

Capital Accumulation plus Foreign Technology Assimilation: An Integrated Plant-Level Account of Productivity Growth in Indonesian Manufacturing

Jojo Jacob^a and Bart Los^b

^aEindhoven University of Technology, Department of Technology Management/Eindhoven Centre for Innovation Studies, P.O. Box 513, NL-5600 MB Eindhoven, The Netherlands; e-mail: j.jacob@tm.tue.nl

^bUniversity of Groningen, Faculty of Economics/Groningen Growth and Development Centre, P.O. Box 800, NL-9700 AV Groningen, The Netherlands; e-mail: b.los@rug.nl

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1. Introduction

For a long time already, development scholars have debated over the sources of high labor productivity growth rates in East-Asian countries. Followers of Young (1995) stressed the traditional accumulationist view that high investment rates should be held responsible. Assimilationists (like Kim, 1997, and Nelson and Pack, 1999), however, explained the remarkably high labor productivity growth rates by emphasizing the ability of the East-Asian countries to use technologies developed elsewhere. Recently, an increasing number of studies conclude that the accumulationist line of reasoning does not suffice to explain actual growth performances (see, e.g., Easterly and Levine, 2001).

Assimilationists do not deny the importance of investment in modern production equipment. To our opinion, a formal growth model that integrates the roles of investment and assimilation to explain macroeconomic growth performances is still lacking. Recently, however, Los and Timmer (2005) proposed an accounting framework that goes a long way into this direction. They agreed with Basu and Weil (1998) that technological progress in very advanced economies is very unlikely to have beneficial effects for developing countries, because of what Abramovitz (1989) calls “lack of congruence”. Only massive investments in modern machinery by developing economies can save them from being trapped in a situation in which they do not attain any labor productivity growth themselves, while advanced countries are continuously raising labor productivity by innovation at the advanced end of the technological spectrum. Hence, substantial capital accumulation is a necessary condition for growth. Los and Timmer

(2005) contend that it is not a sufficient condition, however. If developing countries turn out to be unable to assimilate knowledge pertaining to their increasingly advanced capital stocks, they might still get stuck at low labor productivity levels, far below the frontier of maximum attainable labor productivity levels for ranges of capital intensities. By estimating such frontiers and analyzing the actually observed labor productivity levels, they find that assimilation of knowledge is far from perfect indeed, at least in an international macroeconomic setting.

Like Los and Timmer (2005), this paper adopts an accounting perspective to economic growth. It focuses on the performance of the manufacturing sector in Indonesia in the pre-crisis period 1988-1995. To what extent can its labor productivity growth performance be attributed to productive use of foreign technology by productivity leaders in Indonesia? How much did rapid assimilation of this knowledge by other plants contribute? And to what degree can investment in physical capital goods be held responsible? The paper adds to the relevant body of literature in at least two respects. First, we adopt a microdata-based approach. We first carry out a productivity growth accounting exercise for individual plants. Next, we aggregate the results to several levels: 5-digit industries, broader industry classes and finally the manufacturing sector as a whole. In doing this, we account for the uneven growth patterns of high productivity and low productivity plants and for the effects of entry and exit, by extending the decomposition proposed by Griliches and Regev (1995). Second, the paper does not only estimate the productivity growth effects of accumulation and assimilation in a unified framework, but also relates assimilation performance to variables that are generally considered to affect “absorptive capacity” (Cohen and Levinthal, 1989), i.e. the capacity to benefit from knowledge developed elsewhere. This allows us to give indications of the labor productivity-enhancing effects of increasing labor quality, increasing foreign ownership and so on.

Our plant-level dataset for Indonesia originates from two datasets constructed by the Indonesian Bureau of Statistics (BPS). In the recent past, these datasets have been used intensively by researchers interested in the effects of foreign technology on productivity performance in Indonesian manufacturing, see e.g. Blomström and Sjöholm (1999), Blalock and Gertler (2004), Okamoto and Sjöholm (2005), Takii (2005), and Todo and Miyamoto (2006). Although many of the issues in the present paper already popped up in these contributions, we feel that this paper is the first one to adopt an integrative approach, which allow us to derive results for the Indonesian manufacturing sector using a bottom-up approach.

The organization of the paper is as follows. In the next section, we will discuss theories that inspired our approach. Section 3 is devoted to an introduction of our estimation and accounting framework. A description of the procedures we adopted to

produce a suitable dataset is given in Section 4, after which Section 5 presents the results. Section 6 concludes.

2. Accumulation-Driven and Assimilation-Driven Growth

Convergence (or its absence) of labour productivity levels has attracted a lot of attention, both from economic theorists and from more empirically oriented scholars. Although it is hard to classify theories in a field characterised by synthesis and hybridisation, roughly two categories of theories can be discerned. We follow Nelson and Pack (1999) in using the labels ‘accumulation theories’ and ‘assimilation theories’. Accumulation theories basically assume that raising capital intensities automatically leads to labor productivity growth, although increasingly more investment is required for a given productivity gain. In this view, labor productivity growth is governed by movements along the production function of a given country, sector, firm or plant.

Assimilation theories challenge this view. Productivity gains do not result from accumulation, but are due to firms or countries investing in their ‘absorptive capacities’, to assimilate knowledge related to innovations developed elsewhere. As a result, labor productivity growth is governed by the shifts in the production function, although investment in modern capital goods is a prerequisite for attaining higher production functions. Nelson and Pack (1999), for example, note that Newly Industrialised Countries (NICs) such as Korea and Taiwan had no experience at all in using technologies related to electronics in the 1960s. By the 1980s, this had radically changed, with firms from these countries beginning to compete in the global electronics marketplace. Other countries with similar initial levels of development as Korea and Taiwan could barely match the success of these countries in this field. As Nelson and Pack point out, it is very unlikely that differences in investment in capital goods alone can be held responsible for such differences. In the view of assimilationists, policies to stimulate entrepreneurship and learning have been much more important. Such a view of macroeconomic performance can, with relatively minor modifications, be transferred to studies at firm or plant level. The resource-based view of the firm (see Teece 2000, for example) stresses that long-run firm performance is mainly determined by learning capabilities.

In this paper, we will differentiate between two barriers to attaining labor productivity levels attained by better performing plants. The first type of barrier relates most strongly to the issues mentioned above. Pack (1987) and Van Dijk (2005) show that plants that are similar in terms of the types of machines installed attain widely varying

productivity levels.¹ The differences in learning and organizational capabilities across firms show up in different productivity figures for plants with more or less identical equipment installed. The second type of barrier is quite closely associated with what Abramovitz (1989) labelled ‘technological incongruence’. A similar idea has recently been proposed in the form of a formal model by Basu and Weil (1998). They defined technologies as particular combinations of inputs, or in other words, capital-labor ratios. New knowledge is only ‘appropriate’ within a specific range of such technologies. Firms or countries benefit from new technologies in the short run only if these are comparable to the existing technologies which they operate.² In the longer run, non-appropriate innovations can become appropriate if the firm or country invests to such an extent that it shifts its technology to a capital intensity level comparable to the innovating firm or country.³ The predictions concerning convergence and divergence of productivity levels that follow from the Basu and Weil model are based on the assumption that more capital intensive technologies allow producers to attain higher maximum levels of labor productivity.

Los and Timmer (2005) showed that both types of barriers to catch-up play an important role in the empirics of macroeconomic growth. We adopt several parts of their methodology to investigate how innovations, changes in absorptive capacity and technological upgrading through investment in capital goods contribute to the labor productivity growth experiences of Indonesia’s manufacturing plants. In this way, we are able to integrate the views of accumulationists and assimilationists in a unified framework.

3. Methodology

The methodology we adopt consists of three parts. First we outline the decomposition of labor productivity growth (or decline) of a plant into the effects of innovation, assimilation and technology upgrading, which creates potential for spillovers. Next, we discuss the estimation methods required to arrive at the quantification of these effects.

¹ Pack (1987) studied the performance of textile plants in Kenya, the Philippines and the UK. Van Dijk (2005) focused on the productivity levels of paper-making plants in Indonesia and Finland.

² Basu and Weil (1998) illustrate this concept by arguing that new knowledge pertaining to the very capital-intensive maglev-trains in Japan will not be useful to transporters in Bangladesh using very capital-extensive bullock carts technologies.

³ Atkinson and Stiglitz (1969) introduced the concept of ‘localized learning by doing’ by which they suggested that firms improve the productivity of a particular mix of capital and labor over time. Basu and Weil (1998) extended this notion by emphasizing the importance of localized knowledge spillovers.

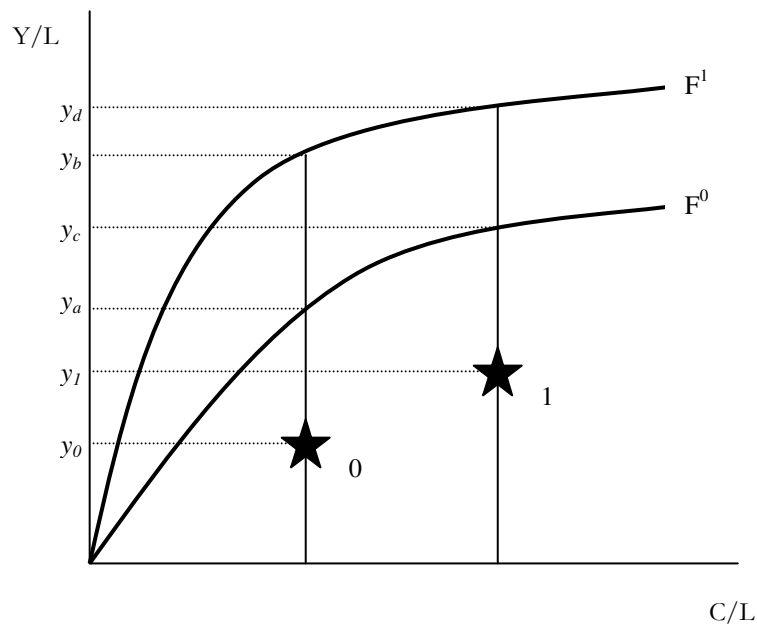
Finally, we introduce our aggregation procedures to transform plant-level outcomes into results for industries and broader aggregates.

3.1. Identifying the Sources of Growth at the Plant Level

Los and Timmer (2005) decomposed labor productivity growth rates of a group of countries, between 1970 and 1990, into the effects of movements towards the frontier, or changes in technical efficiency (assimilation), movements of the frontier (innovation), and capital deepening (creating potential). The decomposition form itself was popularised by Kumar and Russell (2002), but Los and Timmer were the first to link their results to theories discussed in the previous section. Our approach starts from a similar perspective.

Figure 1 shows a plant's actual labor productivity levels y_0 and y_1 in an industry with production frontiers f^0 and f^1 for periods 0 and 1, respectively.

FIGURE 1: *Labor Productivity Growth Decomposition*



The labor productivity change (y_1/y_0) of this plant can be decomposed in the following way:

$$\frac{y_1}{y_0} = \left(\frac{y_1}{y_d} \cdot \frac{y_a}{y_0} \right) \cdot \left(\frac{y_c}{y_a} \cdot \frac{y_d}{y_b} \right)^{0.5} \cdot \left(\frac{y_b}{y_a} \cdot \frac{y_d}{y_c} \right)^{0.5} \quad (1)$$

or

$$(1 + \hat{y}^T) = (1 + \hat{y}^A) \cdot (1 + \hat{y}^C) \cdot (1 + \hat{y}^I) \quad (2)$$

where a hat refers to a proportional growth rate. If industry-specific frontiers are available for two periods in time, this labor productivity decomposition can be done for each and every plant within that industry.

In the first term on the right hand side $(1 + \hat{y}^A)$, a value of \hat{y}^A larger than 0 indicates that the plant under consideration has increased its labor productivity for the technology operated. In other words, it indicates that the plant has been able to bring about an increased exploitation of technological potential (the maximum productivity observed for the equipment operated). We call this the *assimilation* effect.⁴ The second explanatory factor $(1 + \hat{y}^C)$ indicates the changes in labor productivity due to increases in capital intensity alone, everything else constant. While a higher capital intensity in itself does not yield higher labor productivity, it can lead to an upward shift in the attainable or the ‘target’ productivity levels, depending on the slope of the frontier. Therefore, a value greater than 0 for \hat{y}^C can be interpreted as *creating potential*.⁵ The third factor $(1 + \hat{y}^I)$ points to the effect of localized technological change that results in the upward shift of the production frontier. Assuming that the plant’s capital intensity remains constant, a positive value for \hat{y}^I indicates that it has benefited from an increase in the maximum attainable labor productivity levels for the given technologies (given a certain distance from the frontier).

Kumar and Russell (2002) and Los and Timmer (2005) estimated the productivity frontiers for the beginning and end periods using Data Envelopment Analysis (DEA). We follow a similar approach, but with the key difference that we derive the frontier labor productivity levels by means of Stochastic Frontier Analysis (SFA). This change of method has advantages and drawbacks. The major drawback is that truly localized

⁴ Below we will argue that our estimation framework allows us to decompose assimilation effects into ‘explained assimilation’ (explained by means of absorptive capacity indicators) and ‘unexplained assimilation’.

