



# The sources of long-term economic growth in Indonesia, 1880–2008

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## ABSTRACT

This paper presents new time series estimates of GDP, capital stock and education-adjusted employment, and uses a growth accounting approach to analyze GDP growth during 1880–2008. The growth of capital stock, employment and educational attainment explained almost all of GDP growth. During key growth periods 1900–29 and 1975–97, Total Factor Productivity (TFP) growth was on balance negative. TFP growth was substantial during some sub-periods, particularly 1933–41, 1951–61, 1967–74 and 2000–08. Each followed a major economic downturn that slowed capital stock growth and required a more efficient use of productive resources, supported by changes in economic policy that enhanced productivity and efficiency.

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## 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 allows only a growth accounting approach that yields relatively crude TFP estimates. Without the refinement that was possible for other countries (see e.g. Abramovitz and David, 2001; Prados and Rosés, 2007), these cannot necessarily be taken as indications of the contribution made by technological change to long-term economic growth. Summarizing the historical growth accounting literature in particular for 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 '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. 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 eco-

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conomic growth since the 1960s. Young (1994) argued, on the basis of a 4-country study, that this ‘miracle’ was more the result of the mobilization of factors of production (labor and capital) than productivity growth – i.e. ‘perspiration’ rather than ‘inspiration’, as Krugman (1994) summarized the findings, initiating 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.<sup>2</sup> 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, featured in the multi-country studies referred to above. Most found positive TFP growth, albeit to varying degrees (see Section 4). However, there are no reasons to regard the results of these studies as conclusive, as they failed to consider explicitly the quality and availability of Indonesian statistical data. Close scrutiny of the data from these multi-country studies also reveals inexplicable discrepancies with the original data produced at 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 take account of revisions in these data over time, and 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, 2009).

Indonesia’s long-term economic growth has been the subject of several studies (e.g. Booth, 1998; Dick et al., 2002) and its growth experience in recent decades has undergone 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 periodization 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 by using 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 labor 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. 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 Eq. (1) indicates that output during a given year is a function of the productive employment of the total stocks of capital and labor.

$$Q_t = A_t f(K_t, L_t) \quad (1)$$

Here,  $Q_t$  = 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 Eq. (2).

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

Dividing both sides by  $Q_t$  yields Eq. (3).

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

Replacing the marginal productivities by factor prices then gives Eq. (4).

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

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

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

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 Eq. (6).

<sup>2</sup> 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.

$$L_t^* = L_t e^{\alpha Y_t} \quad (6)$$

Here,  $L_t^*$  = education-adjusted employment,  $L_t$  = number of gainfully employed,  $\alpha$  = 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 Eq. (1) and differentiating with respect to time yields a modified Eq. (4). Insertion of Eq. (5) into the modified Eq. (4) yields Eq. (7).

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

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 labor 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 have undergone at least six major revisions since the 1950s. These have in part been due to the adoption of new or 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 2000–08 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 Fig. 1. The chart confirms that the 1951–82 national accounts data were underestimated, and 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 GDP per capita grew at 4.8% per year. 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 scrutinized 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, 2009). 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, non-residential GFCS was estimated 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 f272 million, or 8.1% of GDP (CBS,

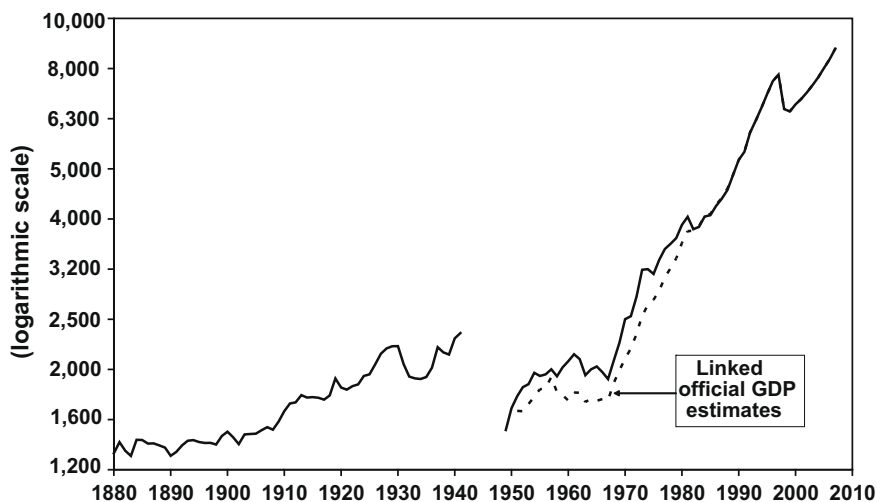
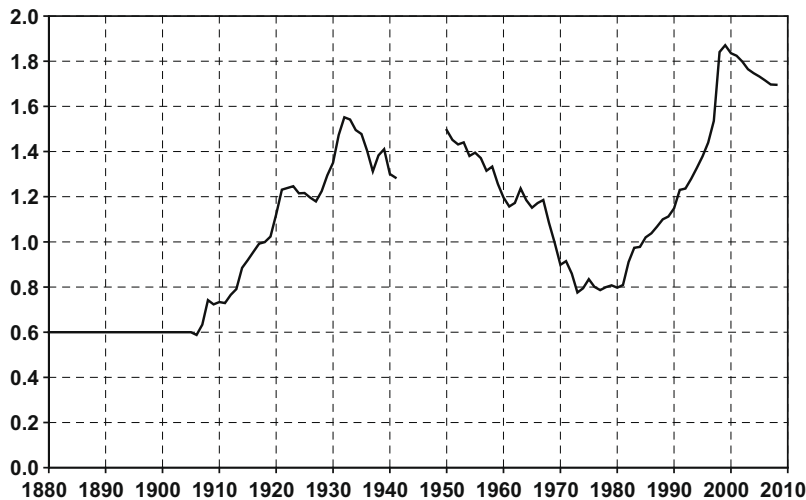


Fig. 1. GDP per Capita in Indonesia, 1880–2008 (thousand 2000 Rupiah). Sources: Table A1; population 1930–61 from Van der Eng (2002b), 1961–2008 interpolations and extrapolation of census data, 1880–1929 unpublished estimates.



**Fig. 2.** Capital-output ratio for Indonesia, 1880–2008. *Note:* Capital stock excludes residential structures. *Sources:* Van der Eng (2009) updated; main text and Tables A1 and A2.

