DOES SIZE MATTER IN DETERMINING THE PERFORMANCE OF MANUFACTURING INDUSTRIES?

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Abstract

This paper examines the effect of size on the performance of industries within the economy. In a panel setting, it applies the augmented Cobb-Douglas model used by Mankiw et al. (1992) on 73 manufacturing industries in Malaysia for the period 1981-1999. Fixed effect is applied to levels and first difference data. Different proxies for size are used to see if it makes a significant difference to the results. Results show that: (1) annual sales turnover is a better measure for size because it is not biased to capital intensive and labour intensive industries, (2) only the medium and large industries are found to have cyclical pattern, and (3) the change in the size of the large industries seems to be able to explain more of the variations in output per labour compared to the medium and small ones.

JEL Classification: J24, L25, L60, C23
Keywords : Industries Performance, Size, Panel Data.

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1. Introduction

This paper examines how the average size, measured by employment, annual sales turnover and paid-up capital of firms in an industry may affect the growth or performance of the industry. The size distribution is divided into 3 groups, i.e. small, medium and large industries[1]. For this purpose, I apply Solow growth model, as used by Mankiw, Romer and Weil (1992). In their model, labour productivity of a country is the dependent variable. They use it as a measure of the standard of living. As labour productivity is also used an indicator of the industry performance, this model is adapted to our industry level data. I am using the data on 73 industries, at 4-digit ISIC[2] level, from 1980-1999 for Malaysia.

Size distribution and growth of firms become the focus of sustained research effort since the 1950s. Early studies are mainly time series studies, which include the works by Hart and Prais (1956), Simon and Bonini (1958), Mansfield (1962), Ijiri and Simon (1964, 1977), Samuels (1965), Prais (1976) and Lucas (1967, 1978), among others. By mid 1960s, a second research literature that uses cross-sectional data emerged. The works by Bain (1966), Pryor (1972) and Philips (1971), for instance, were motivated by the observation that market structure of industries varies in a systematic way with such variables such as scale economies, R&D and advertising. In this period, stochastic growth models were developed based on the paper by Ijiri and Simon (1977). In the late 1970s, the cross-sectional literature has been reformulated using game-theoretic models (see survey by Sutton, 1997). Following this, is the revival of interest in the older growth-of-firms literature (Jovanovic, 1982; and Selten, 1983).

More recent works like Kumar (1985), Hall (1987), Evans (1987), Acs & Audretch (1990) and Farinas and Moreno (2000) that use more complete datasets than in the past proved that the relationship between growth and size is not constant but rather decreasing. Farinas and Moreno (2000) in particular, find the mean growth rate of successful firms decline with size and age. While Kumar (1985) and Acs and Audretch (1990) found that smaller firms grow faster than large firms, earlier studies by Samuels (1965) and Prais (1976) reported the opposite tendency. This tendency partly reflects the role played by growth through acquisition among larger firms (McCloughan, 1995).

The contribution of this paper to the present literature is, it identifies the correct and unbiased measure for size that is consistent to the economic theory. This chapter identifies annual sales turnover as the best measurement for size because it is unbiased to capital intensive and labour intensive industries. My results also prove that it is consistent to the economic theory which states that size of industries grow with the performance of the industries. As far as I am aware of, no effort has been made to compare how different measures of size may affect the industries performance in different ways. As the performance of industries is the main concern to all economies, the correct measure of size, which is an important determinant of industry performance, is a relevant issue to address.

[1] See Gibrat (1931) and Mansfield (1962).
[2] International Standard of Industrial Classification.

In the following section, the empirical framework and methodology is set out. Details of the data, summary of statistics and Pairwise correlation are given in Section 3 and results are presented and discussed in Section 4. Summary and conclusions follow in Section 5.

2. Empirical Framework and Methodology

This study adopts the framework introduced by Mankiw, Romer and Weil (1992) (MRW). MRW assume a Cobb-Douglas production function in their Solow model and develop an output per labour variable on the left side of the equation. In their paper, the following production function is considered:

$$Y_t = K_t^{\alpha} H^{\beta} (A_t L_t)^{1-\alpha-\beta} \qquad (1)$$

where *Y* is real gross output, *K* is the stock of physical capital, *H* is the stock of human capital, *L* is employment, *A* is a labour-augmenting factor reflecting the level of technology and efficiency in the industry, and the subscript *t* refers to the time period in years. It is assumed that $\alpha + \beta < 1$, so that there are constant returns to factor inputs[3] when applied jointly, and decreasing returns when applied separately.

In Solow growth model, labour (*L*) and labour-augmenting technology (*A*) are assumed to grow exogenously at rates *n* and *g*:

$$L_t = L_0 e^{nt} \qquad (2)$$

and

$$A_t = A_0 e^{gt} \qquad (3)$$

where n is the exogenous rate of growth of the labour force in the industries, *A* is the level of technology, *g* is the rate of technological progress. The number of effective units of labour, $A_t L_t$, grows at rate $n + g$. L_0 is normalised to 1 for simplicity. Following Knight, Loayza and Villanueva (KLV) (1993), I assume labour-augmenting technology (A_t) to grow according to the following:

$$A_t = A_0 e^{gt} F^{\theta_F} P^{\theta_P} \qquad (4)$$

where F is the degree of openness of the domestic economy to foreign trade and P is the level of government fixed investment in the economy. I adjust my variables to industry level data, since I am not looking into country level data as in KLV. I use exports instead of the degree of openness, as all industries are subjected to the same level of openness, and industry fixed assets capital instead of government fixed investment. I use this industry fixed assets capital as one of the proxies to the average size of establishments in each industry. Besides that, I observe intermediate materials and economic performance due to their potential importance to the industries' performance. Equation (4) will now be written as

$$A_t = A_0 e^{gt} X^{\theta_X} S^{\theta_S} M^{\theta_M} D^{\theta_E} \qquad (5)$$

Where *X* is exports, *S* is size, *M* is the intermediate materials used in production and *D* is a dummy variable used to capture economic performance within an industry. Thus,

[3] Equation (1) assumes that capital and labour are paid their marginal product.

my efficiency variable, A_t, differs from that used in MRW, in that it depends not only on technological improvements but also on intermediate materials that are used in the production process, economic performance, exports, and average size of firms within the industry. I believe that this modification is relevant to the empirical study of industrial growth in either developing or developed economies, where technological improvements tend to take into account these factors as sources of labour productivity growth.

