,429	9,410	7,507	12,957	14,385	161,229
41	34,232	7,513	5,648	1,516	2,914	2,525	10,275	15,256	94	4,032	19,065	12,980	8,353	9,686	7,799	13,464	12,458	167,810
49	29,799	6,967	4,211	519	2,536	1,064	5,548	7,434	68	2,531	12,704	6,961	4,438	7,968	3,186	11,101	10,023	117,056
1950	27,846	7,144	7,096	552	2,370	1,568	6,168	10,262	74	2,533	14,746	8,504	5,129	8,369	6,072	11,950	11,227	131,610
51	28,824	7,401	8,145	696	3,093	1,523	6,316	13,101	81	3,035	16,934	9,371	4,681	8,781	4,435	12,446	12,864	141,725
52	28,106	8,171	7,130	863	3,474	1,917	6,827	13,817	87	4,159	17,914	9,349	5,336	8,936	5,943	14,163	14,497	150,688
53	29,706	8,022	5,943	971	3,743	1,990	6,511	13,845	104	3,807	17,826	10,466	5,664	9,016	5,828	14,835	17,409	155,687
54	33,275	8,091	7,291	973	3,814	1,792	6,739	14,533	109	4,690	18,912	11,182	6,859	9,419	5,391	15,543	18,449	167,063
1955	30,669	8,980	6,863	986	4,064	1,995	6,219	15,301	123	5,279	19,077	12,463	6,381	9,449	4,316	15,720	19,944	167,830
56	31,268	9,178	6,568	957	4,331	1,902	5,715	16,302	127	5,692	20,152	11,957	6,353	9,560	4,623	16,001	21,635	172,321
57	31,569	8,775	6,575	970	4,415	2,006	5,482	16,971	128	5,193	20,025	12,260	7,561	9,633	5,389	16,271	26,422	179,644
58	34,556	8,641	6,173	908	4,168	1,746	4,563	15,184	145	4,431	19,634	11,193	7,359	9,552	5,104	16,336	27,524	177,216
59	35,315	9,184	7,504	912	4,575	1,812	4,395	15,352	163	4,627	20,242	12,299	7,885	9,785	5,302	17,267	31,594	188,211
1960	36,686	9,242	7,613	841	4,594	1,984	4,484	15,670	163	4,627	20,681	13,646	8,185	9,951	5,876	18,042	34,775	197,059
61	34,730	11,639	7,707	849	4,928	2,194	3,914	18,279	177	5,974	23,604	13,150	8,862	10,265	6,287	19,001	35,924	207,485
62	38,384	11,548	8,438	806	5,288	1,845	3,507	17,206	192	5,037	23,435	12,442	7,534	10,280	3,119	19,460	38,388	206,908
63	33,846	11,222	8,626	820	5,673	1,742	3,029	15,360	222	3,807	22,225	12,023	6,449	9,939	3,761	19,635	37,592	195,970
64	38,322	11,677	7,543	841	6,023	1,251	3,216	16,544	251	3,807	23,136	11,785	7,610	10,201	3,667	20,760	38,770	205,404
1965	37,219	11,602	8,379	884	6,688	646	3,196	19,027	251	4,334	24,244	12,197	7,316	10,364	3,355	21,793	40,695	212,190
66	39,810	12,125	8,172	787	7,291	805	2,828	17,388	251	4,919	24,077	10,471	6,118	10,374	3,417	22,673	39,336	210,844

Table A.1 (continued)