1948).<sup>3</sup> GFCF in 1938 was extrapolated for 1880–1937 and 1939–41 with total imports of all capital goods and cement in current prices.<sup>4</sup> The underlying assumption is that imported goods used for investment purposes had the same share in GFCF, or 32.5%.<sup>5</sup> 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 GDP series was extrapolated for 1880–1920 and 1940–41 by linking the 1921–39 series to a ‘reflated GDP’ series, using constant price GDP estimates in Table A1 and a ‘reflator’ from Van der Eng (2002a: 168–73). Total GDP in 2000 prices in Table A1 was then multiplied by the resulting ratio of GFCF and GDP, both in current prices, to yield GFCF in 2000 prices for 1880–1941.

To estimate non-residential GFCF, 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 GFCF during the 1950s (Van der Eng, 2009). It is also assumed that repairs and maintenance allowed successive vintages of a capital good to deliver the same services and that scrapping took place only 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 constant capital-output ratio (COR) of 0.6 was assumed. This is a low but credible ratio for a still largely agrarian economy such as Indonesia’s prior to 1906.<sup>6</sup>

Fig. 2 shows the results of the estimation of GFCF as a 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 GFCF 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 in 1945–49 (Keppy, 2006: 61–67).<sup>7</sup> 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 it was insufficient to compensate for the retirement of capital goods and prevent a decrease in the COR, as Fig. 2 shows. The decline continued until the rate of GFCF increased significantly in the 1970s and stopped the decrease in the COR. GFCF accelerated further during the 1980s and 1990s, bringing about an increase in the COR. The stagnation of the COR during the 1970s and until the early 1980s, despite an acceleration of GDP growth during the same years, suggests that the main sources of high

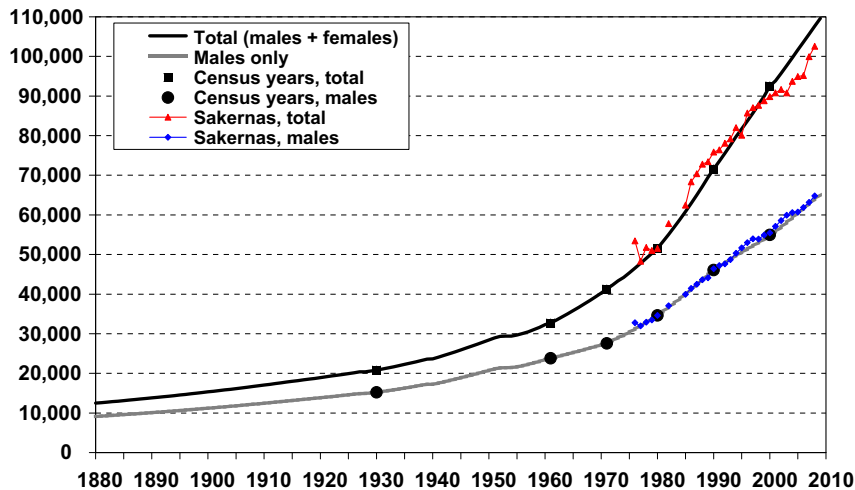
<sup>3</sup> That is, f42 million investment by Indonesian firms and f225 million by foreign-owned firms (CBS, 1948), to which f5 million was added as government investment in public infrastructure in 1938 (CEI3, 1977). The total of f272 million was considerably higher than the f89 million total investment 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 CEI3 data do not include investment by non-Dutch-owned firms, particularly by registered and unregistered ventures that by 1957 were Indonesian-owned (including investments in farm agriculture), which explains the discrepancy.

<sup>4</sup> 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).

<sup>5</sup> 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).

<sup>6</sup> 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).

<sup>7</sup> The implicit estimate of the loss is 8% of capital stock in 1941. This compares with *e.g.* 26% in Japan and 16% in Germany, 10% in The Netherlands and 8% in France of pre-war capital stock (Maddison, 1995: 146–147).



**Fig. 3.** Employment in Indonesia, 1880–2008 (1000). 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 1985–2008 Sakernas data.

economic growth then 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 mobilization of labor for new jobs in agriculture and industry. The ratio increased significantly during 1980–97, indicating that economic growth during those years was more capital-absorbing nature and depended, at least partly, on the mobilization of productive capital. This is related to the significant growth of export-oriented manufacturing 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 Labor Force Survey (*Survei Angkatan Kerja Nasional*, Sakernas), which was conducted for 1976–80, 1982 and 1985–2008. The Sakernas definitions of employment also differ slightly over the years (Sigit, 2000a: 28–29).

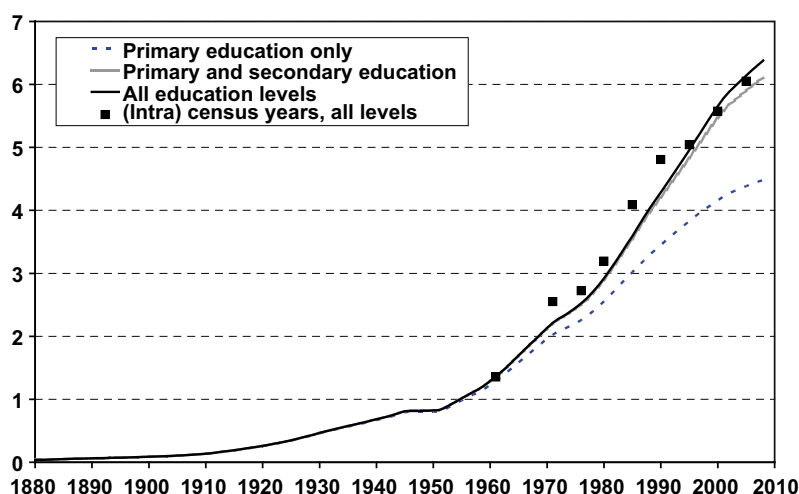
Fig. 3 shows the interpolated employment data from the population censuses and also the Sakernas data. The two series track each other closely until 2000. The deviation in total employment in 2000 is possibly caused by the change in the definition of employment in Sakernas to exclude 10–14 year old workers, 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 those employed 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 had for a long time gainful – but most likely part-time – employment at the age of 10.