Further, MRW model specify s_k as the fraction of income invested in physical capital, s_h is the fraction invested to human capital and $(n+g+\delta)$ as population growth. They come up with the following equation:

$$\ln\left(\frac{Y_t}{L_t}\right) = \ln A_0 + gt + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \varepsilon_t \tag{6}$$

Equation 6 indicates the steady state output per worker or labour productivity. The terms $\frac{\alpha}{1-\alpha-\beta}$, $\frac{\beta}{1-\alpha-\beta}$, and $\frac{\alpha+\beta}{1-\alpha-\beta}$ in this equation represent the elasticities of per capita income with respect to the fraction of income invested in physical capital, the fraction of income invested in human capital and labour growth, respectively. Mainly due to data limitations, this chapter assumes s_h and gt do not vary over time and s_k is defined as the capital-labour ratio. This means that $\ln A_0$, s_h and gt are included as a constant term in A_0 in equation (7). I transform A_t in equation (5) into natural logarithm and incorporate it into equation (6). In a panel data setting, I will obtain the following equation:

$$\ln y_{it}^* = A_0 + \theta_1 x_{it} + \theta_2 s_{it} + \theta_3 m_{it} + \theta_4 d_{it} + \theta_5 \ln k_{it} - \theta_6 \ln(n+g+\delta)_{it} + u_i + v_t + e_{it} \tag{7}$$

where $i = 1, \ldots, 73$
$t = 1981, \ldots, 1999$

y = real gross output (constant at 1987 prices) divided by labour
x = exports
s = average size (paid-up capital/ number of employees/ sales turnover)
m = intermediate materials and services
D = economic performance dummy
k = capital-labour ratio
$(n+g+\delta)$ = n is labour growth, g is industry growth and δ is depreciation of physical capital stock
u_i = industry specific effect
v_t = time specific effect
e_{it} = overall error term, assumed to be identically and independently distributed

A_0 is a constant term and $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5$ and θ_6 are parameters to be estimated. i represents 73 industries at four-digit ISIC level in Malaysia, and t represents the time period in years, from 1981 to 1999. Similarly to MRW, I assume $(g+\delta)$ to be constant over time and across industries at 0.07, primarily reflecting the advancement of knowledge, which is not industry-specific[4].

As I am using industry level data, I redefine labour productivity in the context of an industry. Both MRW and KLV use output per labour in their models to indicate standard of living, as they are looking at the cross-country data. However, this study uses this variable to indicate the performance of industries.

Equation (7) provides the basis for the empirical model to be estimated for the rest of this paper. To capture the effect peculiar to the specific time period or industries on productivity growth, I transform the continuous variables to first difference. The dummy variables are not first differenced. If the economic performance dummy is first differenced, it will not capture the full effect of the dummy, but rather the point where there is a change between the zeroes and ones in the dummy variable. By doing this transformation, I will provide different information in my results relative to growth. To compare their relative results, each model is estimated both at levels and at first difference. Besides that, I also perform robustness checks on other definitions of size to find out if different definitions[5] or proxies for size make any difference to the results.

3. Data Description

I use a panel of 73 four-digit ISIC industries that covers a period of nineteen years, i.e. 1981-1999. For detailed description of data and how they are constructed, refer to Appendix I.

During the period under study, the data shows that real gross output/labour experienced a steady increase throughout the years with a noticeable increase between 1994 and 1996 (Figure 1). From 1997 onwards, it shows a declining trend due to the economic recession.

**** Insert Figure 1 ****

Looking at the distribution of labour productivity by average size[6], it is evident that the industrial chemicals and petroleum refinery industries (ISIC 35) noticeably have higher labour productivity (US$940,236.5) compared to others (see Figure 2). This is followed by the fabricated metals, machinery and equipments industry (ISIC 38, US$230,877.4). The rest of the industries, on average, are below US$143,000.0, with 'other manufacturing industries' (ISIC 39, US$17,833.0) at the lowest.

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[4] This rate is higher than Mankiw, Romer and Weil's rate of 0.05, considering the high average growth rates of 0.047 in the manufacturing output during the period and depreciation cost assumed to be 0.023 per year. Therefore, 0.047+0.023=0.07.

[5] For different definitions of sizes applied in Malaysia, see Appendix III.

[6] Firm size is based on the number of full-time workers employed in a firm. In the next section, other definitions of firm size will also be used, for instance, based on the fixed asset capital or sales turnover of each firm. See Appendix II.

**** Insert Figure 2 ****

4. Results and Discussion

First of all, I determine whether it is efficient to either use fixed or random effect in my regressions. To begin with, I apply OLS estimation on equation (7), i.e. without the fixed effects. The OLS residuals, ε_{it} , is tested for random effect using the Breusch and Pagan Lagrangian Multiplier (LM) test. The LM is distributed as χ^2 with one degree of freedom under the null hypothesis which states that there is no industry specific effect. I find the calculated χ^2 value exceeds the tabulated value, which suggests that the null hypothesis is rejected and there might be industry-specific effects in the data. Because of this, pooled OLS model will provide inefficient estimates on the coefficients and invalid OLS standard errors. Hausman specification test for equation (7) suggests that fixed effect is appropriate because the p-value is too small.

As this paper examines whether the size of firms has an impact on the industry's performance and growth, I focus on the impact of annual sales turnover besides other proxies like paid-up capital and the number of employees, on the industry's performance. Table 1 shows that *s*, defined as the annual sales turnover (gross output), has a positive coefficient, which suggests that the growth of manufacturing output (size) improves the industry performance. This result confirms the Verdoorn's Law which states that the growth of production is closely related to labour productivity. In the same way, this suggests that the mean (labour productivity) growth rate of firms declines with size, and in line with other works by Hall (1987), Evans (1987) and Farinas and Moreno (2000).

**** Insert Table 1 ****

There is a significant cyclical pattern for the whole panel at level, however, at first differenced[7], it is not significant at all. At level, the economic performance has a negative coefficient, which may imply a negative growth in the industry affects the labour productivity in a negative way. Refer to Appendix I for description of this economic performance dummy variable.

Export is significant in determining labour productivity in both panel (1) and (2). Further, my results indicate that there is an important role played by capital intensity (capital-labour ratio) and intermediate material in determining labour productivity. This requires investment in appropriate technology, and good quality materials to be in place, in order to provide the impetus for sustainable industry performance.