⁵ The component ‘creating potential’ can be better understood from the assimilationist view of growth discussed in the preceding section. The increased ‘potential’ from an increase in capital-labor ratio can be realized only if the efficiency level at the final capital intensity is at least equal to, if not greater than, that at the initial capital intensity. This requires an increase in absorptive capacity in tune with the increase in the ‘target’ productivity level. As has been the case in a vast majority of less developed countries, their inability to enhance absorptive capacity and entrepreneurship stood in the way of their achieving growth similar to that in the East Asian NICs—despite comparable investment rates. Note in this context that the simple evocation of the term ‘capital deepening’, as is en vogue in the contemporary literature on the empirics of growth, can therefore be highly misleading—masking many of the significant dynamics of growth.

innovation cannot be modelled, since estimation will always result in an identical proportional growth rate across the full range of technologies. The distance to the frontier, however, can well change, thereby allowing potentials for spillovers to change. The major advantage is that the location of the frontier is not very sensitive to measurement errors for a small number of firms. As is well known (see, e.g. Coelli *et al.* 1998), DEA results can be distorted quite a bit. In view of the sizeable measurement and reporting errors that are often found in plant level surveys, especially in developing countries, we feel that the net advantage of SFA as compared to DEA is clearly positive.

3.2. Plant-Level Estimation Method

In recent years, a number of studies have employed stochastic frontier estimations for estimating and explaining inefficiencies of firms and plants in industries. Until recently, the standard approach was a two-stage estimation procedure, in which the production frontier is first estimated. In the second stage, the resulting inefficiencies (the vertical distances from the observed productivities to the estimated frontier) are regressed on firm-specific variables (see e.g. Pitt and Lee 1981). Estimation in the second stage, however, contradicts the assumption of identically distributed inefficiency effects that underlies the estimation of the stochastic frontier in the first stage. To overcome this methodological problem, several authors have suggested single-stage procedures for simultaneously estimating both the stochastic frontier and inefficiency functions. The Battese and Coelli (1995) model is one such approach.

Consider the following production function (in logarithms) for panel data.

$$y_{it} = \alpha + X_{it}\beta + \mathcal{E}_{it} \quad (3)$$

where y_{it} is the dependent variable corresponding to the i^{th} plant and time t , X is a vector of explanatory variables, and \mathcal{E}_{it} is the composite error term. The latter consists of a white noise error v_{it} : $v_{it} \sim \text{iid } N(0, \sigma_v^2)$ and u_{it} . The two sets of disturbances are assumed to be independent. The u_{it} s are non-negative random variables associated with technical inefficiencies, and are assumed to be independently (but not identically) distributed as truncations (at zero) of the $N(\mu_{it}, \sigma_u^2)$ distribution, with

$$\mu_{it} = Z_{it}\delta \quad (4)$$

in which Z is a vector of observable, non-stochastic explanatory variables associated with technical inefficiency, and δ is a vector of unknown coefficients.

In this model, the maximum likelihood method is used for the simultaneous estimation of the parameters of the frontier and technical inefficiency models—the

unknown parameters β_s , δ_s , σ_u^2 and σ_v^2 . We computed the estimates using the FRONTIER software package (Coelli 1996). Battese and Coelli (1995) provide an expression for the conditional expectation of $\exp(-u_{it})$ given ε_{it} . The maximum likelihood estimation of this function is used to estimate the technical efficiency index of the i^{th} firm at time t , based on the expected values conditional on the observed values of the explanatory variables in X and Z . If the productivity frontier is expressed in logarithms, the technical efficiency index (TEI) can be expressed as follows.

$$TEI_{it} = \exp(-u_{it}) \quad (5)$$

This index has a value between 0 and 1, with 0 ($u_{it} \rightarrow \infty$) indicating the least efficient, and 1 ($u_{it} = 0$) the most efficient plants.

Changes in TEI as defined in (5) denotes a part of the actual upward shift in Figure 1 associated with the assimilation of technology-specific knowledge. It is that part of the assimilation effect which can be explained by the changes in the indicators of absorptive capacity, given their estimated coefficients from the SFA model. The remainder of the upward shift cannot be explained, and is calculated as the difference between the actual growth in labor productivity and the predicted growth derived from the SFA model.

3.3. The Empirical Plant-Level Model

We begin with a production frontier of the Cobb-Douglas form, augmented to account for technological change. As noted in the previous chapters, in most developing countries, and especially so in Indonesia, foreign technology is the key source of technological progress. Own technological efforts are virtually absent. We account for technology flows from abroad by constructing a measure of international R&D stock (IRD). The augmented production function is defined as follows.

$$Y_{it} = AK_i^\alpha L_{it}^\beta IRD_t^\zeta \quad (6)$$

where, Y_{it} is value added of plant i at time t , K the replacement value of capital, L the total number of workers, and IRD the international R&D stock representing the technology flows available to all plants in the industry. The variable IRD is interpreted to be the driver of the shifts in the production frontier in a given industry. Dividing Y and K by L and taking logarithms, equation (6) becomes

$$y_{it} - l_{it} = a + \alpha(k_{it} - l_{it}) + \zeta ird_t + \varepsilon_{it} \quad (7)$$

where the lowercase symbols denote the variables in logarithms. In the transformation of equation (6) to (7), we impose the assumption of constant returns to scale in the rival inputs labor and capital. We use equation (7) as the frontier function that will be estimated simultaneously with the inefficiency function, based on the procedure described in the previous subsection.

We now turn to factors that might determine the “absorptive capacities” of plants, and hence the opportunities to assimilate knowledge from plants at the frontier:

(i) Given that technology-embodied inputs have often shown to be an important channel of foreign technology diffusion, a plant’s *use of imports* might be a good proxy of its access to foreign technology.

(ii) Access to a source of technology does not, however, imply that the acquisition of technology is guaranteed. Therefore, the extent to which a plant is able to ‘absorb’ new technologies probably depends on the *quality of its labour force* (see, e.g. Evenson and Westphal, 1995).

(iii) The ownership structure of a plant can also be a significant factor influencing the capacity to assimilate knowledge. A plant with a high *degree of foreign management control* might be expected to run more productively than, for example, a non-professional, family-controlled enterprise. The ‘foreign-connection’ may enable the former to adapt itself much more quickly than the latter to global changes in technology, production relations, etc.

(iv) The performance of an enterprise as compared to other enterprises with similar technologies may also depend on its *size*. As noted by Tybout (2000), in many developing countries, ‘Engel effects’ skew demand for manufactured products toward simple items which can be efficiently produced using cottage techniques. An opposite effect would be the operation of Schumpeterian dynamics that leads to greater learning efforts by large firms. This may result from scale economies, availability of internal resources in the presence of imperfect markets and/or uncertainties, synergies between technological, production, marketing and distribution activities, etc.

(v) Another factor that may influence the assimilation performance is the *age* of a plant. While a plant with a lot of experience may benefit from learning-by-doing, a younger plant may be more dynamic in adapting to changes in (frontier) technology. In this context, we can think of the distinction made by Winter (1984) between an entrepreneurial regime characterised by the entry of innovative new firms, and a routinised regime involving innovative activities by incumbent firms.

Keeping these considerations in mind, we consider the following absorptive capacity variables for the mean inefficiency model represented by equation (4):

$$\mu_{it} = \beta_{0i} + \beta_1 \text{Access}_{it} + \beta_2 \text{LQual}_{it} + \beta_3 \text{Foreign}_{it} + \beta_4 \text{Age}_{it} + \beta_5 \text{Size}_{it} \quad (8)$$

in which *Access* is defined as the ratio of imported material inputs to total material inputs, *LQual* is expressed as the share of non-production (white-collar) workers in total employment, *Foreign* represents the proportion of foreign ownership in a plant, *Age* has been measured as the difference between the year of operation and the year of inception, and *Size* is defined as the logarithm of the total number of workers.

A final aspect to consider is the influence on technical efficiency of factors observable only to the managers of a plant, which are not reflected in survey-based dataset like ours. As a result, such firm-specific effects (or heterogeneities) may be related to other regressors of the model which may cause biased results. To overcome this problem, we adopt a specification that incorporates plant fixed effect in the inefficiency model (these effects are picked up by β_{0i}). Consequently, the coefficients in (8) should be interpreted in a time series or growth context (see Greene, 2005).

3.4. Aggregation Methods: From Plant-Level to Meso and Macro Results

The ultimate aim of this paper is to assess the relative impacts of accumulation and assimilation on labor productivity growth in Indonesian manufacturing. Hence, plant-level results as can be obtained using the methods outlined above might be interesting for their own sake, but they will not be sufficient to attain the goal of the paper. In a number of papers, firm-level results have been used to gain insights into the effects of within-firm productivity effects and effects of reallocation of resources between low- and high-productivity firms. Examples are the contributions by Griliches and Regev (1995), Foster *et al.* (2006). In the context of a developing country, Aw *et al.* (2001), adopted the Griliches and Regev approach. These studies also take the effects of entry and exit into account.

The basic difference between the decompositions of Griliches and Regev (1995) and Foster *et al.* (2006) is their point of reference. Griliches and Regev weight market shares and productivity levels by averages over the initial year and the final year of the period studied. Foster *et al.* (2006) rightfully argued that contamination of within and reallocation effects cannot be avoided if averages are used, and proposed a decomposition formula that takes initial year values as the point of departure. This approach has the drawback that it is more vulnerable to measurement error.

With respect to our analysis, the Griliches and Regev approach is the only viable way to go, because our plant-level results have already be obtained using Fisher indices, which preclude weighting with initial year values only. Hence, we adapt the Griliches and Regev (1995) approach in order to take into account that we have several sources of within-plant labor productivity growth. Another slight modification is that we do not use an additive framework expressed in logarithmic growth rates, but stick to a multiplicative

framework. Since we look at a relatively long period, the logarithmic growth rate is not a very accurate approximation of the growth rate obtained by the ratio between final year and initial year levels. The line of reasoning is exactly the same, however.

Let us write the industry-level labor productivity growth as $\left(\frac{y_{i,1}}{y_{i,0}}\right)$. Following Foster *et al.* (2006), the subindex i indicates an industry-level variable, whereas subindexes e refers to a plant-level variable. The subindex 0 refers to the initial period, subindexes 1 refers to the final period. Some of the sources of growth to be introduced below relate to “continuing” plants (the subset of plants referred to by C), two to entering plants (the subset of plants referred to by N) and two to exiting plants (referred to by X).⁶ The subindexes a , b , c and d refer to the symbols used in the graphical presentation of our plant-level decomposition formula (Figure 1). For continuing plants we initially have five factors:

$$\text{Assimilation: } \prod_{e \in C} \left(\frac{y_{e,1} \cdot y_{e,a}}{y_{e,d} \cdot y_{e,0}} \right)^{0.5(s_{e,1} + s_{e,0})} \quad (9.1)$$

$$\text{Creation of Spillover Potential (accumulation): } \prod_{e \in C} \left(\frac{y_{e,c} \cdot y_{e,d}}{y_{e,a} \cdot y_{e,b}} \right)^{0.25(s_{e,1} + s_{e,0})} \quad (9.2)$$

$$\text{Innovation: } \prod_{e \in C} \left(\frac{y_{e,b} \cdot y_{e,d}}{y_{e,a} \cdot y_{e,c}} \right)^{0.25(s_{e,1} + s_{e,0})} \quad (9.3)$$

$$\text{Reallocation to (in)efficient firms: } \prod_{e \in C} \left(\frac{y_{e,1} \cdot y_{e,0}}{y_{e,d} \cdot y_{e,a}} \right)^{0.5(s_{e,1} - s_{e,0})} \quad (9.4)$$

$$\text{Reallocation to high/low capital intensity firms: } \prod_{e \in C} (y_{e,d} \cdot y_{e,a})^{0.5(s_{e,1} - s_{e,0})} \quad (9.5)$$

The first three factors are within-plant productivity effects, the latter two are reallocation effects. The shares s_e are computed as shares in total industry labor inputs, i.e. including plants that enter and exit. Factors (9.4) and (9.5) express to what extent industry-level labor productivity would have grown if no entry and exit would have taken place and if continuing plants would not have experienced any productivity growth. All growth would be due to above-average efficient plants (factor (9.4)) and plants with an

⁶ In this study, continuing plants have been present in the dataset for the entire period 1988-1995 (a limited number of observations may have been missing, see the cleaning procedures described in Appendix A. Exiting plants were present in 1988, but not in 1995. Entering plants were absent in 1988, but were observed in the data for 1995. Plants entering after 1988 and exiting before 1995 have been included in the estimation procedures of the frontiers and the inefficiency functions, but do not play a role in the construction of the industry-level results.

above-average target labor productivity (factor (9.5)) experiencing changing shares in industry-wide employment.

Next, following Griliches and Regev (1995), one ‘artificial plant’ is created for entrants and for exiters. Factors similar to (9.1)-(9.5) above can then be computed for this single plant. This was done by computing the average capital intensity and average labor productivity. To derive the 1988-values of these variables for the plant, we aggregated the variable values of the exiting plants for 1988, using each plant’s employment share in total exiting plants as the weight. Likewise, we derived the 1995-values of the variables by aggregating the variable values of the entering plants in 1995, using each plant’s employment share in total entering plants as the weight.

The extended Griliches-Regev decomposition leaves us with ten sources of industry-level productivity growth. As we explained in the previous subsections, we have information on productivity gains that can be attributed to changes in absorptive capacity, whereas the residual part of a plant’s assimilation performance is left unexplained. We compute the increase or decrease of efficiency by multiplying the observed changes in the absorptive capacity indicators by the estimated fixed effects estimators in equation (8), and assuming that efficiency changes do not contain any other form of noise. Hence, both for the subset of continuing plants and for the artificial entering-exiting plant, factor (9.1) can be split into two parts. Hence, we have 12 factors.