	Food crops	Anim. husbandry	Farm cash crops	Estate crops	Fisheries	Forestry	Mining	Manufacturing	Utilities	Construction	Trade	Transport, communications	Financial services	Housing	Public administration	Other services	Oil, Gas	Total
67	36,646	10,543	8,117	784	7,161	1,517	2,804	19,160	325	4,275	24,078	9,101	5,873	10,256	3,771	21,153	42,792	208,356
68	41,568	9,968	8,219	798	7,032	3,903	3,532	21,659	340	5,154	26,417	9,436	6,237	10,717	3,543	22,123	51,002	231,648
69	41,279	11,056	9,031	866	7,367	4,716	3,829	23,070	444	7,028	28,167	9,321	7,138	11,027	6,403	23,000	62,851	256,595
1970	45,808	11,126	8,966	917	7,453	6,709	4,547	30,198	444	8,785	32,990	9,964	8,413	11,748	6,635	24,640	72,270	291,612
71	46,755	9,553	8,587	1,006	7,550	8,348	4,887	30,124	444	10,542	33,313	11,182	9,233	11,921	7,568	24,983	75,534	301,529
72	45,541	10,878	9,295	1,050	7,698	10,036	5,579	34,848	447	13,001	36,815	12,053	10,921	12,424	9,599	25,957	91,762	337,902
73	51,935	11,040	8,801	1,036	7,750	15,049	6,410	41,302	491	14,536	42,950	12,686	12,189	13,235	11,582	27,794	113,331	392,117
74	53,554	10,740	8,838	1,183	8,107	12,643	7,839	42,349	565	16,768	43,512	12,449	11,945	13,334	13,995	28,424	116,379	402,623
1975	53,338	11,140	9,014	1,238	8,433	9,750	7,476	45,566	592	17,991	44,205	12,381	12,354	13,450	16,222	29,364	110,617	403,132
76	54,144	11,965	9,998	1,294	8,997	13,818	8,025	48,313	643	18,331	47,918	13,336	13,153	13,905	18,263	31,139	127,659	440,898
77	55,012	12,386	9,837	1,398	9,536	13,365	8,759	53,052	657	21,349	50,313	15,235	14,279	14,311	19,222	33,006	142,762	474,478
78	60,679	12,397	10,286	1,463	9,996	15,730	8,327	56,903	736	23,476	54,305	17,190	16,029	14,918	21,883	35,450	138,452	498,220
79	61,421	12,529	11,909	1,554	10,607	14,798	9,589	64,986	857	24,055	59,463	19,044	17,118	15,415	27,701	37,922	134,693	523,661
1980	67,805	13,339	11,920	1,630	11,221	16,267	10,302	76,338	933	26,274	67,272	21,109	19,942	16,301	34,821	40,739	133,778	569,993
81	74,306	13,684	12,264	1,691	11,615	13,983	10,249	84,095	1,076	29,599	72,312	23,732	21,625	16,923	38,108	42,788	135,828	603,877
82	73,350	13,304	11,193	1,908	12,119	13,499	11,339	85,120	1,263	31,144	72,547	24,572	22,227	16,975	36,067	43,724	112,171	582,523
83	78,649	12,692	12,211	1,997	13,435	15,187	8,859	86,992	1,350	33,063	76,909	26,856	23,176	17,443	41,542	45,550	105,440	601,351
84	83,079	13,674	12,500	2,370	13,798	13,662	8,231	106,176	1,394	31,600	77,649	29,117	27,799	17,858	43,616	48,423	113,007	643,954
1985	85,251	14,734	13,705	2,718	14,763	12,995	8,536	118,058	1,553	32,422	80,622	29,404	29,678	18,225	46,950	51,062	101,318	661,993
86	87,392	14,930	13,730	2,989	15,605	13,575	9,451	129,025	1,849	33,148	87,019	30,593	34,226	18,848	49,911	53,950	106,375	702,617
87	88,309	15,271	14,330	3,004	16,206	14,785	10,109	142,713	2,128	34,543	92,956	32,363	35,957	19,653	53,576	57,057	106,252	739,212
88	92,282	16,001	15,085	3,069	17,143	15,474	10,595	159,828	2,361	37,824	100,936	34,152	36,870	20,455	57,693	61,187	102,567	783,522
89	96,123	17,287	19,601	←	18,076	15,862	12,478	177,860	2,681	42,835	112,288	37,830	44,166	24,047	61,074	65,171	107,665	855,043
1990	97,331	18,478	21,484	←	18,694	16,106	15,028	199,105	3,201	50,083	124,260	41,312	52,113	28,397	63,865	70,185	112,711	932,355
91	97,200	20,139	23,483	←	20,036	16,399	18,814	220,151	3,472	57,520	102,250	44,815	58,938	32,415	65,840	75,820	123,696	980,988
92	104,141	21,490	25,077	←	21,087	16,668	22,916	242,560	3,780	64,681	149,579	48,343	65,687	32,974	67,789	82,109	119,424	1,088,305
93	103,457	22,511	26,670	←	22,209	16,888	26,068	270,159	4,200	74,054	163,917	51,990	72,246	33,533	69,162	89,715	119,547	1,166,327
94	101,247	23,414	28,021	←	23,342	16,978	29,695	303,555	4,727	85,056	174,995	56,328	82,250	34,888	70,067	97,819	122,644	1,255,025

Table A.1 (continued)