Following the regressions are the diagnostic tests. I use variance-inflation factor (VIF) to diagnose multicollinearity problems. The tests suggest that the regressors are neither correlated across time and industries nor do they have linear relationship among them in all the models. The F statistics and Wald χ^2 of all regressions in Tables 1 to 6 show that the independent variables have a statistically significant

[7] As this is not a thoroughly first differenced model because I did not first difference the dummy variables, I maintained the constants in the regressions.

relationship with the dependent variable. The Ramsey tests (Ramsey, 1969), on the other hand, mainly reject the null hypothesis of correct functional form. Only the Ramsey test on the small industries regression at level (Table 1) suggests that I cannot the reject the null hypothesis. , As a panel dataset, the R^2 from the cross section and within estimates are reported. The R^2 results suggest that the variations in the time series and across industries reasonably explained the variations in the industries performance.

4.1 Average size of industries

I further investigate whether my results are robust across different categories or sub-panels of industries that are considered as small, medium and large on average. I am examining whether the hypothesis that mean growth rate declines/increase with size is true for all size subgroups. For this purpose, the dataset is divided into three subgroups based on their relative industrial average size and specified as small, medium and large. To create these subgroups, the dataset is stratified by their average size and separated at 40% and 70% percentiles. This means, the small size industries consist of industries that are the first lowest 40%, whereas the medium size industries consist of those between 41% to 70% percentile ranges. The large size industries consist of those from the highest 30%.

Firstly, I use average annual sales turnover as the proxy for size, *s*, and the basis to create subgroups of small, medium and large industries. The results are shown in Table 2. Size consistently shows a significant positive impact on labour productivity. At first difference, there is a noticeable pattern among the size subgroups where I find the larger the industries, the bigger is their effect on the performance of industries. As annual sales turnover is used as an indicator for the scale of operation, it also reflects the actual market size the industries are catering to and provides an idea of the investment returns. A larger market size ensures returns on new market investments (Bhavani, 2001). Therefore, industries that have a large scale of operation would have the advantage of exploiting new technologies compared to the smaller ones. As technology replaces human labour, less workers are employed. This is particularly evident in the large industries. Capital-labour ratio and intermediate materials remain important and significant in influencing the industries performance at all sizes.

**** Insert Table 2 ****

Secondly, I use average number of employees as the next proxy to size. This is to check for robustness of the results in Table 2. The results in Table 3 provide evidence that the sign of the coefficients for size is not robust with my earlier results when annual sales turnover is used (Table 2). The negative sign for size means that as more people are employed, labour productivity will decline[8]. If this is true, it implies that downsizing and improving the efficiency of labours may be required to improve the performance of industries in Malaysia. However, these results contradict with the marginal productivity of labour theory where a labour will only be employed if he contributes more than what he is earning. The fact that size is negatively associated with labour may imply an outcome of a bias. When size is associated with labour force, there is a risk that a small labour intensive industry may look more important

[8] Similar results are obtained in the case of the UK and US in van Ark and Monnikhof (1996).

than the one which is capital intensive and has bigger assets or sales. On the other hand, when size is associated with average gross output, which is used as a proxy to annual sales, it is unbiased because it does not favour either capital or labour intensive industries. In this case, Table 2 seems to provide more reliable evidence that is consistent to the economic theory.

**** Insert Table 3 ****

Contrary to size, other regressors in the equation like capital-labour ratio and intermediate materials remain positively significant to industry performance for all industry sizes both at levels and first difference. Further, the capital-labour ratio of large industries contributes more to labour productivity compared to smaller industries. This supports the findings in Othman and Mohamad (1995). Even though large industries show the highest estimates compared to small and medium industries, it shows much lower estimates at first difference, probably due to the fact that they are capital-intensive already. Increase in capital intensity will not improve labour productivity as much as the small and medium industries.

Finally, I use fixed assets capital to identify the size of industries (Table 4). When fixed assets capital is used as a proxy for paid-up capital, the results are similar with those in Table 3. A possible explanation to these results is that the small firms may have higher labour productivity and low transaction costs, since they are, in most cases, family firms. Besides that, some of the small firms may have employed skilled labours, which may have account for the bias estimates.

**** Insert Table 4 ****

4.2 Different periods

Following Pugno (1995), I regress equation (7) in subperiods of five-years. This is to check for the stability of my results over these subperiods. The results are shown in Table 5.

**** Insert Table 5 ****

Size (based on annual sales turnover), capital-labour ratio, intermediate material and labour growth mostly show significant coefficients, both at level and first difference, except for some periods. Thus, many of the subperiods support the estimates of the overall period, with the main exception of the economic performance dummy, D, for all panels. Other exceptions are capital-labour ratio, which is not significant for the 1991-95 period at level and intermediate material that tends to be insignificant during the periods when economic recessions occurred, i.e. 1986-1990 and 1996-99. It is only significant during periods when there is no economic recession. Throughout the period, $(n+g+\delta)$ is negative as expected, similar to the MRW results. Exports for the most part are negatively significant at level, however, at first difference, exports on the whole, are insignificant.

The overall R^2 for the whole period is between 0.55 and 0.88, except for the period 1991-95 at level, which is much lower at 0.29. This shows that the regressions explain quite well the variations in labour productivity. This is further supported by the F-statistics that show p-values of almost zero for all regressions. In most cases, the time variations are able to explain the variations in labour productivity compared to the cross-industries variations. In other words, the overall R^2 mostly come from the variability within the industrial groups.

4.3 Industry level

Following Ghura and Hadjimichael (1996), I use dummies to identify different subgroups based on their characteristics. The panel is identified by 14 subgroups[9] to account for possible fixed effects stemming from the fact that they are similar industries by category. The choices of these industries subgroups are made based on their significant contribution to total output growth. From these subgroups, the impact of each industry at two- to three-digit level on labour productivity is examined. In Table 6, the main variables show similar estimates with those in Table 5. From the Wald χ^2 statistics, all variables in the regressions are found to be jointly significant in explaining the variations in labour productivity. All the main explanatory variables remain significant at 1% level. Even though panel (1) show all of the industry dummies are insignificant at 5% significance level, I find D33 and D35 industries to be significant, at 10% significance level. For this reason, I disaggregate D33 and D35, which at two-digit ISIC level, to three-digit ISIC level in panel (2), to identify the source of this significance. In this panel, within industry D33, only wood products (excluding furniture) (D331) is significant at 10%, but both D331(wood products) and D332 (furniture) are insignificant at 5% significance level. In industry D35, petroleum refinery (D353) is the major contributor to labour productivity, with its labour productivity 1.61% higher than the rest and coefficient estimate significant at 1% level. This is probably due to the fact that it is a very capital-intensive industry. This is followed by industrial chemicals (D351), significant at 1% level, and 'other chemicals' (D352) significant at 10% level. Plastic industry (D356) and rubber industry (D355), on the other hand, are not significant. In this panel, exports seem to be significant at 1% level when regressed with the two- and three-digit industry dummies.