One problem remains. If the employment shares of continuing plants increase, the employment share of the artificial single entering/exiting plant will automatically become smaller. This has effects for two pairs of factors, (9.4) and its counterpart, and (9.5) and its counterpart. Hence, we multiply these pairs of factors and present net effects for continuing and entering/exiting plants. Finally, unexplained assimilation is a somewhat awkward concept in cases in which the plant in 1988 is in no way related to the plant in 1995, which happens in the case of the artificial entering/exiting plant. Hence, we present unexplained assimilation for the entire set of plants. This leaves us with nine factors of labor productivity change at the industry level.

In order to arrive at insights in the most important sources of labor productivity growth at the level of broader industry groupings or even the entire Indonesian manufacturing sector, we need to further aggregate the results. Above, we derived twelve multiplicative components (x_i) of labor productivity growth at the industry level. The aggregation of industry-level components to any higher level components has been obtained as:

$$x_m = \prod_{i \in m} (x_i)^{0.5(s_{i,1} + s_{i,0})}$$

Subscripts m and i stand for sector and industry, respectively. $s_{i,t}$ is the employment share of industry i in sector m in period 1. $s_{i,0}$ is the employment share of industry i in sector m in period 0.

4. Data Issues

Our main data sources are two large plant-level data sets, the ‘backcast’ and ‘Statistic Industri’ (SI) data sets constructed by the Indonesian Bureau of Statistics (BPS).⁷ The data sets cover all large and medium-sized plants in the manufacturing sector of the country, from 1975 to 2001.⁸ We focus our analysis on industries defined at a low level of aggregation (5-digit classification). This allows us to investigate productivity growth for sets of plants with homogeneous activities. Since the panel data SFA-approach is data-intensive, we select 65 industries for which at least 10 plants are included in the data set for each and every year recording positive import of intermediate inputs every year. The samples are unbalanced, so entering and exiting plants can affect the location of the frontiers. The industries under investigation are quite diverse, which allows us to identify inter-industry differences in the importance of absorptive capacity for productivity performance.

Studies aiming at explaining TFP growth are often hindered by immeasurable fluctuations in capacity utilisation. Although we do not study TFP growth but labor productivity growth, we encounter similar problems: our technologies are defined by capital intensities, that is, ratios between a (quasi-) fixed input and a much more variable input.

To construct our measure of international R&D stocks capturing technology flows, we employ data on R&D expenditures by industry for ten countries that together account for approximately 50% of the imports to Indonesia and about 85% of R&D expenditures in the OECD. Apart from imports, technology purchase, technology collaboration and exports by Indonesian firms as well as foreign investment in the domestic market can all act as carriers of technology spillovers. To accommodate these different channels of technology flow, we construct a ‘composite’ stock of foreign R&D by using solely the technological proximity between the foreign and domestic industries

⁷ See Appendix A for a detailed description of the data sources, variables, cleaning processes, etc.

⁸ We limit our analysis to the period 1988-1995 due to the fact that the data on the replacement value of capital are available only from 1988 onwards. We do not consider the period after 1996 in order to insulate our results from the effects of the financial and economic crisis of late 1997. For 1996, separate estimates for each asset category—land, buildings, machinery, transport equipment and others—are not reported. This is problematic as for the preceding (1988-1995) period we consider only assets other than land because foreign plants are not allowed to own land and hence do not report this data.

to weight the foreign R&D stock.⁹ The resulting international R&D stock at the industry level can thus be expressed in terms of the following equation.

$$IRD_j(t) = \sum_{c,k} (RD_{ck} P_{kj} S_{cj})(t) \quad (8)$$

where IRD_j is the international R&D stock resulting from technology flows available to all plants in the Indonesian industry j ; RD_{ck} is the R&D stock in sector k of partner-country c ; P_{kj} is the typical element of the patent information flow matrix that captures the inter-industry flows of the s R&D stocks; and S_{cj} is the technological congruence between sector j of Indonesia and the same sector of its partner country c . S_{cj} is derived by comparing the input coefficient vectors for sector j in the two countries. It takes a value of 1 if sector j is perfectly similar in the two countries, and zero in the event of complete dissimilarity between them. The required input-output data were taken from the OECD Input-Output Database and input-output tables published by the Indonesian Bureau of Statistics.

Given the fact that the R&D data taken from OECD's STAN-ANBERD database are available only at a level of aggregation of 2, 3 and in a few cases, 4-digit (ISIC Rev 2), IRD_j in the above equation corresponds to these levels. To generate IRD at the 5-digit level, we constructed similarity indices between the two sets of classifications, using their respective input coefficients vectors. The appendix tables A.1 and A.2 provide a summary statistics of the variables and the industrial classification we opted for, respectively.

5. Results

In this section, we will report on the implementation of the methods discussed in Section 3, using the data dealt with in the previous section. First, the estimation results for industry-specific productivity frontiers and inefficiency functions will be presented, afterwards we will discuss the implications for the sources of productivity growth for industries and broader aggregates. These results provide insights into the relative importance of assimilation of foreign knowledge vis-à-vis accumulation of physical capital.

⁹ Note that the specific channels of foreign technology flows are introduced in the inefficiency function.

5.1. Results of the Stochastic Frontier Analysis

Table 1 reports the SFA estimation results at the plant level for the 65 5-digit industry samples. For brevity, we do not report the estimation results for the plant-dummies included in the inefficiency function. Table 2 provides a summary of these results.

The results for the frontier production function show that the coefficients of both capital intensity (k) and the international R&D stock representing knowledge spillovers (ird) have a positive sign in most industries. The estimated coefficients of capital intensities representing the slopes of the productivity frontiers are often fairly small, however, and even negative or statistically insignificant at the 10% level for 16 industries. In terms of Figure 1, many frontiers turn out to be rather flat (elasticities of less than 0.20), which implies that it does not pay very much just to invest more in incumbent plants or to start up new capital-intensive plants. This result weakens the arguments put forward by advocates of accumulationist theories.

The sensitivity of the frontier to increases in foreign R&D appears, to be prominent in a few industries. In these industries, the best-practice plants in Indonesia reaped substantial fruits from technological spillovers from abroad. The coefficient for this variable is positive and significant for 32 of the 65 industries studied. For many other industries, however, negative estimates are found. A speculative explanation for this counter-intuitive result could be that high foreign R&D expenditures led to a worsened competitive position of the Indonesian plants. If hiring and (particularly) firing are not immediate, such demand effects imply productivity decline.

Our main interest lies in understanding the factors causing deviations from the best-practice technology. The estimate for the variance parameter γ (*gamma* in Table 1 & 2) that corresponds to the estimated share of the inefficiency term in the variance is significant in the vast majority of industries (55 industries). This suggests that the inefficiency changes that can be attributed to changes in absorptive capacity are a significant determinant of a plant-level efficiency change.

A negative sign for the coefficient of a variable in the inefficiency function indicates a negative impact of that variable on inefficiency (or, a positive impact on efficiency). Among all the absorptive capacity indicators, changes in labor quality ($LQual$) might provide the most promising explanation for the changes relative to best-practice performance. Its coefficient has a negative sign in most industries (40 out of 65), but these estimates are often not significantly different from zero at significance level of 10%. A preliminary conclusion to be drawn could be that the effects of increasing labor quality on productivity must generally have been quite limited. One could, however, also question the accuracy of our labor quality indicator.

Foreign ownership has a negative coefficient in 34 of the 50 industries in which foreign ownership was present. Statistical significance at the 10% level is limited,

however, to only 15 industries. It might well be that a linear specification of the inefficiency effects is not most appropriate here. Explorations to use multiple-regime econometrics (to identify critical values of the degree of foreign ownership), however, are beyond the scope of this chapter, if only because such approaches have hardly been developed in the stochastic frontier econometrics.

We argued before that access to spillovers is likely to exert a major influence on the technical efficiency of plants. We do not find such a relationship, however. Both negative and positive estimates are found and most often both types of estimates are insignificant. One reason for this result could be the narrowness of our measure of access to spillovers as it does not consider the imports of capital goods. Secondly, the import intensities in intermediate input use have been rather low in most industries, which might yield insufficient within-plant variation.

The age variable demonstrates a favorable impact on assimilation in the majority of industries. Negative sign for its coefficient in 53 (with statistical significance in 22 industries) out of a total number of 65 industries suggest that a plant's ability to assimilate knowledge spillovers from similar best-practice plants increases with its experience. Possible explanations for this result are of course highly speculative. One explanation would be the existence of routinised regimes in these industries, discussed earlier. A different explanation, due to Klepper (2002), suggests that increasing competition offers firms with greater experience greater leeway to enhance their capabilities. As he notes, when the price-cost margins are pushed down over the course of an industry's evolution, early entrants are better equipped to meet this challenge. They begin growing early, thus being able to develop absorptive capacities from the start of an industrial technology onwards. While the industries considered in our study are fairly diverse, and we do not have quantitative indications of the stages of their lifecycles they went through, we could speculate on conclusions similar to Klepper's.

Table 1: Frontier and Inefficiency Estimates for 65 5-digit Industries

Ind. No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ISIC	31151	31171	31179	31192	31241	31251	31272	31279	31281	31340	31410	31420	31440	33111	33112	33113
Category	RESOURCE-INTENSIVE INDUSTRIES															
	Production Frontier															
Constant	7.33*	-12.07*	-9.43*	-10.11*	5.90*	-5.89	0.26	-11.73*	30.45*	-7.54*	-0.22	4.34*	46.96*	2.29*	11.75*	10.72*
Cap/Lab	0.28*	0.21*	0.15*	0.39*	0.14*	0.14*	0.07	0.31*	0.08	0.51*	0.32*	0.11	-0.14*	0.23*	0.19*	0.14*
IRD	0.08	1.25*	1.15*	1.00*	0.15	1.00*	0.55	1.16*	-1.13*	0.82*	0.35*	0.18	-2.28*	0.39*	-0.23*	-0.12*
	(Mean) Inefficiency Function															
Constant	3.34*	1.48*	3.14*	1.52*	5.92*	2.70	3.23*	-0.80*	5.37*	-0.36	-1.11	-0.11	21.05*	0.94*	1.97*	2.36*
Age	-0.18	-0.04	-0.08	-0.25	-2.30*	0.78	-0.57	-0.03	-0.50*	-0.26	-0.25*	-0.76	-4.28*	0.02	-0.20	-0.22
Foreign	-0.76	-0.51*	-0.31	-1.41*				-2.86*	-2.55*	-0.81	-0.10			0.44	0.22	-3.38*
Access	-0.11	-0.15	-0.29	-0.45	-0.83	-8.80*	-1.05	-1.16*	0.21	-0.53	-0.16	0.39	1.81*	-0.08	2.94	0.10
LQual	0.24	0.29*	-0.13	1.06	0.12	0.30	-0.65	-1.67*	-0.50	0.20	-0.91	0.22	0.58	0.02	-0.84	-1.05
Size	0.28*	0.01	0.17*	0.06	0.55*	0.13*	0.39*	0.07	-0.05	-0.71*	-0.80	0.00	0.51*	0.11	0.09	-0.17
sigma-sq.	0.22*	0.11*	0.15*	0.15*	0.11*	0.14*	0.14*	0.15*	0.48*	0.73	0.86	0.21*	0.09*	0.39*	0.29*	0.22*
gamma	0.77*	0.13*	0.23*	0.47*	0.26*	0.63	1.00*	0.19*	1.00*	0.67*	0.43*	0.00*	1.00*	0.34*	0.10*	0.32*
Plants	45.5	150.625	113.625	36.75	40.875	128.25	19.5	38.625	28.375	44.25	269.625	51.25	11.875	154	78.5	41.375
Observ.	364	1205	909	294	327	1026	156	309	227	354	2157	410	95	1232	628	331

Notes: * significant at 10%.

(i) Cap/Lab-Capital Labor ratio; IRD-International R&D stock; Age-Age of the plant; Foreign-Percentage of foreign ownership; Access-Access to spillover (share of imported inputs in total inputs); LQual-Labor quality (Proportion of non-production workers in total workers).

(ii) All variables except IRD are plant level variables. IRD is measured at the industry level.

(iii) See appendix table A.2 for industry and industrial category definitions.

(iv) Plants indicates the number of plants present in the sample, averaged over years.

(cont'd) Table 1: Frontier and Inefficiency Estimates for 65 5-digit Industries

Ind. No	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
ISIC	33114	33131	33211	35224	35511	35512	35523	35593	36111	36112	36321	32210	32312	32411	39090
Category	RESOURCE-INTENSIVE INDUSTRIES										LABOR INT. INDUSTRIES				
	Production Frontier														
Constant	3.62*	6.64*	10.90*	-34.63*	-4.17*	-47.01*	-98.80*	-128.14*	-97.31*	-87.90*	-12.32*	42.39*	40.50*	47.22*	44.72*
Cap/Lab	0.44*	0.46*	0.22*	0.06	0.14	0.33*	0.23*	0.13	0.21*	0.00	0.18*	0.15*	0.27*	0.08	0.25*
IRD	0.11	-0.09	-0.23*	2.35*	0.88*	3.25*	6.42*	8.36*	5.95*	5.53*	1.25*	-1.91*	-2.09*	-2.28*	-1.99*
	(Mean) Inefficiency Function														
Constant	0.19	2.15*	1.73*	3.27*	2.51*	2.65	0.73*	2.00*	-0.17	0.59	3.93*	3.30*	0.48	0.71	2.98*
Age	-0.42	-1.08	-0.40*	-2.60*	0.10	-4.75*	-0.03	0.03	0.08	-0.31*	-0.21*	-0.13*	-0.38	0.05	-0.22*
Foreign	-0.05		0.26		-14.63*		-0.23	-1.32*	-0.48	4.49*	-0.98	-0.55		-1.50*	-0.68
Access	0.11	1.11	0.11	-0.88*	0.88*	0.53	-0.68	0.95*	-0.14	0.49	-0.14	0.01	-0.98*	0.66*	0.03
LQual	-0.28	0.35	-0.28	-0.60	-0.40	0.53	-0.28	0.36	-0.46	-0.37	-0.20	-0.15	0.48	-0.57	0.34
Size	-0.50*	0.73*	0.15*	0.65*	-0.33	0.29	0.02	-0.30*	0.12	0.02	0.34*	0.06*	0.08	-0.04	0.01
sigma-sq.	0.42*	0.33*	0.18*	0.17*	0.21*	0.24*	0.26*	0.20*	0.18*	0.18*	0.20*	0.14*	0.24*	0.25*	0.14*
gamma	0.16	0.36*	0.30*	0.28*	1.00*	0.47*	0.06*	0.04	0.26*	0.00	1.00*	0.07*	0.00	0.23*	0.97*
Plants	19.5	19.75	127.5	22.5	10.625	12	47.5	34.75	15	15.625	161	342.25	21.375	42.125	23.25
Observ.	156	158	1020	180	85	96	380	278	120	125	1288	2738	171	337	186

Notes: * significant at 10%.