### 3.4. Educational attainment data

To augment the labor force data, this paper uses an indicator of per capita educational attainment in Indonesia, shown in Fig. 4. It is an approximation of long-term changes based on annual enrolments in institutions of primary, secondary and tertiary education. Fig. 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 year during 1929–67 and 3.0% during 1967–2008, 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 labor market changes that increased the demand for educated workers. As the method used to estimate educational attainment in Fig. 4 does not allow a disaggregation 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 stage of education that employees completed. As the number of years for each stage 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. In the absence of other data, this number is taken as a proxy for the elasticity of



**Fig. 4.** Educational Attainment in Indonesia (average years of schooling per person), 1880–2008. *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 1870–2008. 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 types of schooling or between public and private institutions, nor does it account for 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 1880–2008 from annual statistical publications for Indonesia and the website of the Department of Education in Indonesia, <http://www.depdiknas.go.id/>.

**Table 1**

Share of labor income in GDP in Indonesia, 1975–2005 (billion Rupiah).

	Labor income			Capital income	Total GDP (factor cost)	Total GDP (market prices)	Labor 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
2005	1,064,463	421,705	1,486,168	1,348,467	2,834,635	2,770,960	52.4

*Sources:* BPS (1996a: 72), BPS (1999: 27), BPS (2003: 35), BPS (2005: 11), BPS (2008: Appendix 5).

output with respect to education for the entire period. The estimate 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 labor and non-labor income are the quinquennial I–O Tables and Indonesia’s System of Economic and Social Accounting Matrices and Extension (SESAME) which use the I–O tables as their ‘anchor’ (Keuning and Saleh 2000).<sup>8</sup> Unlike the I–O Tables, SESAME does identify non-cash labor income, as well as total wages and salaries.

<sup>8</sup> The income data in the I–O Tables comprise only the sum of wages and salaries received, which is generally estimated on the basis of Sakernas. They do not include income in kind, 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 with 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 labor 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).



**Table 2**  
Decomposition of economic growth in Indonesia, 1881–2008.

	$s_t$	$g_t^Q$	$g_t^K$	$g_t^L$	$g_t^{TFP}$	$g_t^{TFP}$
<i>A. Annual average growth</i>						
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		–3.1	2.8	1.2	1.5	–5.3
1933–41		3.8	1.6	1.3	1.6	2.2
1951–61		4.2	1.8	1.3	1.8	2.4
1962–66		0.4	0.6	2.3	3.3	–1.6
1967–74		8.5	3.3	2.4	3.3	5.3
1975–97		6.0	9.1	2.9	4.4	–0.9
1998–99		–6.5	2.9	2.1	3.7	–9.7
2000–08		5.1	4.0	2.0	3.1	1.7
<b>1881–08</b>		<b>3.6</b>	<b>4.3</b>	<b>1.7</b>	<b>2.3</b>	<b>0.2</b>
<i>B. Contribution to growth, assuming <math>s_t = 50\%</math> in 1880–1974</i>						
1881–99	50.0%		50%		30%	20%
1900–29	50.0%		102%		22%	–24%
1933–41	50.0%		21%		21%	58%
1951–61	50.0%		18%		22%	59%
1967–74	50.0%		19%		19%	62%
1975–97	44.3%		84%		32%	–15%
2000–08	52.4%		37%		31%	32%
<b>1881–08</b>	<b>48.9%</b>		<b>62%</b>		<b>31%</b>	<b>6%</b>
<i>C. Contribution to growth, assuming <math>s_t = 70\%</math> in 1880–1974</i>						
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%		13%		30%	57%
1967–74	70.0%		11%		27%	61%
<b>1881–08</b>	<b>63.6%</b>		<b>44%</b>		<b>41%</b>	<b>12%</b>

Notes: 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 1 indicates significant changes over time in the labor 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 1975–2005, and the 2005 share was used for 2005–08. No indications of the income shares of labor 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.<sup>9</sup> 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. The paper uses labor income shares of 50% and 70% for that purpose in the next section.<sup>10</sup>

All data presented in this section are necessarily rough, given the difficulties in the compilation of statistical data for 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

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 Fig. 1. The table shows that TFP growth has on average been low during 1880–2008, explaining only 6–12% of the annual average 3.6% GDP growth. Most economic growth can be explained on the basis of the mobilization of capital and labor, and improvements in the quality of labor, 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 tech-

<sup>9</sup> 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.

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

**Table 3**

TFP 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 <sup>a</sup>	1951–2008	0.6	12

Notes: 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.

<sup>a</sup> Assuming 60% labor income share 1951–74, unlike the 50% and 70% in Table 2.

nologies, 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 low contribution of TFP growth (only 10–11%) during the high-growth era of 1967–97, this finding may be further evidence of the ‘Solow Productivity Paradox’.

Table 2 reveals remarkably significant contributions of TFP growth to GDP growth during four periods in particular: 1933–41 (58–59% of 3.8% average annual growth), 1951–61 (57–59% of 4.2%), 1967–74 (61–62% of 8.5%) and 2000–08 (32% of 5.1%). What do these periods have in common? The figures for 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 setbacks in Indonesia’s economic development: respectively 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 setbacks caused a slowdown in GFCF and in GFCS growth. Consequently, subsequent economic recovery was based in first instance on a more efficient use of productive resources, particularly capital stock, assisted by economic policy and institutional changes that enhanced productivity and efficiency.

After 1930–32, this change took the form of import-replacing development strategies to offset 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 benefited food production and manufacturing, but was interrupted during 1942–49. It resumed after the country’s independence, particularly in the face of falling commodity export earnings in the wake of the 1951–52 Korea boom. But this period of expansion ended when an accumulation of erratic policies under President Sukarno paralyzed the economy during 1959–66. The regime change of 1966 eventually resulted in economic stabilization and a phase of rapid economic growth during 1967–97 under President Soeharto. This was carried by significant TFP growth during 1967–74, until GFCF took over as the main factor spurring economic growth during 1975–97. In each case, policy reforms took a few years to crystallize 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 paid hardly any 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 presents GDP in international prices, even though Indonesia featured only 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.



**Table 4**

TFP growth in manufacturing in Indonesia in various studies.

	Study	Period	Annual average TFP growth (%)	% TFP contribution to output growth
1	Aswicahyono 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 <sup>a</sup>
4	Hayashi (2005: 99, 107)	1986–96	1.9 (SMEs) 2.3 (LEs)	22 17
5	Ikhsan-Modjo (2006: 3 and 12)	1988–2000	1.6	16

<sup>a</sup> This source does not specify output growth, which for this table is calculated from national accounts data.