**** Insert Table 6 ****

Panel (1) – (2) are rerun at first difference[10], as shown in panel (3) and (4). In the first difference models, the dummy variables for industries subgroups did not seem to capture significant specific characteristics that might be identifiable within common industries categories. Even so, the results on other variables remain similar between these two panels and the base model in Table 5. As can be observed, exports are significant at 5% significance level, whereas economic performance is not significant at all, even though it is significant at 1% significance level in levels estimates.

All the panels show that the variables are jointly significant in determining the variations in labour productivity growth. Most of the variability in labour productivity (i.e. at levels) are explained by the cross-section variations, rather than the within variations. In contrast, most of the variability in labour productivity growth (i.e. at first difference) is explained by the time series variations, rather than the cross-industries variations.

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[9] See Appendix 2.IV for the list of industries at two-digit and three-digit level.
[10] Only variables that are in natural logarithm are transformed to first difference.

5. CONCLUSIONS

This chapter examines the role of size in determining the performance of industries. Three measures of size are used in the MRW model to identify how size, when regressed with capital-labour ratio, intermediate materials and services, economic performance and exports, determines labour productivity in a panel data framework. It also investigates how specific time period and industry fixed effects can influence their role in influencing labour productivity. Although many contributions have been made in identifying the sources of growth to small, medium and large industries, this chapter contributes in the way of identifying the best measure of size, as an important determinant to industries growth. To obtain different information, I run regressions at level as well as first difference but maintain the dummies in their original form. It offers results that are at levels as well as in growth terms.

From the different measures of size that I use in this paper, I find that annual sales turnover offer an unbiased measure of size. It is not biased towards capital intensive and labour intensive industries as paid-up capital and number of employees might have caused. My results on annual sales turnover also confirm to the economic theory which states that the performance or productivity of industries are determined by growth of sales in goods. Looking at other variables that I control in the model, I find that capital-labour ratio and intermediate materials and services play important roles in influencing labour productivity. Wood products, petroleum refineries, industrial chemicals and other chemicals industries contribute significantly to labour productivity. Generally, the industries are found to be cyclical except for the small ones.

In growth terms, the change in the size of large industries seem to be able to explain more of the variations in labour productivity growth due to the fact they contribute more to the gross output of the manufacturing sector. Similarly, capital-labour ratio and intermediate materials tend to show higher coefficients compared to levels. However, economic performance is found to be insignificant and the industry dummies generally do not explain the variations in labour productivity growth. Large industries do not respond as well as the small and medium industries when it comes to capital-labour ratio and intermediate materials. Labour productivity growth is more responsive to changes in these two variables. Since the manufacturing sector has generally recorded an increasing trend in labour productivity, this means firms' level of employment has decreased during the period. This shows that firms are generally cautious about increasing employment, particularly when it is at the risk of reducing their labour efficiency and productivity. Concurrent to the Malaysian government implementing its Vision 2020 policy, aimed at becoming a developed economy by the year 2020, the results from this study show that the industries are moving in the right direction in improving the performance of labour, and therefore, their firms.