	Food crops	Anim. husbandry	Farm cash crops	Estate crops	Fisheries	Forestry	Mining	Manufacturing	Utilities	Construction	Trade	Transport, communications	Financial services	Housing	Public administration	Other services	Oil, Gas	Total
1995	106,224	24,641	29,324	←	24,451	16,985	36,667	336,566	5,479	96,044	188,876	61,113	93,412	36,812	70,972	106,354	122,645	1,356,565
96	108,465	25,889	30,634	←	25,771	17,364	42,561	375,581	6,226	108,300	204,005	66,419	97,428	38,965	71,873	115,724	124,418	1,459,622
97	105,375	27,158	31,054	←	27,262	19,373	45,493	395,304	6,996	116,269	216,238	71,073	102,943	40,902	72,729	123,663	123,679	1,525,511
98	106,981	23,445	33,237	←	26,874	17,868	43,982	350,095	7,179	73,882	176,292	60,323	67,953	32,774	67,404	112,395	120,681	1,321,365
99	109,643	24,813	31,661	←	29,472	16,943	45,836	363,824	7,804	72,484	174,830	59,869	61,188	30,805	68,523	113,871	114,460	1,326,026
2000	111,324	25,627	31,720	←	30,945	17,215	50,536	385,598	8,394	76,573	184,970	65,012	64,314	31,872	69,460	119,054	117,156	1,389,771
01	113,020	27,770	34,845	←	32,441	17,610	56,794	398,324	9,058	80,080	192,541	70,276	68,810	34,142	70,200	125,622	111,451	1,442,985
02	114,045	29,334	36,819	←	33,768	17,957	60,856	421,783	9,738	84,239	199,649	76,173	70,622	37,321	70,482	133,464	108,131	1,504,381
03	120,139	30,727	38,192	←	35,900	18,118	65,343	441,755	10,448	90,103	210,466	84,979	76,114	40,494	71,148	142,550	103,084	1,579,559
04	122,612	31,673	39,548	←	37,057	17,334	61,464	469,952	10,890	96,334	222,247	96,897	81,443	43,998	72,324	154,419	98,636	1,656,826
2005	125,802	32,347	39,811	←	38,590	17,177	68,196	491,422	11,584	103,484	242,084	109,467	85,610	47,780	73,700	166,713	96,889	1,750,656
06	129,549	33,430	41,318	←	41,419	16,687	72,176	514,100	12,251	112,234	257,847	124,976	87,697	51,755	76,618	179,383	95,853	1,847,293
07	134,076	34,531	42,751	←	43,828	16,401	76,643	538,078	13,525	121,901	280,747	142,945	94,722	55,819	80,778	192,511	94,719	1,963,974

Sources: These estimates are based on Indonesia's new national accounts for 2000-07, following the latest 2000 revision, see Van der Eng (2005). The 2000-07 output data were linked to official national accounts data for 1983-2000 prior to the 2000 revision. For 1880-1982, the 1983-2007 series, except for manufacturing industry 1930-75, were linked to output indicators following the methodology outline in Van der Eng (2002a: 168-170). The index of output in manufacturing industry 1930-75 is from Van der Eng (2008a).

Table A2: Key data for the Calculation of Total Factor Productivity, 1880-2007

	GDP (at market Prices)	Non-residential capital stock	Employ-ment	Educational attainment per person
	(billion 2000 Rp)		(1,000)	(years)
1880	44,596	28,279	12,483	0.04
81	47,410	29,982	12,606	0.04
82	45,825	29,038	12,732	0.04
83	45,334	28,761	12,859	0.04
84	49,280	31,144	12,988	0.05
1885	50,144	31,688	13,119	0.05
86	50,187	31,740	13,252	0.05
87	50,952	32,219	13,386	0.05
88	51,126	32,342	13,523	0.06
89	51,055	32,313	13,661	0.06
1890	50,393	31,954	13,802	0.06
91	51,609	32,692	13,944	0.06
92	53,858	34,062	14,089	0.07
93	54,952	34,718	14,236	0.07
94	55,885	35,299	14,385	0.07
1895	56,393	35,633	14,536	0.07
96	56,803	35,898	14,690	0.08
97	57,795	36,522	14,846	0.08
98	58,352	36,885	15,005	0.08
99	61,707	38,928	15,166	0.08
1900	64,024	40,348	15,330	0.09
01	63,171	39,859	15,490	0.09
02	61,996	39,176	15,652	0.09
03	65,595	41,358	15,817	0.10
04	66,546	41,951	15,985	0.10
1905	67,452	40,132	16,155	0.11
06	69,340	42,539	16,331	0.11
07	71,140	46,966	16,509	0.12
08	71,182	54,028	16,690	0.12
09	74,697	55,839	16,874	0.13
1910	79,300	59,429	17,061	0.14
11	83,129	63,050	17,241	0.15
12	84,543	67,301	17,425	0.16
13	88,446	72,625	17,611	0.17
14	88,459	81,230	17,801	0.18
1915	89,667	85,152	17,993	0.19
16	90,466	89,380	18,173	0.20
17	90,722	93,091	18,357	0.22
18	92,545	95,341	18,545	0.23
19	101,328	106,848	18,736	0.25
1920	98,516	113,971	18,931	0.26
21	98,755	125,394	19,132	0.28
22	101,527	130,061	19,338	0.29
23	103,588	133,113	19,539	0.31
24	108,968	134,922	19,744	0.33
1925	111,121	138,130	19,953	0.35
26	117,710	143,433	20,165	0.37
27	125,168	151,786	20,382	0.39
28	129,784	163,441	20,404	0.42