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 in 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 overestimated capital stock growth, which was based on an incomplete and unpublished BPS estimate, while he also underestimated the share of labor 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 of industrial firms in Indonesia employing 20 or more people. The results are shown in Table 4. They all suggest that in manufacturing 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) it assumes perfect elasticity of substitution of labor 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 Fig. 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, investment in machinery and equipment was predominant and sustained most of the rapid growth of output in that sector (Timmer, 1999: 83 and 89). Some technological change and efficiency gains were captured in the rates of TFP growth in manufacturing in Table 4, but other gains were most likely captured in the measured industrial capital stock, and cannot be disentangled.<sup>11</sup> On the other hand, as most investment outside manufacturing may have been in the form of non-residential structures, particularly investment in public infrastructure, the embodied efficiency gains may not have been as significant as was the case in manufacturing.

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 contribution of employment to economic growth during 1967–74 and 1975–97, shown in Table 2. 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, 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 and services, such as transport and communications, and/or in labor, 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 behavior.

A possible indication that TFP growth measures the residual is the fact that during 2000–08 the residual became positive, explaining a significant 32% of GDP growth. 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 came to be used more efficiently during 2000–08. Still, this change may be understood as an improvement in efficiency caused by the many growth-enhancing, or

<sup>11</sup> 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.

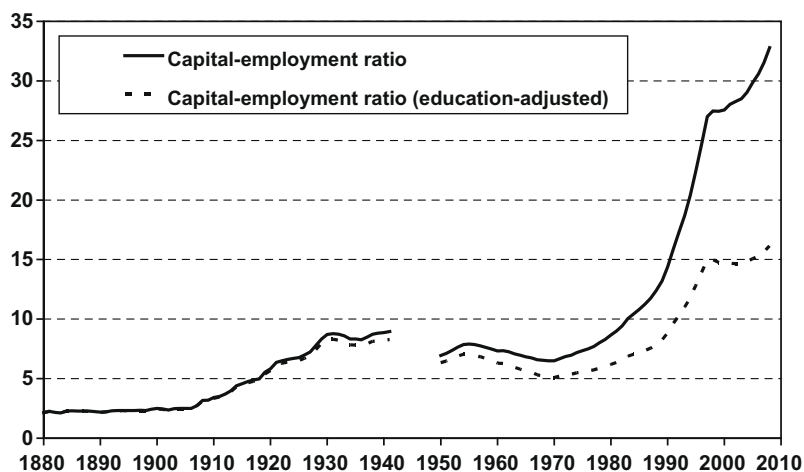


Fig. 5. Capital stock per person employed in Indonesia, 1880–2008 (million 2000 Rp). Source: Appendix 6.

rather inefficiency-decreasing, institutional changes that recent governments have 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 labor and capital. This paper did the same in Eq. (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 labor-saving or a capital-saving nature, the elasticity of substitution would be respectively more than, and less than 1. Hence, if technological change in Indonesia in recent decades was to a degree labor-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-labor ratio, which indeed increased very significantly in Indonesia, as Fig. 5 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.

## 5. Conclusion

This paper estimates 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 7–13% during 1880–2008. It also estimates that the growth of capital stock was responsible for a large part of GDP growth – 44–61% over the whole of this period, and 56–61% during the rapid growth years of 1967–98. Hence, 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 notes 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 1975–97. 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 (e.g. Maddison, 1987; Crafts, 2004) have generally been able to draw on a much wider range of historical statistical data than are available for Indonesia.

The negative residual TFP growth during 1900–29 and 1975–97 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 is found in the fact that TFP growth was significantly positive during 1933–41, 1951–61, 1967–74 and 2000–08, always following periods of economic recession or stagnation. During each of these periods, economic recovery may have been based in the first instance on a more productive use of available resources, particularly capital stock, and in the second instance, 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.

## Appendix

**Table A1**

Gross value added in 17 output sectors in Indonesia, 1880–2008 (billion 2000 Rupiah).