TABLES AND FIGURES

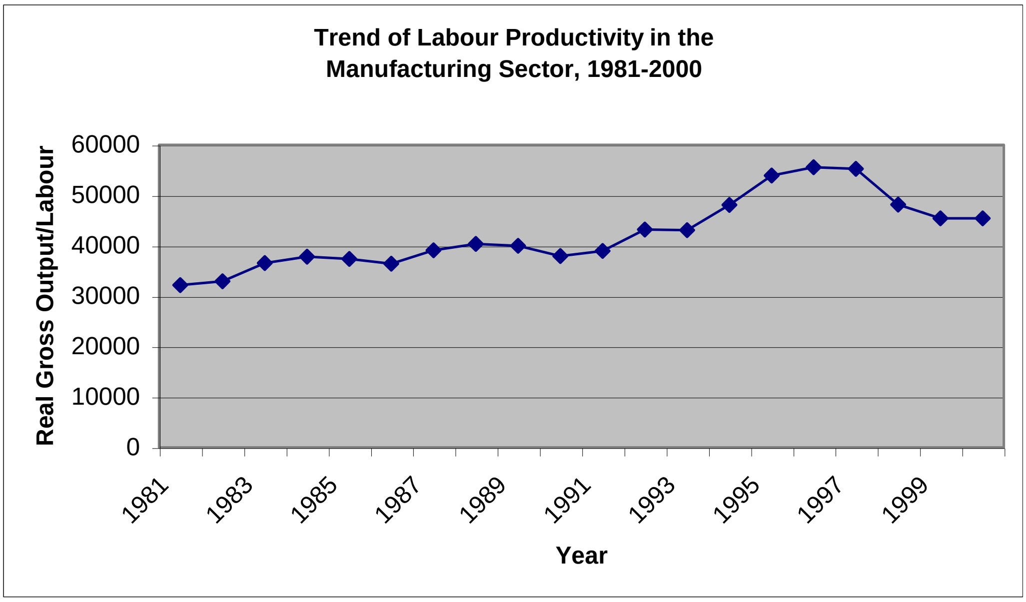

Figure 1

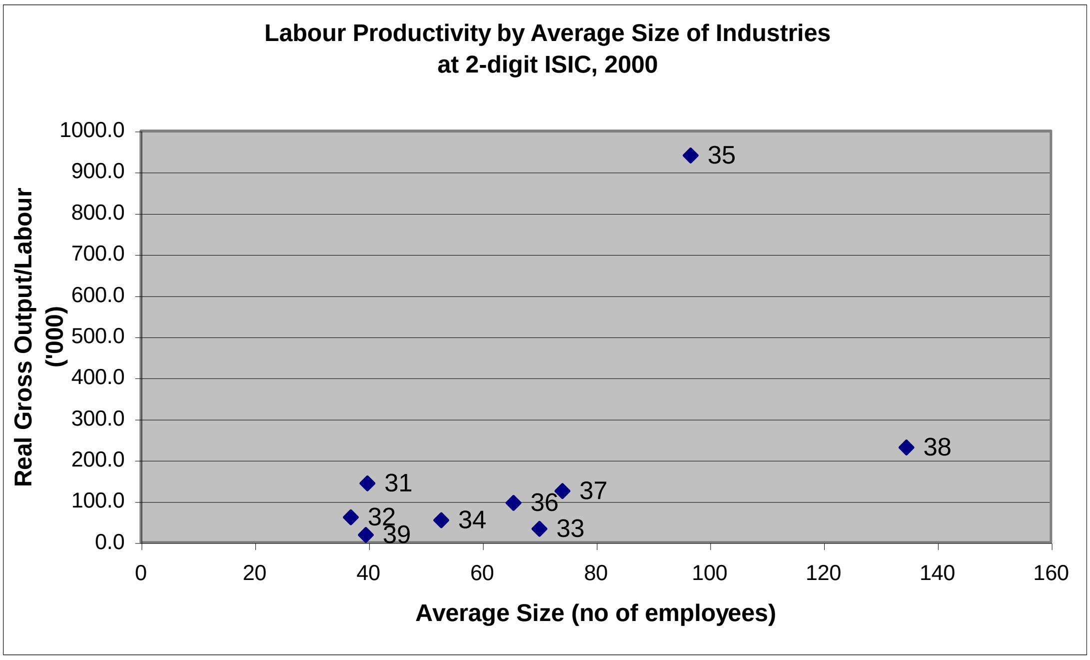

Figure 2

Table 1 :
Determinants of Industry Performance

Variables	Level	First Difference
Constant	1.7762 (0.3298)	-0.0187 (0.0112)
k	0.1243 (0.0149) **	0.2819 (0.0206) **
m	0.2348 (0.0208) **	0.5024 (0.0235) **
D	-0.0601 (0.0149) **	0.0038 (0.0100)
s	0.2313 (0.0162) **	0.1748 (0.0160) **
x	-0.0345 (0.0121) **	-0.0271 (0.0127) *
$(n+g+\delta)$	-0.0694 (0.0171) **	-0.0835 (0.0096) **
R^2 : within between overall	0.6220 0.7488 0.7504	0.6236 0.3803 0.6074
F-stat (P value)	216.23 (0.000)	193.82 (0.000)
Ramsey test	36.04 (0.000)	15.28 (0.000)
VIF	1.99	1.26
Observations	999	892

Notes:
*(1) Coefficients are labelled ** to denote statistical significance at 1%.*
(2) Values in parentheses are standard errors, except for F- stat test.
Source: Generated from UNIDO database.

Table 2 :
Dependent Variable: Labour Productivity by Average Size, 1981-1999
(Size Indicator: Average Gross Output as a Proxy to Annual Sales Turnover)

Variables	Level				First Difference			
	Total	Small Ind.	Medium Ind.	Large Ind.	Total	Small Ind.	Medium Ind.	Large Ind.
Constant	1.7762 (0.3298)	4.4287 (0.7307)	0.8655 (0.6935)	0.4704 (0.6248)	-0.0187 (0.0112)	-0.0083 (0.0168)	0.0043 (0.0200)	-0.0594 (0.0210)
k	0.1243 (0.0149) **	0.0808 (0.0333) *	0.1322 (0.0208) **	0.1424 (0.0346)**	0.2819 (0.0206) **	0.3989 (0.0336)**	0.1156 (0.0295) **	0.3546 (0.0411) **
m	0.2348 (0.0208) **	0.1254 (0.0384) **	0.2857 (0.0352) **	0.3231 (0.0339) **	0.5024 (0.0235) **	0.4865 (0.0373) **	0.4438 (0.0427) **	0.5836 (0.0412) **
D	-0.0601 (0.0149) **	-0.0287 (0.0251)	-0.0620 (0.0204) **	-0.0829 (0.0259) **	0.0038 (0.0100)	0.0035 (0.0152)	0.0063 (0.0155)	-0.0246 (0.0179)
s	0.2313 (0.0162) **	0.1953 (0.0336) **	0.2271 (0.0410) **	0.1895 (0.0427) **	0.1748 (0.0160) **	0.0870 (0.0234) **	0.1031 (0.0318) **	0.2405 (0.0284) **
x	-0.0345 (0.0121) **	-0.0447 (0.0236)	-0.0467 (0.0206) *	0.0149 (0.0188)	-0.0271 (0.0127) *	-0.0667 (0.0204) **	-0.0200 (0.0261)	0.0168 (0.0174)
$(n+g+\delta)$	-0.0694 (0.0171) **	-0.0599 (0.0208) **	-0.3194 (0.0434) **	-0.0420 (0.0414)	-0.0835 (0.0096) **	-0.0455 (0.0115) **	-0.2687 (0.0215) **	-0.0619 (0.0216)**
R^2 : within	0.6220	0.4405	0.6774	0.5753	0.6236	0.6066	0.5935	0.7867
between	0.7488	0.4697	0.4512	0.4053	0.3803	0.8268	0.2936	0.6810
overall	0.7504	0.4254	0.3639	0.5180	0.6074	0.6261	0.5392	0.7687
F-stat (P value)	216.23 (0.000)	34.41 (0.000)	81.27 (0.000)	54.38 (0.000)	193.82 (0.000)	56.17 (0.000)	50.89 (0.000)	138.57 (0.000)
Ramsey test	36.04 (0.000)	0.58 (0.630)	5.03 (0.002)	14.66 (0.000)	15.28 (0.000)	3.19 (0.023)	54.62 (0.000)	11.35 (0.000)
VIF	1.99	1.98	1.64	1.68	1.26	1.43	1.51	1.50
Observations	999	356	325	318	892	302	291	299

*Notes: (1) Coefficients are labelled ** and * to denote statistical significance at 1% and 5%, respectively.*
(2) Values in parentheses are standard errors except for F-stat and Ramsey tests .
Source: Generated from UNIDO database.