(i) Cap/Lab-Capital Labor ratio; IRD-International R&D stock; Age-Age of the plant; Foreign-Percentage of foreign ownership; Access-Access to spillover (share of imported inputs in total inputs); LQual-Labor quality (Proportion of non-production workers in total workers).

(ii) All variables except IRD are plant level variables. IRD is measured at the industry level.

(iii) See appendix table A.2 for industry and industrial category definitions.

(iv) Plants indicates the number of plants present in the sample, averaged over years.

(cont'd) Table 1: Frontier and Inefficiency Estimates for 65 5-digit Industries

Ind. No	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
ISIC	32111	32114	32115	32116	32117	32121	32130	32190	34112	34113	34120	34200	35142	35210	35231	35232	35291
Category	SCALE INTENSIVE INDUSTRIES																
	Production Frontier																
Constant	-5.47*	37.63*	37.20*	27.98*	34.23*	30.74*	30.59*	35.68*	-18.30*	11.25*	25.22*	17.09*	-7.36*	-37.57*	-15.88*	-23.17*	-3.12*
Cap/Lab	0.27*	0.22*	0.29*	0.31*	0.21*	0.24*	0.26*	0.11*	0.60*	0.09	0.07	0.13*	0.73*	0.08	0.28*	0.30*	0.34*
IRD	0.75*	-1.72*	-1.75*	-1.20*	-1.59*	-1.33*	-1.33*	-1.55*	1.23*	-0.08	-0.79*	-0.42*	0.52*	2.43*	1.29*	1.65*	0.56*
	(Mean) Inefficiency Function																
Constant	0.79	0.93*	1.28*	5.24*	-0.05	2.09*	0.42	-0.42	1.22	1.82*	4.06*	3.94*	-1.56*	2.21*	3.65*	4.32*	-0.87
Age	-0.21	-0.16*	-0.02	-0.90*	-0.01	-0.12	-0.17	0.14	-0.41	-0.03	-0.59*	-0.33	-0.09	-0.11	-0.16	-0.13	0.28
Foreign	-1.52*	-0.01	-1.47*	-4.40*		-0.26	1.20*	0.90		0.19	0.69		0.20	-0.59	-4.67*	2.07*	0.59
Access	0.35	0.01	0.30	0.13	0.11	0.05	0.07	-0.43	0.42	0.15	0.93*	0.20	-0.20	-0.20	0.12	-0.07	0.07
LQual	3.38*	-0.76*	2.99*	2.37*	-0.09	-1.14	-1.03	-4.86*	0.03	-1.27*	0.43	-0.13	2.23*	-0.28	-2.53*	-0.07	1.13
Size	-0.32*	-0.08	0.15	0.43*	-0.29	-0.09	-0.16	-0.22	-0.04	-0.16*	0.27*	0.09	-0.43*	-0.07	0.21	0.15	-0.24
sigma-sq.	0.46*	0.22*	0.22*	0.22*	0.34	0.15*	0.22*	0.20*	0.97	0.13*	0.20*	0.19*	0.37*	0.19*	0.14*	0.24*	0.24*
gamma	0.58*	0.11*	0.29*	0.14*	0.00	0.54*	0.32*	0.26*	0.79*	0.12*	0.04	0.39*	0.35*	0.11*	0.07	1.00*	0.31*
Plants	37.625	183	35.5	23.25	58.5	71.125	60.625	22	19.5	14.75	33.125	205.75	17.875	37	30.125	26.375	14.375
Observ.	301	1464	284	186	468	569	485	176	156	118	265	1646	143	296	241	211	115

Notes: * significant at 10%.

(i) Cap/Lab-Capital Labor ratio; IRD-International R&D stock; Age-Age of the plant; Foreign-Percentage of foreign ownership; Access-Access to spillover (share of imported inputs in total inputs); LQual-Labor quality (Proportion of non-production workers in total workers).

(ii) All variables except IRD are plant level variables. IRD is measured at the industry level.

(iii) See appendix table A.2 for industry and industrial category definitions.

(iv) Plants indicates the number of plants present in the sample, averaged over years.

(cont'd) Table 1: Frontier and Inefficiency Estimates for 65 5-digit Industries

No	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
ISIC	37103	38432	38433	38444	38113	38114	38120	38191	38193	38195	38199	38245	35222	35605	35606	35609	38396
Category	SCALE INTENSIVE INDUSTRIES				DIFFERENTIATED INDUSTRIES								SCIENCE-BASED INDUSTRIES				
Production Frontier																	
Constant	53.12*	7.87	16.10	-21.49*	34.84*	68.03*	40.82*	-3.39*	69.38*	-45.80*	43.90*	-7.45*	-12.04*	-52.50*	-17.58*	-64.45*	-73.92*
Cap/Lab	0.26*	0.17*	0.30	0.43*	0.33*	0.34*	0.14	0.48*	-0.09*	0.36*	0.09	0.18*	0.18*	0.25*	0.39*	0.45*	0.55*
IRD	-2.53*	0.15	-0.36	1.50*	-1.50*	-3.24*	-1.40	0.47*	-3.01*	2.75*	-1.84*	0.79*	1.10*	3.60*	1.42*	4.22*	4.33*
(Mean) Inefficiency Function																	
Constant	3.29*	4.20*	3.19	2.30*	0.16	0.25	11.02*	2.03*	5.17*	0.64	4.05*	1.65	2.21*	1.48*	1.29*	0.89	-0.29
Age	0.17	-0.36*	-0.17	-0.72*	-0.20	0.02	-0.72*	-0.36*	-0.78*	0.33*	-1.48*	-2.12*	-0.13	0.27	-0.29*	-0.06	-0.17
Foreign	-0.24	-1.20	-1.94*	-1.36	-2.85*	0.00	1.76*	-0.32	1.06	0.03			-0.76		1.38	-2.52*	-0.57
Access	-0.22	-0.10	-0.17	0.41	2.33	0.04	0.11	-0.03	-0.38	0.24*	-0.45	1.52*	-0.01	0.28	0.03	-0.11	-0.83
LQual	-1.06	-0.70*	-0.71	-1.34	0.79	-0.44	-0.05	-0.17	-2.20*	0.05	-0.26	-4.44*	-0.12	0.43	-0.04	0.28	-0.45
Size	-0.27	-0.06	0.23	-0.13	-0.27*	-0.08	0.58*	0.11	-0.07	0.12	0.57*	1.42*	0.34*	0.17	0.02	0.03	-0.60*
sigma-sq.	0.48*	0.15*	0.35*	0.31*	0.15*	0.30*	0.19*	0.35*	0.23*	0.36*	0.20*	0.28*	0.26*	0.22*	0.26*	0.26*	1.07
gamma	1.00*	1.00*	0.22	0.46*	0.28*	0.36*	0.93*	0.21*	0.83*	0.10*	0.26*	0.77*	0.41*	0.28*	0.28*	0.32*	0.73
Plants	19.625	32.75	29.875	27.875	18	31.375	26.375	18.375	26.875	17	19.375	13.125	77.125	45.375	106.375	37.5	13.5
Observ.	157	262	239	223	144	251	211	147	215	136	155	105	617	363	851	300	108

Notes: * significant at 10%.

(i) Cap/Lab-Capital Labor ratio; IRD-International R&D stock; Age-Age of the plant; Foreign-Percentage of foreign ownership; Access-Access to spillover (share of imported inputs in total inputs); LQual-Labor quality (Proportion of non-production workers in total workers).

(ii) All variables except IRD are plant level variables. IRD is measured at the industry level.

(iii) See appendix table A.2 for industry and industrial category definitions.

(iv) Plants indicates the number of plants present in the sample, averaged over years.

Table 2: Summary of the Stochastic Frontier Estimation Results

Sign and significance	Cap/ Lab	IRD	Age	Foreign	Access	LQual	Size	Gamma
<i>Total Sample (Number of Industries: 65)</i>								
Positive & sig.	49	32	1	4	7	5	17	55
Negative & sig.	2	23	22	15	4	8	9	
Positive & non-sig	14	6	11	12	29	20	22	10
Negative & non-sig	0	4	31	19	25	32	17	
<i>Total</i>	<i>65</i>	<i>65</i>	<i>65</i>	<i>50</i>	<i>65</i>	<i>65</i>	<i>65</i>	<i>65</i>
<i>Resource-intensive Industries (Number of Industries: 27)</i>								
Positive & sig.	19	16	0	1	3	1	10	23
Negative & sig.	1	5	9	7	3	1	4	
Positive & non-sig	7	5	5	3	9	11	10	4
Negative & non-sig	0	1	13	8	12	14	3	
<i>Total</i>	<i>27</i>	<i>27</i>	<i>27</i>	<i>19</i>	<i>27</i>	<i>27</i>	<i>27</i>	<i>27</i>
<i>Labour-intensive Industries (Number of Industries: 4)</i>								
Positive & sig.	3	0	0	0	1	0	1	3
Negative & sig.	0	4	2	1	1	0	0	
Positive & non-sig	1	0	1	0	2	2	2	1
Negative & non-sig	0	0	1	2	0	2	1	
<i>Total</i>	<i>4</i>	<i>4</i>	<i>4</i>	<i>3</i>	<i>4</i>	<i>4</i>	<i>4</i>	<i>4</i>
<i>Scale-intensive Industries (Number of Industries: 21)</i>								
Positive & sig.	17	8	0	2	1	4	2	17
Negative & sig.	0	10	5	5	0	5	3	
Positive & non-sig	4	1	3	5	13	3	5	4
Negative & non-sig	0	2	13	6	7	9	11	
<i>Total</i>	<i>21</i>	<i>21</i>	<i>21</i>	<i>18</i>	<i>21</i>	<i>21</i>	<i>21</i>	<i>21</i>
<i>Differentiated Industries (Number of Industries: 8)</i>								
Positive & sig.	5	3	1	1	2	0	3	8
Negative & sig.	1	4	5	1	0	2	1	
Positive & non-sig	2	0	1	3	3	2	2	0
Negative & non-sig	0	1	1	1	3	4	2	
<i>Total</i>	<i>8</i>	<i>8</i>	<i>8</i>	<i>6</i>	<i>8</i>	<i>8</i>	<i>8</i>	<i>8</i>
<i>Science-based Industries (Number of Industries: 5)</i>								
Positive & sig.	5	5	0	0	0	0	1	4
Negative & sig.	0	0	1	1	0	0	1	
Positive & non-sig	0	0	1	1	2	2	3	1
Negative & non-sig	0	0	3	2	3	3	0	
<i>Total</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>4</i>	<i>5</i>	<i>5</i>	<i>5</i>	<i>5</i>

See appendix table A.2 for industry and industrial category definitions

The final variable to be discussed is size, which displays considerable inter-industry variations in its influence. It had an adverse impact on assimilation in a majority of the industries (a positive coefficient in 39, with statistical significance in 17 industries). Of the 26 remaining industries where its influence has been favorable, in a mere 9 cases the coefficients displayed statistical significance. The adverse impact of this variable in a small

majority of industries could suggest, as Tybout (2000) argues, that quickly growing firms have less incentive to improve their productive efficiency, for example, by periodic training of its work force.

To gain insights into interindustry differences, we have classified industries into five categories: resource-intensive, labor-intensive, scale-intensive, differentiated, and science-based industries (a classification based on OECD, 1987). While the results for the 65 industries in general appear to hold largely true across these five categories, a few significant differences are worth noting. First, we noted earlier that the estimates for the international R&D variable yielded a positive coefficient in a majority of the industries. However, for most industries in the labor-intensive, scale-intensive and differentiated industries categories, this variable has a negative sign. It is in the resource-intensive industries, which account for the majority of industries in the total sample, that foreign R&D was most important. Science-based industries, although only five in number, show a positive coefficient for this variable, too. The resource-intensive and science-based industries played a central role in the export-orientation drive of the late 1980s. The resulting competitive pressure and external contacts have caused greater technology spillovers in these industries than in others. Note also that the scale-intensive and differentiated industries were the most important beneficiaries of the import-substituting regime that prevailed until the mid-1980s. Continuing protection in many of these industries might explain the low impact of foreign R&D spillovers in these industries.

Another notable difference in results across the industrial categories is with respect to the age variable. The negative significance of its coefficient in the majority of industries has been dominated by industries in the resource-intensive category; most industries (22 out of 27 industries) in this category show a negative coefficient for the age variable. This result suggests that the incumbent establishments were successful in enhancing their operational efficiency to meet the challenges of the new export-orientation drive in this category of industries.