	Food crops	Animal 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
1880	12,933	4,244	710	135	1,290	357	1,806	4,443	1	273	6,214	373	937	5,494	982	4,446	0	44,638
81	14,447	4,299	837	185	1,304	432	1,676	4,488	1	278	6,533	390	1,399	5,570	1,023	4,607	0	47,470
82	13,284	4,351	734	184	1,311	388	1,536	4,513	1	347	6,375	415	1,397	5,422	1,065	4,544	0	45,868
83	12,621	4,410	733	202	1,327	395	1,449	4,570	2	305	6,344	491	1,437	5,352	1,178	4,551	0	45,367
84	14,605	4,469	801	227	1,341	435	1,661	4,616	2	333	6,798	546	1,642	5,647	1,446	4,768	0	49,338
1885	15,175	4,537	803	202	1,366	425	1,453	4,701	2	309	6,907	626	1,708	5,712	1,426	4,856	0	50,206
86	14,682	4,620	940	216	1,390	489	1,451	4,784	1	354	6,959	632	1,733	5,685	1,404	4,902	0	50,241
87	14,695	4,702	867	199	1,409	451	1,951	4,851	1	448	6,991	649	1,786	5,686	1,342	4,976	0	51,003
88	14,326	4,784	920	195	1,427	472	1,963	4,911	1	422	7,055	704	1,848	5,667	1,461	5,017	0	51,171
89	14,030	4,864	909	220	1,439	478	1,754	4,954	1	381	7,148	848	1,897	5,663	1,469	5,039	0	51,094
1890	13,567	4,961	793	217	1,475	427	1,677	5,078	1	418	7,059	951	1,850	5,591	1,285	5,073	0	50,423
91	13,555	5,002	983	237	1,483	516	1,991	5,107	1	456	7,215	1,095	1,903	5,654	1,289	5,150	0	51,638
92	15,121	5,055	1,028	244	1,503	538	2,184	5,174	1	403	7,449	1,154	1,780	5,813	1,161	5,297	0	53,905
93	16,112	5,107	828	231	1,502	448	2,174	5,171	2	386	7,551	1,169	1,818	5,896	1,262	5,353	0	55,010
94	15,533	5,155	1,045	267	1,522	555	2,385	5,241	2	485	7,674	1,218	1,876	5,897	1,481	5,429	169	55,935
1895	16,076	5,220	914	156	1,549	452	2,071	5,335	2	348	7,704	1,310	1,981	5,913	1,659	5,503	254	56,446
96	15,446	5,232	1,058	269	1,568	561	2,193	5,397	2	494	7,799	1,386	1,977	5,908	1,670	5,551	340	56,849
97	16,107	5,252	1,009	306	1,594	556	2,477	5,489	2	543	7,858	1,485	1,756	5,952	1,234	5,635	593	57,848
98	15,315	5,273	1,071	325	1,622	591	2,659	5,583	2	590	7,919	1,577	2,011	5,922	1,547	5,711	677	58,394
99	16,858	5,294	1,150	370	1,650	643	3,098	5,679	2	593	8,248	1,860	2,261	6,132	1,573	5,935	423	61,768
1900	17,289	5,317	1,213	373	1,678	671	4,024	5,776	3	634	8,429	2,084	2,205	6,197	1,592	6,097	509	64,089
01	17,121	5,318	1,215	360	1,699	666	3,234	5,848	3	641	8,422	2,242	1,970	6,166	1,319	6,078	931	63,234
02	15,665	5,322	1,396	443	1,720	778	2,687	5,920	3	880	8,392	2,515	2,008	6,112	1,528	6,080	593	62,041
03	17,007	5,327	1,372	471	1,741	780	3,511	5,993	4	776	8,571	2,699	2,030	6,237	1,519	6,262	1,357	65,657
04	17,605	5,334	1,318	458	1,762	751	2,818	6,068	4	821	8,735	2,881	2,184	6,313	1,684	6,350	1,528	66,614
1905	17,542	5,340	1,589	474	1,784	873	2,280	6,143	5	783	8,943	3,080	2,281	6,369	1,746	6,424	1,863	67,519
06	18,712	5,395	1,514	500	1,805	852	2,284	6,215	6	787	9,144	3,270	2,366	6,489	1,661	6,559	1,863	69,420
07	18,567	5,452	1,805	537	1,827	991	2,518	6,288	6	1,003	9,309	3,633	2,249	6,558	1,522	6,668	2,286	71,217
08	18,069	5,510	1,671	539	1,848	935	2,679	6,363	6	968	9,256	3,922	2,285	6,519	1,588	6,717	2,377	71,251
09	19,917	5,568	1,614	517	1,870	901	2,580	6,438	7	970	9,581	4,291	2,545	6,719	1,782	6,946	2,540	74,787
1910	21,282	5,628	1,749	551	1,892	973	3,260	6,514	8	1,237	10,011	4,786	2,745	6,936	2,052	7,242	2,540	79,407
11	21,912	5,689	1,705	681	1,915	1,010	4,395	6,592	9	1,363	10,240	5,533	2,838	7,073	2,010	7,485	2,794	83,242
12	21,657	5,815	1,998	640	1,937	1,116	4,869	6,670	10	1,537	10,357	6,087	2,757	7,133	1,876	7,645	2,547	84,650
13	22,431	5,942	1,846	643	1,960	1,053	5,516	6,748	12	2,019	10,626	6,560	2,912	7,270	2,498	7,900	2,625	88,559
14	22,838	6,148	1,831	637	1,983	1,044	4,426	6,827	13	1,772	10,720	6,732	3,039	7,309	2,707	7,920	2,625	88,572
1915	23,519	6,248	1,783	640	2,006	1,025	3,768	6,906	14	1,914	10,846	6,674	3,422	7,389	2,799	8,038	2,794	89,785
16	22,385	6,188	1,750	800	2,030	1,078	5,101	6,987	15	1,825	10,800	7,038	3,436	7,324	2,788	8,141	2,887	90,572
17	23,450	6,134	1,565	831	2,053	1,013	3,849	7,069	16	1,745	10,817	7,167	3,564	7,381	2,932	8,205	3,048	90,841