Table 3 :
Dependent Variable: Labour Productivity by Relative Size, 1981-1999
(Size Indicator: Average Number of Employment)

Variables	Level				First Difference			
	Total	Small Ind.	Medium Ind.	Large Ind.	Total	Small Ind.	Medium Ind.	Large Ind.
Constant	1.8597 (0.3614)	2.3940 (0.5360)	2.1054 (0.6558)	1.7742 (0.8333)	0.0049 (0.0119)	-0.0081 (0.0182)	0.0189 (0.0186)	-0.0631 (0.0265)
k	0.1562 (0.0161) **	0.1103 (0.0261) **	0.0972 (0.0275) **	0.2749 (0.0469) **	0.3106 (0.0216) **	0.4277 (0.0317) **	0.2176 (0.0365) **	0.1065 (0.0418) *
m	0.4074 (0.0203) **	0.3922 (0.0291) **	0.4135 (0.0367) **	0.3700 (0.0414) **	0.6259 (0.0220) **	0.5607 (0.0353) **	0.7004 (0.0380) **	0.6774 (0.0398)**
D	-0.0888 (0.0161) **	-0.0260 (0.0201)	-0.0642 (0.0224) **	-0.1049 (0.0373) **	0.0206 (0.0106)	0.0142 (0.0149)	0.0027 (0.0174)	0.0468 (0.0199) *
s	-0.0790 (0.0195) **	-0.0680 (0.0319) *	-0.0755 (0.0661)	-0.2145 (0.0677) **	-0.0753 (0.0180) **	-0.0272 (0.0230)	-0.1544 (0.0397) **	-0.0981 (0.0415) *
x	-0.0031 (0.0134)	-0.0165 (0.0198)	0.0273 (0.0249)	0.0460 (0.0299)	-0.0168 (0.0135)	-0.0531 (0.0204) **	0.0093 (0.0227)	0.0482 (0.0244) *
$(n+g+\delta)$	-0.0551 (0.0188) **	-0.0436 (0.0163) **	0.0239 (0.0568)	-0.0800 (0.0603)	-0.0892 (0.0102) **	-0.0470 (0.0109) **	-0.1200 (0.0238) **	-0.2546 (0.0272) **
R^2 : within	0.5471	0.6920	0.6135	0.4391	0.5782	0.6516	0.6570	0.6257
between	0.5327	0.4576	0.4597	0.5796	0.2733	0.8141	0.4424	0.3578
overall	0.5024	0.4244	0.4893	0.5606	0.5616	0.6433	0.6386	0.5622
F-stat (P value)	158.75 (0.000)	94.67 (0.000)	65.09 (0.000)	28.63 (0.000)	160.36 (0.000)	67.59 (0.000)	71.97 (0.000)	55.64 (0.000)
Ramsey test	58.59 (0.000)	22.18 (0.000)	19.19 (0.000)	41.95 (0.000)	38.80 (0.000)	83.90 (0.000)	23.02 (0.000)	8.27 (0.000)
VIF	1.70	1.80	1.84	1.68	1.15	1.20	1.15	1.29
Observations	999	352	345	302	892	302	315	275

*Notes: (1) Coefficients are labelled ** and * to denote statistical significance at 1% and 5%, respectively.*
(2) Values in parentheses are standard errors except for F-stat and Ramsey tests.
Source: Generated from UNIDO database.

Table 4 :
Dependent Variable: Labour Productivity by Average Size, 1981-1999
(Size Indicator: Average Capital Stock as a Proxy to Paid-up Capital)

Variables	Level				First Difference			
	Total	Small Ind.	Medium Ind.	Large Ind.	Total	Small Ind.	Medium Ind.	Large Ind.
Constant	1.8597	1.3061	-1.6618	-.3216	0.0049	0.0139	0.0380	-0.0332
	(0.3614)	(0.5689)	(0.8369)	(0.9882)	(0.0119)	(0.0129)	(0.0226)	(0.0307)
k	0.2353	0.2156	0.4612	0.3238	.3860	0.5919	0.3226	0.4328
	(0.0250) **	(0.0345) **	(0.0464) **	(0.0628) **	(0.0268) **	(0.0434) **	(0.0389) **	(0.0643)**
m	0.4074	0.4627	0.4656	0.4460	0.6259	0.6315	0.5087	0.7433
	(0.0203) **	(0.0316) **	(0.0341) **	(0.0396) **	(0.0220) **	(0.0282) **	(0.0363) **	(0.0446) **
D	-0.0888	-0.0806	-0.0457	-0.1385	0.0206	0.0078	-0.0065	0.0348
	(0.0161) **	(0.0185) **	(0.0174) **	(0.0402) **	(0.0106)	(0.0112)	(0.0159)	(0.0268)
s	-0.0790	-0.0625	-0.0903	-0.0747	-0.0753	-0.0428	-0.1244	-0.1510
	(0.0195) **	(0.0229) **	(0.0431) *	(0.0575)	(0.0180) **	(0.0173) *	(0.0321) **	(0.0468) **
x	-0.0031	-0.0859	0.0182	0.0904	-0.0168	-0.0435	-0.0494	0.0178
	(0.0134)	(0.0234) **	(0.0178)	(0.0276) **	(0.0135)	(0.0206) *	(0.0250) *	(0.0232)
$(n+g+\delta)$	-0.0551	-0.1113	-0.0153	-0.0567	-0.0892	-0.1096	-0.0397	-0.1281
	(0.0188) **	(0.0362) **	(0.0144)	(0.0542)	(0.0102) **	(0.0197) **	(0.0113) **	(0.0268) **
R^2 : within	0.5471	0.6663	0.6839	0.4922	0.5782	0.7795	0.5849	0.5739
between	0.5327	0.4146	0.5550	0.6011	0.2733	0.5339	0.6057	0.2984
overall	0.5024	0.3993	0.5730	0.6194	0.5616	0.7491	0.5712	0.5546
F-stat (P value)	158.75	92.71	82.85	37.81	160.36	142.41	48.51	47.71
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ramsey test	58.59	16.10	2.12	20.79	38.80	3.19	54.62	11.35
	(0.000)	(0.000)	(0.0976)	(0.000)	(0.000)	(0.0239)	(0.000)	(0.000)
VIF	2.51	2.41	1.75	1.99	1.35	1.43	1.51	1.50
Observations	999	371	318	310	892	325	287	280

Notes:
*(1) Coefficients are labelled ** and * to denote statistical significance at 1% and 5%, respectively.*
(2) Values in parentheses are standard errors except for F-stat and Ramsey tests.
Source: Generated from UNIDO database.