Finally, and not surprisingly, the size variable generated a favourable impact, against the general trend, in most of the scale intensive industries. As Pavitt (1984) notes, firms that are bigger in these industries are able to benefit from static scale economies of production.

5.2. Results of the Decomposition Analysis

The discussion so far has revealed that changes in deviations from best-practice (due to plant-specific factors) are a significant determinant of a plant's labor productivity growth. In the following section we extend these results by decomposing labor productivity growth into the nine components introduced in subsection 3.4. The results for the 65 5-digit industries are presented in Table 3.

Table 3: Decompositions of Labor Productivity Growth Rates by 5-Digit Industry

ind.	Cat.	growth	E_As_C	Pot_C	Inn_C	E_As_XN	Pot_XN	Inn_XN	R_As_T	R_Pot_T	U_As_T
31171	1	3.438	1.048	1.028	1.468	1.011	1.121	1.148	1.055	1.024	1.549
35593	1	3.333	1.186	1.012	1.438	0.878	1.050	1.100	1.145	1.006	1.655
31151	1	3.216	1.088	1.085	1.020	1.056	1.287	1.013	1.206	1.002	1.604
31179	1	2.715	0.971	1.007	1.435	0.986	1.033	1.126	1.291	1.046	1.250
31340	1	2.338	1.514	1.113	1.294	1.018	1.094	1.088	1.327	1.016	0.656
31279	1	2.319	1.018	1.139	1.419	0.991	1.317	1.143	0.885	1.035	1.030
31281	1	1.975	1.430	1.029	0.734	0.649	1.031	0.851	1.261	1.009	2.526
31241	1	1.946	1.544	0.994	1.047	0.447	1.044	1.017	1.282	1.031	1.930
36112	1	1.894	1.269	1.000	1.373	0.920	1.000	1.093	1.150	1.000	0.939
31272	1	1.839	1.277	1.050	1.199	0.812	1.035	1.049	0.933	0.991	1.404
36111	1	1.823	0.873	0.968	1.497	1.026	1.042	1.034	1.056	1.024	1.206
31251	1	1.763	0.694	1.037	1.365	1.132	1.054	1.112	0.990	0.981	1.394
35523	1	1.580	1.006	1.096	1.334	1.013	1.039	1.066	1.013	1.001	0.944
33211	1	1.432	1.136	1.008	0.968	0.866	1.091	0.984	0.986	1.014	1.390
36321	1	1.331	1.021	1.033	1.065	0.798	1.030	1.029	1.094	1.032	1.240
33111	1	1.308	0.967	0.977	1.053	0.996	1.036	1.031	1.139	1.020	1.064
33131	1	1.192	2.093	1.118	0.985	1.289	0.895	0.996	1.031	1.368	0.319
31192	1	1.160	1.033	1.067	1.312	0.903	1.078	1.157	0.998	1.027	0.695
33114	1	1.148	1.685	1.057	1.020	1.267	1.026	1.003	1.078	0.943	0.477
33113	1	1.106	1.212	1.002	0.979	1.193	0.971	0.996	0.922	1.010	0.866
35512	1	0.742	34.855	0.909	1.186	0.735	0.990	1.008	0.849	0.915	0.035
33112	1	0.688	1.025	0.933	0.964	0.942	1.020	0.988	0.938	0.970	0.864
31410	1	0.542	1.398	0.901	1.088	0.650	1.368	1.063	0.428	0.694	1.408
31420	1	0.538	1.184	1.026	1.046	0.523	0.898	1.031	1.592	0.923	0.596
32411	2	2.195	1.001	1.008	1.276	1.116	1.044	1.379	1.036	1.003	1.022
32210	2	1.855	1.041	1.029	1.286	1.036	1.063	1.249	1.009	1.000	0.971
39090	2	1.453	1.023	1.034	1.015	0.942	1.519	1.089	0.959	0.990	0.914
32312	2	1.363	1.208	1.061	1.403	0.856	1.091	1.197	1.062	1.006	0.633
38444	3	2.765	1.525	1.267	1.013	0.945	1.108	1.003	1.043	1.112	1.160
32115	3	2.672	1.041	1.010	1.353	1.175	1.240	1.141	1.076	0.962	1.090
34120	3	2.495	1.122	1.043	1.192	0.644	1.056	1.180	1.024	0.996	2.185
32114	3	2.348	1.085	1.020	1.394	0.965	1.104	1.100	1.007	1.027	1.255
35231	3	2.143	1.137	1.162	1.240	0.909	1.032	1.042	0.884	0.968	1.563
32111	3	1.898	1.087	1.216	0.891	0.799	1.088	0.931	1.108	1.037	1.732
35210	3	1.865	1.047	0.981	1.415	0.951	1.019	1.146	1.052	1.002	1.096
32121	3	1.570	1.076	1.064	1.235	0.983	1.113	1.127	0.954	1.027	0.919
32130	3	1.562	1.058	1.093	1.158	0.790	1.097	1.201	1.097	1.039	0.983
35232	3	1.514	0.815	1.163	1.326	1.038	0.967	1.048	1.231	1.051	0.885
35142	3	1.475	1.203	0.907	1.086	0.746	1.405	1.021	1.325	0.866	1.014
35291	3	1.375	0.910	1.048	1.099	1.205	1.101	1.017	0.870	0.927	1.205
32116	3	1.307	1.084	0.991	1.185	0.300	1.049	1.136	0.957	1.011	2.963
34200	3	1.098	1.115	1.054	1.159	0.894	1.009	1.034	0.878	0.985	0.999
32190	3	1.021	0.854	0.956	1.382	1.015	1.041	1.063	0.990	0.977	0.833
34112	3	0.975	1.163	1.284	0.638	0.943	1.007	0.921	1.081	1.154	0.938
38433	3	0.943	0.948	0.904	1.081	0.872	1.075	1.029	1.211	0.943	0.924
38432	3	0.906	1.193	1.084	0.972	0.882	1.003	0.984	0.830	0.979	1.020

growth: ratio between labor productivity levels in 1995 and 1988;

C: continuing plants; XN: exiting and entering plants; T: total set of plants;

E_As: explained assimilation; Pot: Potential creation; Inn: Innovation; R_As: Reallocation w.r.t. Assimilation; R_Pot: Reallocation w.r.t. Potential creation; U_As: unexplained assimilation;

yellow cells: >1.20; green cells: <0.80

(cont'd) Table 3: Decompositions of Labor Productivity Growth Rates by 5-Digit Industry

38120	4	2.431	1.159	0.966	1.076	0.654	1.003	1.029	1.092	1.008	2.713
38199	4	1.813	2.199	1.020	1.121	0.759	1.011	1.020	0.887	1.019	1.019
38114	4	1.655	1.063	1.142	1.229	1.001	1.088	1.030	1.300	1.068	0.712
38193	4	1.428	1.344	0.924	1.170	0.874	0.993	1.064	0.952	1.011	1.105
38113	4	1.126	1.192	0.946	1.068	1.019	0.924	1.045	0.892	1.008	1.059
38191	4	1.063	1.070	1.026	0.974	0.843	1.284	0.993	1.235	1.068	0.703
38396	5	3.334	1.372	1.239	1.753	1.185	0.948	1.124	1.006	1.008	0.873
35222	5	1.685	1.007	1.070	1.342	0.961	0.984	1.070	1.139	1.060	0.955
35606	5	1.478	1.115	0.963	1.049	0.863	1.171	1.031	1.076	1.007	1.164
35609	5	1.450	1.036	1.025	1.180	0.979	1.035	1.068	1.103	1.010	0.960
35605	5	0.824	0.898	1.052	1.098	1.597	0.969	1.110	0.938	0.993	0.497

The results in Table 3 show a wide variety of contributions of the nine factors, heterogeneity abound. Nevertheless, the pattern of colored cells (indicating substantial negative or positive contributions) give some interesting insights. First of all, explained assimilation and innovation have contributed positively in a large number of industries, whereas continuing plants did not experience huge productivity growth as a consequence of capital accumulation leading to more spillover potential. This might not come as a surprise, since firms might well prefer setting up new plants with advanced machinery rather than replacing their outdated machinery in an existing plant. The column “Pot_XN”, however indicates that in only seven industries, starting new modern plants and/or closing down older one led to productivity compound growth rates of more than 20%. Reallocation effects are mixed. The effects of unexplained assimilation are often sizeable, into both directions. It should be mentioned, however, that a few results for explained assimilation are not very plausible, especially in industry 35512. Most probably, this is due to the use of rather inaccurate point estimates for the absorptive capacity indicator coefficients in deciding on the contributions of explained assimilation (and therefore, as a residual) unexplained assimilation.

Table 4: Decompositions of Labor Productivity Growth Rates by Sector

	growth	E_As_C	Pot_C	Inn_C	E_As_XN	Pot_XN	Inn_XN	R_As_T	R_Pot_T	U_As_T
Resource-Int.	1.109	1.175	1.006	1.093	0.863	1.029	1.034	1.054	0.965	0.920
Labor-Int.	1.844	1.041	1.029	1.277	1.032	1.077	1.249	1.010	1.000	0.961
Scale-Int.	1.709	1.084	1.070	1.159	0.867	1.081	1.057	1.017	1.016	1.242
Differentiated	1.559	1.272	1.009	1.133	0.868	1.037	1.036	1.061	1.031	1.050
Science-Based	1.510	1.056	1.045	1.219	1.045	1.037	1.070	1.061	1.021	0.893

Notes: see Table 3

Table 4 documents more consolidated results, for the five categories of industries we gave estimation results for before. The most interesting result is that accumulation contributed positively to labor productivity growth in all five sectors (although reallocation effects to plants with a high capital intensity contributed negatively), but that effects of assimilation

and (particularly) innovation are more substantial. Apparently, plants on the frontier managed to gain significantly from foreign technology, while other plants did not lose much ground to the frontier plants. In general, the assimilation effect of net entry and exit have been small or even negative. In many cases, this might be the result of entering plants being young by definition. We estimated positive assimilation effects of age.

Table 5: Decomposition of Manufacturing Labor Productivity Growth Rate

	growth	E_As_C	Pot_C	Inn_C	E_As_XN	Pot_XN	Inn_XN	R_As_T	R_Pot_T	U_As_T
Manufacturing	1.381	1.127	1.030	1.141	0.892	1.051	1.065	1.038	0.990	1.016

Notes: see Table 3

The final result we would like to present is for the entire Indonesian manufacturing sector, which experienced a 38% labor productivity growth rate in the 1988-1995 period. The absorptive capacity of entering plants in comparison to exiting plants would have led to an 11% reduction in labor productivity and reallocation effects towards relatively capital-intensive plants would have yielded an additional 1% decrease, but the remaining seven factors all contributed positively. The most important contributors were innovation (induced by foreign technology) and explained assimilation by continuing firms (14 and 13%, respectively). The effects of investment in more or more modern capital goods were also positive, but of a clearly smaller magnitude. Apparently, assimilation theories were more relevant than accumulation theories with regard to the explanation of productivity growth in Indonesian manufacturing in the period considered.

6. Conclusions and Future Research

In this paper we examined the sources of labor productivity growth in the Indonesian manufacturing sector for the period 1988-95. The main objective has been to introduce and accounting framework that is capable of assessing the relative degrees of importance of accumulation of physical capital and the assimilation of foreign technology (the Indonesian manufacturing did hardly spend anything on R&D itself). With regard to the latter determinant of growth, an important advantage of our choice to start from plant-level data is that we could distinguish between plants operating on upward shifting frontiers and less productive plants operating technologies with a similar capital intensity. In this sense, our framework can be considered as an empirical tool that adopts the perspective of appropriate technology growth models (Basu and Weil, 1998).

Our approach contains a few novel aspects. Next to the bottom-up approach, we were also able to link assimilation performance of plants (plus industries and broader aggregates)

to changes in indicators of ‘absorptive capacity’, that is, the capabilities to turn knowledge from elsewhere into productivity gains. Examples of such indicators are age of the plant, labor quality, degree of foreign ownership. Some of our theory-driven hypotheses regarding the effects of changes in these variables over time could be confirmed, others could not. In some cases (particularly regarding labor quality), the somewhat counterintuitive results could be due to imperfect indicators we had to use. Another novel aspect relates to the aggregation of plant-level results to industry-level contributions. We extended the well-known Griliches-Regev (1995) formula, which decomposes aggregate productivity growth into the effects of within-plant productivity growth and the effects of reallocation of resources, taking net effects of entry and exit into account. Taking the Los-Timmer (2005)-inspired decomposition results at the plant-level as the point of departure, the within and reallocation effects could be further split into accumulation-related and assimilation-related contributions.

We found that foreign R&D played a significant role in upwardly shifting the productivity frontier; the best-practice plants benefited crucially from foreign technology spillovers. However, the creation of spillover potential (by investing to use more capital-intensive technologies) did hardly contribute to labour productivity growth for best-practice plants. Thus, shifting to higher capital intensities *per se* did not imply more potential spillovers to benefit from. This finding is clearly at odds with the major assumptions underlying the accumulationist theories of growth.

Assimilation (movements towards the frontier) did play an important role. We could distinguish between two kinds of assimilation effects. The first type can be explained by our absorptive capacity indicators. For many industries, the estimation results underline the importance of building absorptive capacity for assimilating technology spillovers—from abroad and from best-practice firms that operate similar technology. In a quantitative sense, however, these effects were often dwarfed by the second kind of assimilation effects. This unexplained assimilation effects were very big and dominated the composite effect.

The sizeable number of 5-digit industries considered offered us the possibility to gain insights into differences in productivity dynamics across industries. Among them, the most notable is the uniquely significant effect of foreign R&D in industries that were at the forefront of the export-orientation drive of the late 1980s. These are the resource-intensive and science-based industries. In the former category, we also noted that a majority of industries experienced a favourable assimilation effect as a result of the increased-learning efforts by more experienced firms.