18	24,763	6,059	1,781	848	2,054	1,112	3,458	7,072	17	2,068	11,151	7,245	3,468	7,531	2,793	8,298	2,963	92,683
19	25,605	5,988	2,974	680	2,081	1,546	5,065	7,166	18	1,581	11,943	8,311	4,473	7,828	3,919	8,746	3,556	101,480
1920	23,631	5,890	2,416	765	2,109	1,346	4,300	7,260	20	2,449	11,508	9,590	3,416	7,673	3,549	8,654	4,066	98,644
21	22,037	6,024	2,504	798	2,134	1,397	4,401	7,347	23	2,233	11,576	10,231	3,607	7,621	4,209	8,785	3,934	98,861
22	24,169	6,088	2,623	880	2,160	1,481	4,728	7,435	24	2,156	11,780	9,601	3,894	7,758	3,899	9,023	3,959	101,657
23	23,810	6,284	2,915	923	2,186	1,623	5,315	7,525	25	2,317	11,971	9,368	4,282	7,799	3,638	9,122	4,609	103,709
24	24,861	6,455	3,447	1,015	2,212	1,887	5,761	7,615	26	2,220	12,637	9,802	5,195	8,043	3,705	9,471	4,749	109,100
1925	23,716	6,939	3,712	1,193	2,239	2,075	5,330	7,707	27	2,811	13,118	10,476	5,134	8,133	3,986	9,664	4,969	111,230
26	25,747	7,240	3,840	1,120	2,266	2,125	6,589	7,801	30	3,195	13,627	11,265	5,198	8,379	4,396	10,090	4,928	117,834
27	26,973	7,373	4,145	1,302	2,293	2,408	6,810	7,896	33	3,618	14,212	12,570	5,455	8,651	4,699	10,493	6,370	125,299
28	26,029	7,823	4,499	1,499	2,321	2,567	6,981	7,992	37	4,213	14,678	13,800	5,318	8,776	5,212	10,706	7,450	129,901
29	24,408	7,566	4,496	1,522	2,350	2,870	7,082	8,743	42	4,882	14,979	14,802	4,781	8,790	5,601	10,812	9,112	132,837
1930	26,969	7,279	4,180	1,526	2,378	2,145	7,016	9,900	47	4,097	15,134	14,216	4,559	8,823	5,677	10,912	9,680	134,540
31	26,375	7,087	4,171	1,539	2,414	1,674	5,733	9,261	48	3,041	14,269	12,860	4,403	8,487	5,449	10,704	8,244	125,759
32	27,520	6,634	4,082	1,470	2,449	1,304	3,358	8,016	45	2,563	13,372	11,974	4,463	8,278	5,369	10,528	9,045	120,471
33	28,115	6,465	4,215	1,171	2,485	1,096	3,046	8,860	43	2,173	13,607	11,209	4,652	8,270	5,315	10,601	9,900	121,224
34	25,846	6,595	4,838	1,045	2,522	1,237	3,940	9,954	41	2,129	14,026	10,836	4,634	8,232	5,335	10,693	10,793	122,697
1935	28,402	6,783	4,738	938	2,559	1,355	4,600	9,545	43	2,463	14,218	9,728	4,853	8,322	5,242	10,878	10,942	125,612
36	30,132	6,667	4,987	1,010	2,597	1,507	6,186	9,602	47	2,738	14,650	10,339	5,407	8,527	5,737	11,284	11,604	133,020
37	29,759	7,805	5,549	1,419	2,635	1,923	7,771	13,262	52	3,108	17,502	11,517	5,680	9,071	6,077	12,060	13,158	148,348
38	31,383	6,980	5,202	1,290	2,674	1,989	5,469	12,531	58	3,464	16,922	12,278	5,614	9,057	6,689	12,092	13,296	146,989
39	31,525	7,213	5,293	1,420	2,714	2,036	5,755	12,357	65	3,942	16,825	12,286	5,030	9,053	5,634	12,184	14,402	147,733
1940	33,237	7,245	5,446	1,492	2,754	2,172	8,838	14,138	90	4,284	18,166	11,920	7,437	9,425	7,507	12,972	14,385	161,510
41	34,549	7,397	5,786	1,553	2,863	2,397	10,275	15,256	94	4,032	19,118	12,980	8,361	9,701	7,799	13,480	12,458	168,099
49	30,075	6,859	4,314	532	2,492	1,010	5,548	7,434	68	2,531	12,744	6,961	4,444	7,980	3,186	11,115	10,023	117,313
1950	28,104	7,033	7,269	565	2,329	1,489	6,168	10,262	74	2,533	14,803	8,504	5,137	8,383	6,072	11,966	11,227	131,918
51	29,091	7,286	8,343	713	3,040	1,445	6,316	13,101	81	3,035	17,002	9,371	4,692	8,796	4,435	12,464	12,864	142,075
52	28,367	8,044	7,303	884	3,414	1,820	6,827	13,817	87	4,159	17,965	9,349	5,344	8,947	5,943	14,176	14,497	150,943
53	29,981	7,898	6,088	995	3,678	1,889	6,511	13,845	104	3,807	17,868	10,466	5,670	9,026	5,828	14,848	17,409	155,912
54	33,584	7,966	7,468	997	3,748	1,701	6,739	14,533	109	4,690	18,974	11,182	6,869	9,433	5,391	15,561	18,449	167,394
1955	30,953	8,841	7,030	1,010	3,994	1,894	6,219	15,301	123	5,279	19,124	12,463	6,388	9,459	4,316	15,734	19,944	168,073
56	31,557	9,036	6,728	980	4,257	1,805	5,715	16,302	127	5,692	20,199	11,957	6,360	9,570	4,623	16,014	21,635	172,558
57	31,862	8,639	6,735	993	4,339	1,904	5,482	16,971	128	5,193	20,072	12,260	7,568	9,643	5,389	16,284	26,422	179,884
58	34,876	8,507	6,324	930	4,096	1,658	4,563	15,184	145	4,431	19,687	11,193	7,367	9,564	5,104	16,351	27,524	177,503
59	35,642	9,042	7,686	934	4,496	1,720	4,395	15,352	163	4,627	20,301	12,299	7,894	9,798	5,302	17,285	31,594	188,527
1960	37,026	9,099	7,798	861	4,514	1,883	4,484	15,670	163	4,627	20,740	13,646	8,194	9,963	5,876	18,059	34,775	197,379
61	35,052	11,459	7,895	870	4,843	2,083	3,914	18,279	177	5,974	23,652	13,150	8,869	10,274	6,287	19,014	35,924	207,715
62	38,740	11,370	8,643	826	5,196	1,751	3,507	17,206	192	5,037	23,496	12,442	7,543	10,292	3,119	19,477	38,388	207,224
63	34,160	11,049	8,836	840	5,575	1,654	3,029	15,360	222	3,807	22,279	12,023	6,457	9,949	3,761	19,650	37,592	196,241
64	38,677	11,496	7,726	861	5,919	1,188	3,216	16,544	251	3,807	23,195	11,785	7,619	10,212	3,667	20,777	38,770	205,710
1965	37,563	11,423	8,583	905	6,572	613	3,196	19,027	251	4,334	24,318	12,197	7,327	10,377	3,355	21,813	40,695	212,550
66	40,179	11,938	8,370	806	7,165	764	2,828	17,388	251	4,919	24,142	10,471	6,128	10,386	3,417	22,691	39,336	211,180

(continued on next page)

Table A1 (continued)