Table 5 :
Dependent Variable: Labour Productivity and Labour Productivity Growth by Different Periods, 1981-1999

Variables	Level				First Difference			
	1981-1985 (1)	1986-1990 (2)	1991-1995 (3)	1996-1999 (4)	1981-1985 (5)	1986-1990 (6)	1991-1995 (7)	1996-1999 (8)
Constant	-7.7500 (0.8334)	2.6719 (0.5496)	0.3793 (0.5773)	-9.413 (1.0617)	-0.0380 (0.0093)	-0.0000 (0.0115)	-0.0421 (0.0108)	-0.0615 (0.0064)
k	0.4898 (0.0449) **	0.0770 (0.0253) **	0.0338 (0.0295)	0.6108 (0.0592)**	0.7365 (0.0682) **	0.0957 (0.0313) **	0.4699 (0.0518) **	0.7784 (0.0420) **
m	0.5910 (0.0419) **	-0.0063 (0.0532)	0.5524 (0.0312) **	-0.0652 (0.0376)	0.6978 (0.0444) **	-0.0253 (0.0645)	0.6236 (0.0508) **	0.7432 (0.0531) **
D	-0.0133 (0.0115)	-0.0331 (0.0230)	-0.0190 (0.0180)	-0.0053 (0.0130)	-0.0155 (0.0146)	0.0091 (0.0268)	-0.0636 (0.0201) **	-0.0069 (0.0108)
s	0.2217 (0.0283) **	0.5189 (0.0478) **	0.0168 (0.0202)	0.9981 (0.0299) **	0.1495 (0.0290) **	0.6097 (0.0576) **	0.0668 (0.0201) **	-0.0232 (0.0435)
x	-0.0773 (0.0168) **	-0.0591 (0.0199) **	-0.0710 (0.0237)**	0.0039 (0.0276)	-0.0073 (0.0209)	-0.0459 (0.0234)	-0.0079 (0.0272)	0.0005 (0.0196)
$(n+g+\delta)$	-0.0854 (0.0254) **	-0.0273 (0.0119) *	-0.3735 (0.0342)**	-0.1470 (0.0470) **	-0.0248 (0.0341)	-0.0834 (0.0139) **	-0.0571 (0.0250) *	-0.0379 (0.0212)
R^2 : within	0.8416	0.6609	0.7830	0.9097	0.8870	0.5878	0.6375	0.8864
between	0.7397	0.7174	0.2751	0.6205	0.8751	0.4201	0.5418	0.2683
overall	0.7327	0.7244	0.2896	0.6529	0.8804	0.5499	0.5613	0.7849
F-stat (P value)	145.24 (0.000)	66.60 (0.000)	148.42 (0.000)	248.60 (0.000)	134.81 (0.000)	22.54 (0.000)	56.87 (0.000)	187.33 (0.000)
Ramsey test	53.62 (0.000)	28.73 (0.000)	9.97 (0.000)	12.88 (0.000)	14.04 (0.000)	4.11 (0.007)	15.74 (0.000)	11.25 (0.000)
VIF	1.36	1.48	1.98	1.64	1.40	1.15	1.15	1.28
Observations	234	271	270	224	168	262	256	206

*Notes: (1) Coefficients are labelled ** and * to denote statistical significance at 1% and 5%, respectively.*
(2) Values in parentheses are standard error except for F-stat and Ramsey tests.
Source: Generated from UNIDO database

Table 6 :
Dependent Variable: Labour Productivity and Labour Productivity Growth with Industries at 2-digit and 3-digit Levels Dummies, 1981-1999

Variables		Level (1)	Level (2)	First Difference (3)	First Difference (4)
Constant		1.4411 (0.3204)	1.5343 (0.3012)	-0.0407 (0.0294)	-0.0408 0.0293)
k		0.1435 (0.0130) **	0.1402 (0.0129) **	0.2867 (0.0197) **	0.2891 (0.0196) **
m		0.2333 (0.0173) **	0.2369 (0.0170) **	0.4893 (0.0227) **	0.4893 (0.0226) **
D		-0.0586 (0.0149) **	-0.0598 (0.0148) **	0.0030 (0.0096)	0.0031 (0.0095)
s		0.2368 (0.0143) **	0.2286 (0.0142) **	0.1789 (0.0151) **	0.1798 (0.0151) **
x		-0.0332 (0.0104) **	-0.0343 (0.0103) **	-0.0252 (0.0120) *	-0.0241 (0.0119) *
$(n+g+\delta)$		-0.0660 (0.0171) **	-0.0660 (0.0171) **	-0.0777 (0.0090) **	-0.0772 (0.0090) **
D31		0.2723 (0.2401)	0.2820 (0.2090) **	0.0330 (0.0301)	0.0329 (0.0299)
D32		-0.0675 (0.2502)	-0.0679 (0.2174) **	0.0146 (0.0317)	0.0143 (0.0316)
D33		-0.3454 (0.2851)		0.0262 (0.0333)	
	D331		-0.3877 (0.2642)		0.0497 (0.0347)
	D332		-0.2252 (0.3708)		-0.0333 (0.0419)
D34		-0.1004 (0.2854)	-0.0948 (0.2477)	-0.0259 (0.0327)	-0.0265 (0.0326)
D35		0.4034 (0.2458)		0.0041 (0.0305)	
	D351		0.7492 (0.2672) **		0.0204 (0.0336)
	D352		0.4324 (0.2474)		0.0111 (0.0322)
	D353		1.6118 (0.3762) **		-0.0549 (0.0399)
	D355		-0.2510 (0.2956)		0.0069 (0.0350)
	D356		-0.4797 (0.3706)		-0.0165 (0.0399)
D36		-0.1041 (0.2733)	-0.0942 (0.2374)	0.0140 (0.0319)	0.0137 (0.0318)
D37		0.2364 (0.3415)	0.2538 (0.2966)	0.0205 (0.0372)	0.0203 (0.0370)
D38		-0.0452 (0.2333)	-0.0364 (0.2030)	-0.0028 (0.0305)	-0.0032 (0.0304)
R^2 :	**within**	0.6210	0.6213	0.6228	0.6228
	between	0.8020	0.8686	0.4765	0.5311
	overall	0.7928	0.8580	0.6154	0.6206
Wald χ^2 (P value)		1788.47 (0.000)	1928.93 (0.000)	1403.26 (0.000)	1426.37 (0.000)
Ramsey Test		91.92 (0.000)	42.95 (0.000)	33.90 (0.000)	32.44 (0.000)
VIF		4.45	3.88	4.52	3.70
Observations		999	999	892	892

*Notes: (1) Coefficients are labelled ** and * to denote statistical significance at 1% and 5%, respectively.*
(2) Values in parentheses are standard errors, except for p-value for Wald chi-sq except and Ramsey tests
Source: Generated from UNIDO database.