References

- Abramovitz, M. (1989), *Thinking About Growth* (Cambridge: Cambridge University Press).
- Aigner, D.J. and Chu, S.F. (1968), "On Estimating the Industry Production Function", *American Economic Review*, vol. 58, pp. 826-839.
- Aitken, B. and Harrison, A. (1999), "Do Domestic Firms Benefit from Foreign Direct Investment? Evidence from Venezuela", *American Economic Review*, vol. 89, pp. 605-618.
- Atkinson, A.B. and Stiglitz, J.E. (1969), "A New Wave of Technological Change", *Economic Journal*, vol. 79, pp. 573-578.
- Aw, B.Y., Chen, X. and Roberts, M.J. (2001), "Firm-Level Evidence on Productivity Differentials and Turnover in Taiwanese Manufacturing", *Journal of Development Economics*, vol. 66, pp. 51-86.
- Basu, S. and Weil, D.N. (1998), "Appropriate Technology and Growth", *Quarterly Journal of Economics*, vol. 113, pp.1025-1054.
- Battese, G.E. and Coelli, T.J. (1995), "A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data", *Empirical Economics*, vol. 20, pp. 325-332.
- Blalock, G. and Gertler, P.J. (2004), "Learning from Exporting Revisited in a Less Developed Setting", *Journal of Development Economics*, vol. 75, pp. 397-416.
- Blomström, M. and Kokko, A. (1998), "Multinational Corporations and Spillovers", *Journal of Economic Surveys*, vol. 12, pp. 247-277.
- Blomström, M. and Sjöholm, F. (1999), "Technology Transfer and Spillovers: Does Local Participation with Multinational Matter?", *European Economic Review*, vol. 43, pp. 915-923.
- Coelli, T.J. (1996), "A Guide to FRONTIER Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation.", *CEPA (Centre for Efficiency and Productivity Analysis) Working Paper*, No.7, University of New England, Department of Econometrics, University of New England, Armidale, pp.33.
- Coelli, T.J., Rao, D.S.P. and Battese, G.E. (1998), *An Introduction to Efficiency and Productivity Analysis* (Boston: Kluwer Academic Publishers).
- Cohen, W.M. and Levinthal, D.A. (1989), "Innovation and Learning: The Two Faces of R&D", *Economic Journal*, vol. 99, pp. 569-596.
- Easterly, W. and Levine, R. (2001), "It's Not Factor Accumulation: Stylized Facts and Growth Models", *World Bank Economic Review*, vol. 15, pp. 177-219.
- Evenson, R. and Westphal, L. (1995) "Technological Change and Technology Strategy", in T.N. Srinivasan and J. Behrman (eds.), *Handbook of Development Economics*, Vol. 3. (Amsterdam: North Holland).
- Foster, L., Haltiwanger, J. and Krizan, C.J. (2006), "Market Selection, Reallocation, and Restructuring in the U.S. Retail Trade Sector in the 1990s", *Review of Economic and Statistics*, vol. 88, pp. 748-758.
- Greene, W.A. (2005), "Reconsidering Heterogeneity and Inefficiency: Alternative Estimators for Stochastic Frontier Models", *Journal of Econometrics*, vol. 126, pp. 269-303.
- Griliches, Z. and Regev, H. (1995), "Firm Productivity in Israeli Industry 1979-1988", *Journal of Econometrics*, vol. 65, pp. 175-203.
- Hill, H. (1996), *The Indonesian Economy since 1966: Southeast Asia's Emerging Giant* (Cambridge: Cambridge University Press).
- Kim, L. (1997), *Imitation to Innovation: The Dynamics of Korea's Technological Learning* (Boston: Harvard Business School Press).

- Kumar, S. and Russell, R.R. (2002), "Technological Change, Technological Catch-Up and Capital Deepening: Relative Contributions to Growth and Convergence", *American Economic Review*, vol. 92, pp. 527-549.
- Kumbhakar, S.C. and Lovell, C.A.K (2000), *Stochastic Frontier Analysis* (Cambridge: Cambridge University Press).
- Lichtenberg, F.R. and van Pottelsberghe de la Potterie, B. (1998), "International R&D Spillovers: A Comment", *European Economic Review*, vol. 42, no. 8, pp. 1483-1491.
- Los, B. and Timmer, M.P. (2005), "The 'Appropriate Technology' Explanation of Productivity Growth Differentials: An Empirical Approach", *Journal of Development Economics*, vol. 77, pp. 517-531.
- Nelson R.R. and Pack, H. (1999), "The Asian Miracle and Modern Growth Theory", *Economic Journal*, vol. 109, pp. 416-436.
- Okamoto, Y. and Sjöholm, F. (2005), "FDI and the Dynamics of Productivity in Indonesian Manufacturing", *Journal of Development Studies*, vol. 41, pp. 160-182.
- OECD (1987) *Structural Adjustment and Economic Performance*, OECD, Paris.
- Pack, H. (1987), *Productivity, Technology, and Industrial Development: A Case Study in Textiles* (New York: Oxford University Press).
- Pavitt, K. (1984), "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory", *Research Policy*, vol. 13, pp. 343-373.
- Pitt, M.M. and Lee, L.F. (1981), "The Measurement and Sources of Technical Efficiency in the Indonesian Weaving Industry", *Journal of Development Economics*, vol. 9, pp. 43-64.
- Takii, S. (2005), "Productivity Spillovers and Characteristics of Foreign Multinational Plants in Indonesian Manufacturing 1990-1995", *Journal of Development Economics*, vol. 76, pp. 521-542.
- Teece, D.J. (2000), *Managing Intellectual Capital* (Oxford: Oxford University Press).
- Todo, Y. and Miyamoto, K. (2006), "Knowledge Spillovers from Foreign Direct Investment and the Role of Local R&D Activities: Evidence from Indonesia", *Economic Development and Cultural Change*, vol. 55, pp. 173-200.
- Tybout, J.R. (2000), "Manufacturing Firms in Developing Countries: How Well Do They Do and Why?", *Journal of Economic Literature*, vol. 38, pp. 11-44.
- Van Dijk, M. (2005), *Industry Evolution and Catch Up: The Case of the Indonesian Pulp and Paper Industry*, unpublished PhD thesis, University of Eindhoven.
- Verspagen, B. (1997), "Estimating International Technology Spillovers Using Technology Flow Matrices", *Weltwirtschaftliches Archiv*, vol. 133, pp. 226-248.
- Winter, S.G. (1984), "Schumpeterian Competition in Alternative Technological Regimes", *Journal of Economic Behavior and Organization*, vol. 5, pp. 287-320.
- Young, A. (1995), "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience", *Quarterly Journal of Economics*, vol. 110, pp. 641-680.

Appendix A: Data and Sample Selection

A.1. Combining the Backcast and Statistik Industri (SI) Data Sets

The Statistik Industri (SI) data is based on annual surveys conducted on plants in the medium and large manufacturing sector by the Central Statistical Agency of Indonesia (Badan Pusat Statistik, BPS). In earlier surveys, especially those before 1985, a large number of plants that were in operation were not accounted for. To correct for this, BPS initiated a new manufacturing survey in 1993 to collect information on plants that were not covered by SI from 1975 onwards (Jammal 1993). The additional survey, called the backcast survey, however, is limited to information on only key variables such as output, value added and labour (in contrast to the detailed coverage of plant-level variables in SI). To profit from variables additionally reported in SI (among which data on import of material and foreign ownership are of relevance for this paper) on the one hand, and from the greater reliability of key variables—output, value added and labour—reported in backcast on the other, we merged the two data sets. In both the data sets, each plant is given a unique identifier. Across the two data sets, however, different identifiers have been assigned to the *same* plants, in many cases. In view of this problem, first we identified and merged plants with identical output, value added and labour, and second, for the remaining un-merged observations, we used the plant-identification codes. The observations that did not merge after the two above steps were dropped from the sample.

A.2. Choice of the Sample Period

As noted above, until the mid-1980s, the SI manufacturing survey suffered from considerable under-representation of the medium and large manufacturing industry. This is discernable, in addition to by comparing it with the backcast data, from a jump in the number of plants of more than 50% between 1984 and 1985 (resulting from the ‘discovery of new plants’ by the BPS). This has been less of a problem after 1985, and since the post-1985 period covers a large part of the Indonesian industrialisation, and due to the availability of data on replacement value of capital only from 1988 we choose 1988 as the starting year of analysis. For 1996 only the replacement value as total of all assets—land, building, machinery, transport equipment and others—is available, while for the previous years replacement value for each asset category is available. In calculating the total replacement value from 1988 to 1995, we do not consider the asset category land, because foreign firms in Indonesia are not allowed to own land.

A.3. Generating Unique Observations

A key problem with both the backcast and SI data sets is the presence of duplicate observations, and even duplicate plant-identification codes. Most of these result from the BPS practice of generating data for plants that do not report data for some years based on

the data of plants with ‘similar’ characteristics. While this is justifiable for a more accurate representation of manufacturing at the industry level, this may distort analyses at the plant level. We therefore removed observations with either repeated values for the variables output, value-added and labour, or repeated plant identification codes (in any given year). While generating unique observations, care is taken to retain observations that possessed information on other variables. We also identified and removed 81 plants for which no identification codes were assigned. At the end of this stage we were left with a sample of 161,932 unique observations off a total of 168,400 observations for the period 1988-1995. This was reduced further to 119,597 when 5-digit industries which did not possess at least 10 plants a year, and without a positive raw material import every year were dropped.

A.4. Selection of Plants and Removing Outliers

In addition to removing duplicate observations, we have made adjustments for outliers and other errors in the data. In what follows we discuss the corrections made for each variable.

Age

The SI data provide information on the year of inception for each plant. For some plants the data reported show variations over time, however. To correct this we retained the year of inception that is reported for the maximum number of years. For some plants, however, the year of inception reported was more recent than the earliest year for which information about them was recoded in the full data set (1975-1996). In such cases, we considered the earliest recorded year of a plant as its year of inception.

Foreign Ownership

The foreign ownership variable we use in the study shows the percentage share of foreign ownership in a manufacturing establishment. Instances of erroneous reporting falls roughly into two categories: 1. positive values in the border years (not necessarily the first and last years) coupled with zeros in the intervening years (e.g. 50 **0 0 0** 50), 2. unrealistically different value for a given year (two times as high or half as less) compared to the values reported in the preceding and following years (e.g. 15 **45** 15 or 65 **5** 65). In both cases, we used interpolation to correct the series.

Other Variables

For the remaining variables used in the study—output, employment (total number of employees, and number of non-production workers), value added and raw materials (total as well as imported)—the problem is one of unrealistic rises or falls over time. To correct for this, we used interpolation to replace such values within a window of two consecutive years. We adopted carefully constructed criteria to identify errors in the series for different sets of variables.

For the output and labour variables, we consider as erroneous if the value for a given year has risen either 6 times or more, or fallen to .17 times or less, compared to the previous year. Correcting for this has led to the elimination of 6,695 observations, leaving 112,902 observations in the sample.

For value added and raw materials, identification of errors is carried out in relation to their shares in output; for imported raw materials in relation to their share in total raw material use; and for non-production workers in relation to their share in total employment. Removal of outliers in the value added variable reduced the sample to 111,479 observations, that in raw materials to 105,577 observations, and that in non-production workers to 97,138 observations.

Finally we generated a balanced sample for the period 1988-1995 consisting of 65 5-digit industries (each with at least 10 plants or more, and with a positive raw material import every year). Appendix table A1 presents the summary statistics for these industries, which together consist of 17,520 observations.

A.5. Price Indices

We represent our data in 1990 Purchasing Power Parity dollars. We used three price indices for deflating the variables. For value added and output, we used the detailed commodity price index data made available to us by the BPS. For the replacement value of capital we used: a price index of non-residential and residential building for building; a price index of imported machinery for machinery and equipment; and a price index of imported transport equipment for vehicles and for others (see chapter 5). For the OECD R&D data, we used implicit price indices derived from the current and constant price value added series for each industry.