	Food crops	Animal 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	36,985	10,380	8,314	803	7,038	1,440	2,804	19,160	325	4,275	24,134	9,101	5,881	10,265	3,771	21,168	42,792	208,638
68	41,953	9,814	8,419	818	6,910	3,705	3,532	21,659	340	5,154	26,447	9,436	6,241	10,724	3,543	22,134	51,002	231,831
69	41,662	10,885	9,251	887	7,240	4,477	3,829	23,070	444	7,028	28,186	9,321	7,141	11,032	6,403	23,008	62,851	256,715
1970	46,232	10,954	9,184	939	7,324	6,369	4,547	30,198	444	8,785	32,991	9,964	8,413	11,751	6,635	24,644	72,270	291,644
71	47,188	9,405	8,795	1,030	7,420	7,925	4,887	30,124	444	10,542	33,292	11,182	9,230	11,920	7,568	24,983	75,534	301,470
72	45,963	10,709	9,521	1,075	7,565	9,527	5,579	34,848	447	13,001	36,769	12,053	10,914	12,420	9,599	25,950	91,762	337,703
73	52,416	10,869	9,014	1,062	7,617	14,287	6,410	41,302	491	14,536	42,834	12,686	12,171	13,223	11,582	27,773	113,331	391,604
74	54,051	10,574	9,053	1,211	7,967	12,003	7,839	42,349	565	16,768	43,444	12,449	11,935	13,328	13,995	28,413	116,379	402,321
1975	53,832	10,968	9,234	1,268	8,288	9,256	7,476	45,566	592	17,991	44,189	12,381	12,352	13,450	16,222	29,363	110,617	403,044
76	54,645	11,779	10,241	1,326	8,841	13,118	8,025	48,313	643	18,331	47,841	13,336	13,141	13,898	18,263	31,124	127,659	440,522
77	55,522	12,194	10,076	1,432	9,371	12,688	8,759	53,052	657	21,349	50,245	15,235	14,269	14,305	19,222	32,993	142,762	474,130
78	61,241	12,205	10,536	1,498	9,823	14,933	8,327	56,903	736	23,476	54,214	17,190	16,015	14,910	21,883	35,433	138,452	497,776
79	61,990	12,335	12,199	1,591	10,424	14,048	9,589	64,986	857	24,055	59,412	19,044	17,110	15,411	27,701	37,913	134,693	523,357
1980	68,434	13,132	12,210	1,670	11,028	15,443	10,302	76,338	933	26,274	67,218	21,109	19,934	16,296	34,821	40,727	133,778	569,647
81	74,995	13,472	12,562	1,732	11,414	13,275	10,249	84,095	1,076	29,599	72,320	23,732	21,626	16,924	38,108	42,789	135,828	603,796
82	74,030	13,098	11,466	1,955	11,909	12,816	11,339	85,120	1,263	31,144	72,556	24,572	22,229	16,976	36,067	43,725	112,171	582,435
83	79,378	12,496	12,508	2,045	13,203	14,418	8,859	86,992	1,350	33,063	76,909	26,856	23,176	17,443	41,542	45,549	105,440	601,227
84	83,849	13,463	12,804	2,428	13,560	12,970	8,231	106,176	1,394	31,600	77,649	29,117	27,799	17,858	43,616	48,423	113,007	643,944
1985	86,041	14,506	14,038	2,784	14,508	12,337	8,536	118,058	1,553	32,422	80,622	29,404	29,678	18,225	46,950	51,062	101,318	662,041
86	88,202	14,699	14,064	3,062	15,336	12,888	9,451	129,025	1,849	33,148	87,019	30,593	34,226	18,847	49,911	53,950	106,375	702,645
87	89,127	15,035	14,678	3,077	15,927	14,036	10,109	142,713	2,128	34,543	92,956	32,363	35,957	19,653	53,576	57,057	106,252	739,186
88	93,137	15,754	15,451	3,144	16,847	14,690	10,595	159,828	2,361	37,824	100,936	34,152	36,870	20,455	57,693	61,187	102,567	783,491
89	97,014	17,019	20,077	←	17,764	15,058	12,478	177,860	2,681	42,835	112,288	37,830	44,166	24,046	61,074	65,171	107,665	855,027
1990	98,233	18,192	22,006	←	18,371	15,290	15,028	199,105	3,201	50,083	124,260	41,312	52,113	28,397	63,865	70,185	112,711	932,354
91	98,101	19,828	24,053	←	19,690	15,568	18,814	220,151	3,472	57,520	102,250	44,815	58,938	32,415	65,840	75,820	123,696	980,971
92	105,106	21,158	25,687	←	20,723	15,824	22,916	242,560	3,780	64,681	149,579	48,343	65,687	32,974	67,789	82,108	119,424	1,088,339
93	104,416	22,163	27,318	←	21,826	16,033	26,068	270,159	4,200	74,054	163,917	51,990	72,246	33,533	69,161	89,714	119,547	1,166,346
94	102,185	23,052	28,702	←	22,939	16,118	29,695	303,555	4,727	85,056	174,995	56,328	82,250	34,888	70,067	97,819	122,644	1,255,019
1995	107,208	24,260	30,037	←	24,029	16,125	36,667	336,566	5,479	96,044	188,876	61,113	93,412	36,812	70,972	106,354	122,645	1,356,598
96	109,470	25,488	31,379	←	25,326	16,484	42,561	375,581	6,226	108,300	204,005	66,419	97,427	38,965	71,872	115,724	124,418	1,459,647
97	106,352	26,738	31,808	←	26,792	18,392	45,493	395,304	6,996	116,269	216,238	71,073	102,942	40,902	72,729	123,663	123,679	1,525,369
98	107,972	23,082	34,045	←	26,410	16,963	43,982	350,095	7,179	73,882	176,292	60,323	67,952	32,774	67,404	112,395	120,681	1,321,432
99	110,659	24,429	32,431	←	28,963	16,085	45,836	363,824	7,804	72,484	174,830	59,869	61,188	30,805	68,522	113,871	114,460	1,326,061
2000	112,356	25,231	32,491	←	30,411	16,343	50,536	385,598	8,394	76,573	184,970	65,012	64,314	31,872	69,460	119,054	117,156	1,389,770
01	112,580	27,629	35,015	←	31,912	16,738	56,794	398,324	9,058	80,080	192,541	70,276	68,991	34,142	70,200	125,622	111,451	1,441,353
02	114,982	29,431	37,073	←	33,003	17,125	61,801	419,388	9,868	84,470	199,649	76,173	72,322	37,321	70,482	134,141	108,131	1,505,359
03	119,165	30,647	38,694	←	34,668	17,214	64,517	441,755	10,349	89,622	210,653	85,458	76,434	40,512	71,148	143,249	103,087	1,577,171
04	122,612	31,673	38,849	←	36,596	17,434	61,464	469,952	10,898	96,334	222,290	96,897	81,420	44,112	72,324	155,026	98,636	1,656,517
2005	125,802	32,347	39,811	←	38,746	17,177	68,328	491,561	11,584	103,598	241,887	109,262	85,570	47,715	73,700	166,834	96,895	1,750,815
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	133,889	34,221	43,136	←	43,653	16,504	76,665	538,085	13,517	121,901	280,486	142,327	94,722	55,819	80,778	192,634	94,757	1,963,092
08	141,800	35,553	44,793	←	45,753	16,440	77,111	557,766	14,994	130,816	301,498	166,077	101,934	60,775	84,378	207,229	95,190	2,082,105

Sources: These estimates are based on Indonesia's new national accounts for 2000–08, following the latest 2000 revision (see Van der Eng, 2005), and updates. The 2000–08 output data were linked to official national accounts data for 1983–2000 prior to the 2000 revision. For 1880–1982, the 1983–2008 series, except for manufacturing industry 1930–75, were linked to output indicators following the methodology outlined 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 TFP, 1880–2008.