Table A2 (continued)

	GDP (at market prices)	Non-residential capital stock	Employ-ment	Educational attainment per person
	(billion 2000 Rp)		(1,000)	(years)
29	132,757	177,054	20,606	0.44
1930	134,373	184,553	20,813	0.47
31	125,560	189,540	21,091	0.49
32	120,227	189,169	21,374	0.51
33	120,959	185,491	21,662	0.53
34	122,456	187,877	21,955	0.56
1935	125,364	187,856	22,259	0.58
36	132,749	190,538	22,572	0.60
37	148,097	198,642	22,907	0.62
38	146,726	207,431	23,252	0.64
39	147,472	210,340	23,604	0.66
1940	161,229	217,265	23,649	0.68
41	167,810	223,600	24,088	0.71
1949	117,056		27,912	0.82
1950	131,610	205,338	28,434	0.83
51	141,725	213,720	28,956	0.87
52	150,688	223,224	29,336	0.91
53	155,687	231,298	29,403	0.96
54	167,063	237,333	29,418	1.02
1955	167,830	239,958	29,672	1.07
56	172,321	241,501	30,056	1.12
57	179,644	240,469	30,498	1.16
58	177,216	240,149	31,052	1.22
59	188,211	240,057	31,612	1.29
1960	197,059	239,112	32,279	1.36
61	207,485	242,907	32,709	1.44
62	206,908	245,226	33,456	1.52
63	195,970	244,472	34,225	1.61
64	205,404	245,136	35,016	1.70
1965	212,190	245,997	35,834	1.78
66	210,844	248,497	36,672	1.87
67	208,356	248,181	37,534	1.96
68	231,648	251,953	38,430	2.05
69	256,595	256,081	39,318	2.13
1970	291,612	262,527	40,279	2.21
71	301,529	275,898	41,261	2.28
72	337,902	290,237	42,377	2.33
73	392,117	303,973	43,523	2.39
74	402,623	319,723	44,486	2.45
1975	403,132	336,548	45,726	2.52
76	440,898	352,766	47,000	2.61
77	474,478	372,879	48,310	2.70
78	498,220	397,876	49,657	2.81
79	523,661	422,664	51,041	2.92
1980	569,993	454,022	52,421	3.05
81	603,877	488,314	54,294	3.18
82	582,523	530,510	56,238	3.32
83	601,351	585,571	58,254	3.45

Table A2 (continued)

	GDP (at market prices)	Non-residential capital stock	Employ-ment	Educational attainment per person
	(billion 2000 Rp)		(1,000)	(years)
84	643,954	629,553	60,347	3.59
1985	661,993	675,304	62,519	3.74
86	702,617	729,207	64,774	3.89
87	739,212	789,059	67,114	4.03
88	783,522	861,529	69,543	4.16
89	855,043	950,963	72,064	4.29
1990	932,355	1,070,367	74,396	4.42
91	980,988	1,206,918	76,137	4.55
92	1,088,305	1,345,078	77,928	4.69
93	1,166,327	1,491,961	79,768	4.82
94	1,255,025	1,665,387	81,660	4.96
1995	1,356,565	1,870,200	83,311	5.10
96	1,459,622	2,101,457	85,003	5.24
97	1,525,511	2,342,447	86,738	5.38
98	1,321,365	2,432,764	88,517	5.52
99	1,326,026	2,480,787	90,342	5.66
2000	1,389,771	2,550,632	92,528	5.78
01	1,442,985	2,629,659	93,818	5.88
02	1,504,381	2,712,872	95,738	5.97
03	1,579,559	2,788,177	97,689	6.06
04	1,656,826	2,899,091	99,665	6.14
2005	1,750,656	3,037,607	101,652	6.23
06	1,847,293	3,172,832	103,635	6.30
07	1,963,974	3,333,858	105,632	6.38

Sources: See Table A1 and main text.