Table A.1.a : *Summary Statistics for 1988: Employment Share, Number of Plants, and Mean of the Variables for Stayers (first line) and Exits (second line)*

Isic Rev.2	Emp. Share	Plants	Val/ Lab	Cap/ Lab	IRD	Age	Foreign	Access	LQual	Size
RESOURCE-INTENSIVE INDUSTRIES										
31151	0.40	24	11.96	25.53	5.70	18.96	0.03	0.00	0.24	0.13
	0.60	35	12.98	42.47	5.70	17.74	0.03	0.00	0.29	0.14
31171	0.67	104	2.16	2.71	4.33	13.29	0.00	0.02	0.06	0.05
	0.33	74	1.80	1.86	4.33	15.20	0.00	0.02	0.07	0.04
31179	0.64	73	4.22	8.61	7.20	14.93	0.01	0.03	0.15	0.08
	0.36	63	2.85	4.25	7.20	13.51	0.00	0.02	0.11	0.05
31192	0.56	21	4.43	9.23	5.77	20.71	0.04	0.06	0.15	0.10
	0.44	21	4.78	4.33	5.77	16.43	0.00	0.07	0.09	0.08
31241	0.51	28	4.62	5.04	3.96	28.36	0.00	0.01	0.17	0.05
	0.49	19	3.34	3.15	3.96	24.95	0.00	0.01	0.09	0.07
31251	0.60	83	1.85	1.62	4.91	11.65	0.00	0.00	0.07	0.04
	0.40	58	2.20	1.59	4.91	10.05	0.00	0.00	0.08	0.03
31272	0.83	15	2.40	2.60	7.20	18.93	0.00	0.02	0.16	0.05
	0.17	4	1.91	1.24	7.20	15.50	0.00	0.00	0.04	0.04
31279	0.76	26	3.59	5.32	7.15	9.27	0.01	0.03	0.13	0.07
	0.24	15	2.26	2.15	7.15	10.47	0.00	0.00	0.06	0.04
31281	0.69	18	28.79	28.96	6.70	6.83	0.07	0.19	0.29	0.11
	0.31	10	50.86	40.62	6.70	10.40	0.20	0.11	0.41	0.09
31340	0.65	25	12.82	22.17	5.59	17.36	0.06	0.11	0.32	0.09
	0.35	28	5.39	8.20	5.59	13.96	0.01	0.09	0.19	0.04
31410	0.23	137	0.77	1.21	5.93	16.99	0.00	0.00	0.02	0.04
	0.77	209	0.90	1.43	5.93	17.11	0.00	0.00	0.03	0.09
31420	0.27	33	8.13	2.31	6.36	20.64	0.00	0.07	0.10	0.52
	0.73	21	5.73	25.01	6.36	25.90	0.00	0.01	0.14	2.19
31440	0.63	10	3.83	1.52	5.93	27.20	0.00	0.10	0.11	0.18
	0.37	3	1.93	3.81	5.93	36.33	0.00	0.14	0.15	0.36
33111	0.42	69	12.56	12.17	1.78	9.32	0.02	0.01	0.19	0.19
	0.58	159	11.13	10.94	1.78	8.58	0.02	0.00	0.21	0.11
33112	0.78	40	13.20	16.42	3.54	7.28	0.01	0.00	0.18	0.19
	0.22	26	10.06	15.99	3.54	7.38	0.03	0.00	0.17	0.09
33113	0.72	30	17.37	25.51	3.45	8.87	0.04	0.03	0.13	1.12
	0.28	14	27.13	44.61	3.45	5.14	0.06	0.04	0.19	0.95
33114	0.99	13	14.01	31.47	8.31	7.77	0.07	0.06	0.11	0.74
	0.01	2	9.47	16.87	8.31	4.50	0.00	0.00	0.09	0.03
33131	0.58	11	7.99	5.83	3.45	8.73	0.00	0.02	0.07	0.27
	0.42	11	3.98	3.98	3.45	6.73	0.00	0.03	0.11	0.20
33211	0.76	69	4.99	5.80	4.35	9.78	0.02	0.01	0.12	0.08
	0.24	43	5.25	4.62	4.35	9.79	0.00	0.01	0.09	0.04
35224	0.85	19	2.89	4.53	80.83	18.42	0.00	0.05	0.20	0.24
	0.15	6	3.18	3.57	80.83	26.33	0.00	0.17	0.10	0.13
35511	1.00	10	13.27	31.83	15.57	21.70	0.14	0.36	0.15	0.41
35512	0.93	11	11.80	14.44	15.57	9.45	0.00	0.20	0.30	0.08
	0.07	1	5.10	7.34	15.57	15.00	0.00	0.00	0.23	0.06
35523	0.80	33	12.96	12.77	16.61	16.30	0.15	0.10	0.19	0.23

	0.20	16	16.13	21.52	16.61	14.19	0.13	0.08	0.15	0.12
35593	0.65	27	2.84	6.85	13.18	12.19	0.05	0.11	0.11	0.14
	0.35	8	4.08	5.80	13.18	13.00	0.00	0.15	0.12	0.26
36111	0.87	12	3.96	6.40	39.38	8.25	0.07	0.50	0.11	0.42
	0.13	3	3.79	6.15	39.38	5.33	0.00	0.15	0.23	0.26
36112	0.90	11	9.84	21.36	37.79	7.82	0.04	0.46	0.16	0.34
	0.10	1	14.35	69.14	37.79	5.00	0.00	0.91	0.20	0.42
36321	0.64	107	6.59	8.61	46.54	13.10	0.01	0.05	0.16	0.06
	0.36	76	7.16	8.29	46.54	14.47	0.01	0.03	0.16	0.05
LABOUR INTENSIVE INDUSTRIES										
32210	0.45	182	3.22	3.20	38.84	12.59	0.00	0.09	0.07	0.13
	0.55	246	3.91	8.10	38.84	10.30	0.01	0.06	0.08	0.12
32312	0.57	13	9.10	17.26	15.99	22.23	0.00	0.07	0.15	0.06
	0.43	9	14.68	16.97	15.99	19.00	0.00	0.17	0.12	0.07
32411	0.41	17	4.70	5.83	27.79	11.24	0.00	0.10	0.13	0.08
	0.59	27	3.98	3.76	27.79	7.81	0.00	0.07	0.11	0.07
39090	0.15	10	4.54	3.74	91.71	13.10	0.00	0.19	0.16	0.04
	0.85	17	4.76	4.17	91.71	10.59	0.00	0.11	0.16	0.13
SCALE INTENSIVE INDUSTRIES										
32111	0.50	19	13.96	31.10	48.87	16.11	0.20	0.28	0.18	0.68
	0.50	15	16.07	22.10	48.87	13.33	0.18	0.33	0.16	0.85
32114	0.71	113	5.70	13.82	39.68	14.65	0.01	0.08	0.12	0.33
	0.29	99	3.42	5.62	39.68	17.22	0.00	0.08	0.10	0.15
32115	0.59	22	6.74	15.04	38.84	12.36	0.00	0.14	0.13	0.19
	0.41	17	4.97	14.30	38.84	11.24	0.00	0.12	0.10	0.18
32116	0.55	12	7.96	12.20	32.42	19.83	0.05	0.16	0.11	0.34
	0.45	10	18.71	25.59	32.42	13.40	0.13	0.14	0.13	0.34
32117	0.31	26	2.65	3.73	48.87	15.77	0.00	0.17	0.05	0.05
	0.69	63	2.72	8.13	48.87	17.75	0.00	0.13	0.04	0.05
32121	0.54	43	3.14	4.05	32.42	16.40	0.05	0.05	0.09	0.10
	0.46	37	3.33	5.50	32.42	13.32	0.00	0.05	0.07	0.10
32130	0.45	28	5.89	6.69	54.92	12.00	0.00	0.05	0.12	0.14
	0.55	46	4.33	7.65	54.92	12.37	0.00	0.03	0.08	0.10
32190	0.88	15	6.18	13.13	54.92	8.07	0.00	0.18	0.17	0.14
	0.12	4	2.92	3.10	54.92	11.00	0.00	0.05	0.10	0.07
34112	0.75	12	14.65	39.49	117.62	15.92	0.00	0.23	0.21	0.58
	0.25	7	10.63	13.94	117.62	13.57	0.00	0.25	0.15	0.34
34113	0.80	11	11.46	15.23	117.62	10.09	0.00	0.14	0.19	0.16
	0.20	6	19.42	10.76	117.62	12.17	0.12	0.00	0.17	0.08
34120	0.58	11	15.20	17.61	108.59	13.18	0.00	0.08	0.13	0.20
	0.42	13	7.06	9.68	108.59	9.54	0.02	0.01	0.15	0.13
34200	0.70	136	6.90	16.91	114.93	17.65	0.00	0.09	0.23	0.12
	0.30	123	7.70	15.45	114.93	20.42	0.00	0.08	0.22	0.06
35142	0.61	13	19.34	42.07	292.17	9.69	0.13	0.45	0.29	0.18
	0.39	8	12.80	12.48	292.17	7.75	0.00	0.59	0.14	0.19
35210	0.66	24	9.08	11.10	304.74	11.42	0.02	0.29	0.21	0.08
	0.34	14	25.76	9.75	304.74	12.86	0.10	0.36	0.29	0.07
35231	0.74	18	7.44	8.24	249.38	14.61	0.00	0.21	0.22	0.20
	0.26	19	9.99	5.76	249.38	11.21	0.03	0.10	0.17	0.07
35232	0.75	19	10.17	8.89	220.49	10.42	0.02	0.41	0.26	0.11
	0.25	11	9.06	19.97	220.49	20.27	0.09	0.48	0.26	0.06
35291	0.93	12	45.69	98.61	220.49	9.75	0.04	0.58	0.43	0.10
	0.07	2	7.62	9.26	220.49	23.00	0.00	0.56	0.61	0.05
37103	0.77	18	29.33	37.68	21.95	11.00	0.07	0.18	0.28	0.21
	0.23	2	4.83	28.62	21.95	14.50	0.00	0.28	0.15	0.57

38432	0.51	22	5.32	7.30	729.17	10.23	0.00	0.04	0.14	0.10
	0.49	14	22.05	8.83	729.17	10.29	0.05	0.00	0.17	0.15
38433	0.70	18	32.64	54.90	729.17	8.28	0.04	0.38	0.21	0.16
	0.30	9	26.84	32.60	729.17	8.44	0.10	0.64	0.21	0.14
38444	0.73	19	7.21	8.35	58.66	11.63	0.03	0.17	0.13	0.10
	0.27	9	3.97	4.29	58.66	7.11	0.00	0.31	0.10	0.08
DIFFERENTIATED INDUSTRIES										
38113	0.29	12	2.73	3.41	224.48	10.92	0.00	0.03	0.09	0.06
	0.71	9	5.17	3.87	224.48	14.67	0.00	0.22	0.11	0.21
38114	0.76	22	7.48	9.23	183.10	9.86	0.11	0.43	0.12	0.15
	0.24	12	5.89	9.85	183.10	17.67	0.00	0.22	0.11	0.09
38120	0.66	15	7.26	9.86	197.53	9.13	0.00	0.01	0.21	0.11
	0.34	16	4.53	6.32	197.53	8.44	0.04	0.06	0.12	0.05
38191	0.72	15	20.10	17.25	183.10	12.13	0.05	0.06	0.17	0.07
	0.28	4	10.48	5.72	183.10	28.50	0.00	0.00	0.14	0.11
38193	0.61	13	10.42	22.59	197.53	12.85	0.05	0.15	0.17	0.24
	0.39	23	10.01	11.73	197.53	14.30	0.04	0.11	0.17	0.09
38195	0.73	14	65.81	43.93	232.03	10.57	0.21	0.37	0.28	0.18
	0.27	6	9.28	15.10	232.03	20.17	0.00	0.09	0.17	0.16
38199	0.77	13	5.27	6.24	224.48	7.54	0.00	0.13	0.10	0.14
	0.23	10	5.06	4.94	224.48	8.30	0.00	0.18	0.16	0.06
38245	0.92	12	6.43	6.33	359.42	19.08	0.00	0.19	0.20	0.09
	0.08	2	6.12	14.39	359.42	29.50	0.00	0.05	0.14	0.05
SCIENCE-BASED INDUSTRIES										
35222	0.66	55	17.67	20.52	190.26	16.56	0.17	0.74	0.36	0.15
	0.34	33	15.22	21.56	190.26	16.09	0.08	0.59	0.31	0.13
35605	0.17	24	4.92	7.34	14.55	8.50	0.00	0.36	0.15	0.06
	0.83	25	5.53	11.79	14.55	8.36	0.00	0.41	0.14	0.27
35606	0.51	67	6.50	14.32	14.55	10.58	0.00	0.59	0.13	0.09
	0.49	49	6.32	13.10	14.55	9.84	0.00	0.61	0.14	0.12
35609	0.65	26	4.46	6.82	14.55	7.00	0.00	0.27	0.13	0.06
	0.35	11	17.25	39.33	14.55	9.18	0.00	0.36	0.15	0.08
38396	0.75	10	17.36	33.13	77.60	9.90	0.04	0.32	0.22	0.29
	0.25	5	9.28	16.76	77.60	16.40	0.00	0.05	0.23	0.19

Table A.1.b : *Summary Statistics for 1995: Employment Share, Number of Plants, and Mean of the Variables for Stayers (first line) and Entrants (second line)*

Isic Rev.2	Emp. Share	Plants	Val/ Lab	Cap/ Lab	IRD	Age	Foreign	Access	LQual	Size
RESOURCE-INTENSIVE INDUSTRIES										
31151	0.82	24	14.00	32.81	8.65	25.96	0.03	0.00	0.30	0.09
	0.18	4	37.38	480.39	8.65	4.25	0.00	0.25	0.30	0.13
31171	0.80	104	4.22	4.00	6.57	20.29	0.01	0.01	0.07	0.07
	0.20	15	6.87	5.50	6.57	3.47	0.03	0.00	0.07	0.13
31179	0.87	73	6.33	8.04	10.92	21.93	0.01	0.04	0.13	0.13
	0.13	17	7.55	20.96	10.92	3.35	0.11	0.04	0.07	0.09
31192	0.75	21	5.02	8.34	8.75	27.71	0.03	0.05	0.13	0.14
	0.25	5	10.12	22.90	8.75	4.20	0.00	0.07	0.20	0.20
31241	0.94	28	6.64	6.04	6.00	35.36	0.00	0.01	0.20	0.12