	(Billion 2000 Rp)		Employment (1000)	Educational attainment per person (years)
	GDP (at market prices)	Non-residential capital stock		
1880	44,638	26,758	12,483	0.04
81	47,470	28,446	12,606	0.04
82	45,868	27,495	12,732	0.04
83	45,367	27,200	12,859	0.04
84	49,338	29,568	12,988	0.05
1885	50,206	30,086	13,119	0.05
86	50,241	30,112	13,252	0.05
87	51,003	30,571	13,386	0.05
88	51,171	30,676	13,523	0.06
89	51,094	30,633	13,661	0.06
1890	50,423	30,236	13,802	0.06
91	51,638	30,965	13,944	0.06
92	53,905	32,315	14,089	0.07
93	55,010	32,971	14,236	0.07
94	55,935	33,531	14,385	0.07
1895	56,446	33,836	14,536	0.07
96	56,849	34,082	14,690	0.08
97	57,848	34,677	14,846	0.08
98	58,394	35,011	15,005	0.08
99	61,768	37,024	15,166	0.08
1900	64,089	38,414	15,330	0.09
01	63,234	37,903	15,490	0.09
02	62,041	37,198	15,652	0.09
03	65,657	39,357	15,817	0.10
04	66,614	39,927	15,985	0.10
1905	67,519	40,471	16,155	0.11
06	69,420	40,759	16,331	0.11
07	71,217	45,079	16,509	0.12
08	71,251	52,811	16,690	0.12
09	74,787	54,020	16,874	0.13
1910	79,407	58,178	17,061	0.14
11	83,242	60,598	17,241	0.15
12	84,650	64,717	17,425	0.16
13	88,559	69,940	17,611	0.17
14	88,572	78,268	17,801	0.18
1915	89,785	82,397	17,993	0.19
16	90,572	86,515	18,173	0.20
17	90,841	89,999	18,357	0.22
18	92,683	92,434	18,545	0.23
19	101,480	103,697	18,736	0.25
1920	98,644	110,449	18,931	0.26
21	98,861	121,580	19,132	0.28
22	101,657	125,744	19,338	0.29
23	103,709	129,119	19,539	0.31
24	109,100	132,381	19,744	0.33
1925	111,230	135,180	19,953	0.35
26	117,834	140,766	20,165	0.37
27	125,299	147,594	20,382	0.39
28	129,901	158,907	20,404	0.42
29	132,837	171,899	20,606	0.44
1930	134,540	181,478	20,813	0.47
31	125,759	184,971	21,091	0.49
32	120,471	186,564	21,374	0.51
33	121,224	186,484	21,662	0.53
34	122,697	183,100	21,955	0.56
1935	125,612	185,254	22,259	0.58
36	133,020	186,361	22,572	0.60
37	148,348	194,363	22,907	0.62
38	146,989	202,936	23,252	0.64
39	147,733	208,005	23,604	0.66
1940	161,510	209,669	23,649	0.68
41	168,099	215,555	24,088	0.71
1949	117,313		27,912	0.82
1950	131,918	197,227	28,434	0.82
51	142,075	206,233	28,956	0.83
52	150,943	216,064	29,336	0.87
53	155,912	224,614	29,403	0.91
54	167,394	231,088	29,418	0.96

(continued on next page)



Table A2 (continued)

	(Billion 2000 Rp)		Employment (1000)	Educational attainment per person (years)
	GDP (at market prices)	Non-residential capital stock		
1955	168,073	234,524	29,672	1.02
56	172,558	236,563	30,056	1.07
57	179,884	236,526	30,498	1.12
58	177,503	236,647	31,052	1.16
59	188,527	236,880	31,612	1.22
1960	197,379	236,200	32,279	1.29
61	207,715	240,232	32,709	1.36
62	207,224	242,919	33,456	1.44
63	196,241	242,680	34,225	1.52
64	205,710	243,710	35,016	1.61
1965	212,550	244,667	35,834	1.70
66	211,180	247,468	36,672	1.78
67	208,638	247,348	37,534	1.87
68	231,831	251,258	38,430	1.96
69	256,715	255,740	39,318	2.05
1970	291,644	262,058	40,279	2.13
71	301,470	275,712	41,261	2.21
72	337,703	290,177	42,377	2.28
73	391,604	303,745	43,523	2.33
74	402,321	319,589	44,486	2.39
1975	403,044	336,419	45,726	2.45
76	440,522	352,660	47,000	2.52
77	474,130	372,794	48,310	2.61
78	497,776	397,818	49,657	2.70
79	523,357	422,625	51,041	2.81
1980	569,647	454,004	52,421	2.92
81	603,796	488,300	54,294	3.05
82	582,435	530,502	56,238	3.18
83	601,227	585,570	58,254	3.32
84	643,944	629,553	60,347	3.45
1985	662,041	675,301	62,519	3.59
86	702,645	729,203	64,774	3.74
87	739,186	789,056	67,114	3.89
88	783,491	861,528	69,543	4.03
89	855,027	950,963	72,064	4.16
1990	932,354	1,070,366	74,396	4.29
91	980,971	1,206,918	76,137	4.42
92	1,088,339	1,345,078	77,928	4.55
93	1,166,346	1,491,960	79,768	4.69
94	1,255,019	1,665,386	81,660	4.82
1995	1,356,598	1,870,199	83,311	4.96
96	1,459,647	2,101,456	85,003	5.10
97	1,525,369	2,342,446	86,738	5.24
98	1,321,432	2,432,763	88,517	5.38
99	1,326,061	2,480,786	90,342	5.52
2000	1,389,770	2,550,631	92,528	5.66
01	1,441,353	2,629,659	93,818	5.78
02	1,505,359	2,706,739	95,738	5.88
03	1,577,171	2,783,430	97,689	5.97
04	1,656,517	2,894,323	99,665	6.06
2005	1,750,815	3,033,085	101,652	6.14
06	1,847,293	3,168,553	103,635	6.23
07	1,963,092	3,331,091	105,632	6.32
08	2,082,105	3,530,096	107,637	6.39

Sources: See Table A1 and main text.

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