	0.06	5	5.94	4.61	6.00	4.20	0.00	0.00	0.09	0.04
31251	0.89	83	2.90	2.19	7.45	18.65	0.00	0.00	0.07	0.04
	0.11	9	4.64	5.33	7.45	3.78	0.00	0.00	0.08	0.05
31272	0.75	15	4.30	5.29	10.92	25.93	0.00	0.03	0.14	0.05
	0.25	4	3.62	14.97	10.92	4.00	0.00	0.00	0.08	0.07
31279	0.69	26	9.61	5.04	10.85	16.27	0.01	0.02	0.14	0.07
	0.31	8	8.84	26.27	10.85	2.88	0.00	0.12	0.12	0.10
31281	0.63	18	68.32	50.13	10.16	13.83	0.11	0.14	0.35	0.11
	0.37	6	52.79	83.49	10.16	4.83	0.00	0.36	0.49	0.19
31340	0.86	25	38.50	35.78	8.48	24.36	0.11	0.04	0.23	0.14
	0.14	8	5.40	16.46	8.48	3.75	0.00	0.01	0.27	0.07
31410	0.93	137	1.06	1.09	9.00	23.99	0.00	0.00	0.02	0.07
	0.07	10	2.92	8.01	9.00	3.60	0.10	0.01	0.04	0.07
31420	0.92	33	9.71	6.05	9.65	27.64	0.00	0.01	0.13	0.73
	0.08	11	4.64	6.87	9.65	3.27	0.00	0.00	0.15	0.18
31440	1.00	10	2.27	1.44	9.00	34.20	0.00	0.09	0.09	0.13
33111	0.84	69	17.46	19.15	2.20	16.32	0.03	0.01	0.19	0.27
	0.16	34	14.46	12.35	2.20	3.29	0.02	0.00	0.17	0.10
33112	0.73	40	12.06	16.12	4.37	14.28	0.01	0.00	0.18	0.43
	0.27	42	14.48	27.83	4.37	3.76	0.12	0.01	0.18	0.15
33113	0.95	30	17.41	33.33	4.26	15.87	0.05	0.02	0.13	1.73
	0.05	1	44.90	11.29	4.26	6.00	0.40	0.00	0.12	2.46
33114	0.74	13	19.20	38.49	10.26	14.77	0.00	0.01	0.19	1.20
	0.26	9	10.09	9.95	10.26	4.33	0.00	0.00	0.09	0.63
33131	0.96	11	7.56	8.67	4.26	15.73	0.00	0.03	0.12	0.30
	0.04	2	4.67	5.37	4.26	5.00	0.00	0.00	0.17	0.06
33211	0.58	69	6.29	6.30	5.37	16.78	0.01	0.02	0.10	0.17
	0.42	62	7.13	11.45	5.37	3.47	0.03	0.00	0.16	0.14
35224	1.00	19	8.18	7.32	112.27	25.42	0.00	0.11	0.22	0.28
35511	0.99	10	28.18	49.28	16.45	28.70	0.14	0.24	0.14	0.58
	0.01	1	4.86	10.84	16.45	5.00	0.00	0.47	0.09	0.07
35512	0.98	11	16.02	14.10	16.45	16.45	0.00	0.19	0.33	0.11
	0.02	1	1.22	3.67	16.45	3.00	0.00	0.00	0.09	0.02
35523	0.84	33	20.90	19.64	17.55	23.30	0.15	0.08	0.20	0.21
	0.16	7	14.57	22.85	17.55	4.43	0.07	0.23	0.30	0.19
35593	0.93	27	6.43	5.52	13.92	19.19	0.05	0.11	0.12	0.29
	0.07	3	5.78	18.83	13.92	5.00	0.00	0.23	0.12	0.19
36111	0.98	12	6.19	7.40	42.38	15.25	0.07	0.51	0.13	0.93
	0.02	2	3.43	38.72	42.38	2.50	0.00	0.50	0.07	0.12
36112	0.66	11	21.63	73.99	40.67	14.82	0.04	0.33	0.17	0.47
	0.34	7	20.28	84.22	40.67	4.29	0.07	0.49	0.17	0.37
36321	0.74	107	6.67	10.11	50.09	20.10	0.01	0.01	0.19	0.08
	0.26	19	11.61	22.45	50.09	3.63	0.00	0.04	0.23	0.15
LABOUR-INTENSIVE INDUSTRIES										
32210	0.61	182	7.07	4.99	30.30	19.59	0.00	0.06	0.07	0.20
	0.39	70	9.92	9.26	30.30	3.91	0.11	0.16	0.12	0.33
32312	0.74	13	21.31	23.24	12.48	29.23	0.00	0.10	0.16	0.11
	0.26	5	7.39	31.49	12.48	3.00	0.00	0.37	0.21	0.10
32411	0.45	17	12.15	6.59	21.68	18.24	0.00	0.08	0.15	0.20
	0.55	18	9.71	13.26	21.68	3.83	0.14	0.25	0.13	0.23
39090	0.15	10	11.72	17.75	87.19	20.10	0.00	0.12	0.17	0.03
	0.85	12	6.61	23.63	87.19	3.58	0.14	0.41	0.16	0.15
SCALE-INTENSIVE INDUSTRIES										
32111	0.73	19	21.70	42.92	38.13	23.11	0.20	0.38	0.19	0.80

	0.27	12	18.86	55.55	38.13	4.25	0.07	0.25	0.14	0.46
32114	0.84	113	10.00	15.67	30.96	21.65	0.01	0.04	0.11	0.47
	0.16	24	28.14	62.62	30.96	4.13	0.05	0.05	0.10	0.42
32115	0.80	22	9.75	16.30	30.30	19.36	0.00	0.11	0.12	0.32
	0.20	7	17.53	58.60	30.30	3.86	0.21	0.08	0.14	0.24
32116	0.60	12	15.40	12.87	25.30	26.83	0.05	0.16	0.15	0.43
	0.40	8	24.95	59.12	25.30	3.88	0.07	0.01	0.14	0.43
32117	1.00	26	5.09	5.43	38.13	22.77	0.00	0.21	0.08	0.10
32121	0.74	43	4.55	5.01	25.30	23.40	0.00	0.04	0.10	0.13
	0.26	6	7.92	11.27	25.30	3.33	0.16	0.31	0.11	0.34
32130	0.44	28	7.31	9.05	42.85	19.00	0.00	0.03	0.10	0.19
	0.56	21	7.40	13.17	42.85	3.90	0.24	0.11	0.11	0.32
32190	0.81	15	6.64	11.92	42.85	15.07	0.00	0.08	0.12	0.34
	0.19	9	13.12	39.17	42.85	3.89	0.27	0.27	0.14	0.14
34112	0.95	12	18.13	83.38	76.39	22.92	0.00	0.26	0.18	0.75
	0.05	6	8.29	35.67	76.39	3.67	0.00	0.15	0.19	0.09
34113	1.00	11	8.47	37.90	76.39	17.09	0.00	0.14	0.17	0.27
34120	0.45	11	18.65	35.36	70.53	20.18	0.04	0.05	0.21	0.32
	0.55	26	31.54	53.31	70.53	3.65	0.06	0.10	0.22	0.16
34200	0.93	136	10.40	31.59	74.65	24.65	0.00	0.08	0.24	0.14
	0.07	7	10.02	19.23	74.65	4.00	0.00	0.20	0.24	0.19
35142	0.98	13	20.93	32.98	356.54	16.69	0.13	0.32	0.23	0.20
	0.02	1	13.36	58.82	356.54	5.00	0.00	0.00	0.23	0.04
35210	0.77	24	15.03	9.92	371.88	18.42	0.03	0.18	0.22	0.13
	0.23	11	24.72	21.73	371.88	4.18	0.04	0.29	0.30	0.08
35231	0.94	18	5.14	7.34	304.32	21.61	0.00	0.15	0.21	0.21
	0.06	2	12.91	9.36	304.32	5.50	0.00	0.48	0.14	0.13
35232	0.97	19	12.77	13.16	269.06	17.42	0.05	0.47	0.25	0.27
	0.03	3	41.07	8.38	269.06	4.00	0.00	0.06	0.14	0.05
35291	0.77	12	65.81	119.17	269.06	16.75	0.14	0.40	0.40	0.15
	0.23	3	42.93	82.26	269.06	2.00	0.23	0.63	0.41	0.18
37103	1.00	18	101.60	52.94	19.60	18.00	0.09	0.22	0.22	0.27
38432	0.76	22	7.97	13.42	542.78	17.23	0.00	0.01	0.21	0.12
	0.24	4	9.32	8.72	542.78	4.50	0.00	0.00	0.17	0.21
38433	0.77	18	28.66	50.04	542.78	15.28	0.06	0.38	0.20	0.43
	0.23	11	11.67	30.40	542.78	3.55	0.07	0.38	0.18	0.22
38444	0.87	19	8.71	10.97	59.28	18.63	0.03	0.07	0.17	0.17
	0.13	8	13.67	24.84	59.28	3.25	0.05	0.00	0.16	0.06
DIFFERENTIATED INDUSTRIES										
38113	0.91	12	4.06	3.19	208.70	17.92	0.00	0.01	0.10	0.09
	0.09	2	3.27	2.17	208.70	3.00	0.00	0.00	0.10	0.05
38114	0.98	22	10.47	10.07	170.24	16.86	0.07	0.36	0.11	0.40
	0.02	3	9.90	9.38	170.24	4.33	0.00	0.29	0.20	0.05
38120	0.77	15	8.84	6.18	183.65	16.13	0.00	0.01	0.20	0.17
	0.23	7	16.16	11.52	183.65	3.57	0.34	0.18	0.17	0.11
38191	0.84	15	12.53	17.33	170.24	19.13	0.05	0.11	0.13	0.15
	0.16	3	10.62	63.06	170.24	4.33	0.00	0.04	0.17	0.14
38193	0.82	13	19.53	37.98	183.65	19.85	0.05	0.15	0.14	0.28
	0.18	4	20.25	91.70	183.65	3.50	0.00	0.13	0.16	0.21
38195	1.00	14	21.26	61.00	215.72	17.57	0.15	0.32	0.24	0.37
38199	0.93	13	9.58	11.71	208.70	14.54	0.00	0.15	0.09	0.23
	0.07	2	12.55	8.21	208.70	2.50	0.00	0.21	0.17	0.11
38245	1.00	12	11.18	22.74	499.22	26.08	0.00	0.11	0.19	0.10
SCIENCE-BASED INDUSTRIES										

35222	0.97	55	33.14	27.96	264.26	23.56	0.16	0.57	0.35	0.17
	0.03	2	7.00	27.04	264.26	4.00	0.00	0.00	0.33	0.15
35605	0.77	24	5.36	12.24	15.37	15.50	0.00	0.19	0.16	0.11
	0.23	8	5.93	13.89	15.37	3.38	0.00	0.12	0.18	0.10
35606	0.72	67	7.35	11.48	15.37	17.58	0.00	0.27	0.14	0.17
	0.28	20	8.95	38.08	15.37	3.30	0.02	0.31	0.16	0.22
35609	0.78	26	10.60	7.26	15.37	14.00	0.04	0.09	0.15	0.10
	0.22	12	15.01	23.52	15.37	3.17	0.00	0.07	0.15	0.06
38396	0.91	10	82.43	87.89	90.77	16.90	0.08	0.19	0.16	0.56
	0.09	2	16.80	17.35	90.77	3.50	0.48	0.50	0.25	0.29

TABLE A.2. *Industrial Classification*^a

No.	Industry	Isic Revision 2
RESOURCE-INTENSIVE INDUSTRIES		
1	crude vegetable and animal cooking oil	31151
2	macaroni, spaghetti, noodle and the like	31171
3	bakery products	31179
4	food made of chocolate and sugar confectionery	31192
5	soya sauce	31241
6	all kinds of chip (shrimp chip, fish chip etc)	31251
7	cake, pastry and similar products	31272
8	other food products n.e.c	31279
9	prepared animal feeds	31281
10	soft drinks	31340
11	dried tobacco and processed tobacco	31410
12	clove cigarettes	31420
13	other type of cigarettes	31440
14	Spinning mills	32111
15	Weaving mills except gunny and other sacks	32114
16	finished textiles	32115
17	printed textiles	32116
18	batik	32117
19	made	32121
20	Knitting mills	32130
21	textile n.e.c	32190
22	wearing apparel made of textile (garments)	32210
23	leather tanneries	32312
24	footwear for daily use	32411
25	Sawmills	33111
26	moulding and building components	33112
27	plywood	33113
LABOUR INTENSIVE INDUSTRIES		
28	laminated board including decorative plywood	33114
29	plaits made of rattan and bamboo	33131
30	furniture and fixtures mainly made of wood	33211
31	cultural papers	34112
SCALE INTENSIVE INDUSTRIES		
32	industrial papers	34113
33	boxes made of paper and cardboard	34120
34	Printing, publishing and allied industries	34200
35	pesticides	35142
36	paints, varnishes and lacquers	35210
37	drugs and medicines	35222
38	herbal medicine	35224
39	soap and cleaning preparations, including tooth paste	35231
40	cosmetics	35232
41	adhesive	35291

42	tire and inner tubes	35511
43	vulcanized tire	35512
44	crumb rubber	35523
45	products of rubber n.e.c	35593
46	furniture and fixtures mainly made of plastics	35605
47	plastics bags, containers	35606
48	plastic products n.e.c	35609
49	household wares made of porcelain	36111
50	structural materials made of porcelain	36112
51	structural cement products	36321
52	Steel rolling industry	37103
DIFFERENTIATED INDUSTRIES		
53	kitchen ware made of aluminium	38113
54	kitchen ware made of metal other than aluminium	38114
55	furniture and fixtures primarily made of metal	38120
56	nail, screw and bolts	38191
57	all kind of metal containers	38193
58	metal pipe and pipe fitting	38195
59	products of metal n.e.c	38199
60	other industrial machinery and equipments n.e.c	38245
SCIENCE-BASED INDUSTRIES		
61	electric and telephone cables	38396
62	motor vehicle bodies	38432
63	motor vehicle component and apparatus	38433
64	bicycle and tricycles components	38444
65	Other manufacturing industries n.e.c	39090

^a Classification of industries into the five categories is based on OECD (1987).