Appendix I

Description of Variables

Real gross output and capital are calculated into constant prices using the GDP deflator (1987 as base year for Malaysia), in the absence of a sector-level producer price index to give real output, Y. The value of census output covers only activities of an industrial nature and is compiled on a production basis. This is comprised of the value of all products of the establishments; the net change between the beginning and the end of the reference period in the value of work in progress and stocks of goods to be shipped in the same condition as received; the value of industrial work done or industrial services rendered to others; the value of goods shipped in the same condition as received less the amount paid for these goods; and the value of fixed assets produced during the period by the unit for its own use. Valuation is in factor cost, excluding all indirect taxes falling on production and including all current subsidies received in support of production activity.

Bought-in materials and services are calculated from output minus value added, i.e. M = Y – VA . Bought-in materials is the value of materials consumed in production (including transport charges incurred, and taxes and duties paid on materials); while bought-in services is the value of supplies consumed such as packaging materials, consumable stores (including stationery and office supplies, materials for repairs and maintenance), cost of printing, lubricants, cost of goods sold in same condition as purchases, water, electricity, fuel, payments to contractors, payments for industrial work done by others, supplies and payments for non-industrial services.

Either value added per employee and gross output per employee can be used as proxies for labour productivity (National Productivity Corporation, 2002). Gross output based labour productivity measures are more sensitive to the degree of vertical integration and outsourcing than value-added based labour productivity measures (OECD, 2001). On the other hand, value added based labour productivity produce negative values in the event of losses. Due to that, the former definition is preferred to overcome the problem of non-positive labour productivity and therefore avoid losses of observations when transformed to log. To obtain labour productivity, Y^*, gross real output is divided with the number of full time employees. Since data on industrial working hours is not available, employment is measured by the number of workers employed in the industries. Employment is defined as the number of persons who worked in or for the establishments during the reference year, excluding home workers. The concept covers working proprietors, active business partners and unpaid family workers as well as employees. The figures reported normally refer to the average number of persons engaged during the reference year, obtained as the sum of the 'average number of employees' during the year and the total number of other persons engaged measured for a single period of the year.

Due to the absence of capital stock data, I construct physical capital stock from gross fixed capital formation, deflated over time using the gross domestic product deflator (1987 – base year), using the perpetual inventory method, as follows,

$$K_t = (1-\delta)K_{t-1} + I_t$$

where K_t represents the current capital stock, δ is the rate of physical capital depreciation, K_{t-1} is the capital stock in the previous year and I_t is investment, which is given by real gross fixed capital formation. We estimate an initial value of the 1980 capital stock for each industry as $K_{1980} = \frac{I_{1981}}{(g+\delta)}$, where g is calculated as the average geometric growth rate from 1981 to 1999, under the assumption that over long periods of time, capital and output grow at the same rate. A depreciation rate of 6% is assumed[11]. For the rest of the chapter, I use *K* to denote capital-labour ratio.

Economic performance, *D*, is derived from the industrial production index growth (IPIG) of industries at three-digit level. IPIG at four-digit level is not available. A dummy variable is then generated to capture non-positive growth for these industries. Initially, two dummies are tested, (i) to include 0% growth, and (ii) to exclude 0% growth, from the dummy variable. The dummy that includes the 0% growth is found to generate significance for all variables at 5% confidence interval. Therefore, the model includes 0% IPIG for the economic performance dummy variable.

Exports, *X*, is real total industrial exports to the world, valued at freight on board (f.o.b.) prices, deflated over time using the gross domestic product deflator (1987 – base year). Within the $(n+g+\delta)$ component of the model, *n* represents the rate of labour growth and is allowed to change with time, *g* is the growth of industries and is assumed to be constant, and δ is the depreciation rate of physical capital stock. MRW model measures n as the average rate of growth of the working population, where working age is defined as 15-64 years, this model measures n as the rate of employment within each of the four-digit level industries. $(g+\delta)$, collectively, is constant and assumed to be at 0.07. Variable $(n+g+\delta)$ is not transformed into log due to significantly high occurrences of negative value. Transforming this variable into log would mean a loss of more than 400 observations. Therefore, this variable will maintain its actual level value in the semilog model.

Appendix II

Measures of Average Sizes

(1) Average size of industries is defined by the average number of workers per establishment. This is one of the common methods of identifying the size of firms, besides their paid-up capital and turnover of sales. From this value, percentiles of the first 40% represent the small size industries, the second 30% represents the medium industries whereas the third 30% represents the large industries. The first percentile consists of industries with an average number of workers per establishment of less than 62, the second, from 62 workers to less than 109, and the third, equal to and more than 110 workers. Of course, the definition of relative sizes of industries or firms may vary, depending on the government authority[12]. Percentiles, in this case, are used for convenience, particularly to distribute the number of observations quite evenly among the grouped samples.

(2) Size can also be characterised by annual sales turnover. Average gross output of each establishment within each industry is used as a proxy for annual sales turnover.

[11] Following the assumption of Hall and Jones (1999).

[12] The State Government, Ministry of International Trade and Industries (MITI) (see Appendix 4) and the Department of Statistics use different definitions in identifying the size of firms.

Average gross output or production represents the value of goods and/or services produced in a year whether sold or stocked. The related measure, annual sales turnover, corresponds to the actual sales in the year and can be greater than production in a given year if all production is sold together with stock from the previous years. While production and turnover will be different in a year, their averages over a long period of time should converge. This would depend on how perishable the stock is. As in this case, gross output of the industry is divided by the number of establishments within the industry. The small industries consist of industries with average real annual sales turnover less than US$1,800,000, the medium industries, from US$1,800,000 to less than US$5,340,000, and the large industries, equal to and more than US$5,340,000.

(3) Paid-up capital is another definition that may be used to categorise the sizes of manufacturing establishments. In this study, capital stock is used as a proxy for paid-up capital. The small industries consist of industries with average real paid-up capital of less than U$1,550,000, the medium industries, between U$1,550,000 to less than U$5,000,000, and the large industries, equal to and more than U$5,000,000.

Appendix III

Definitions of Small, Medium and Large Enterprises

Various definitions have been given to small and medium enterprises (SMEs) within Malaysia and among different countries. World Bank (1984), United Nations Development Organisation (1986) and Asia Development Bank (1990) have defined small and medium enterprises as follows[13]:

1. small-sized firms employ less than 50 workers
2. medium-sized firms employ between 50 and 199 workers.

From this definition, the large entreprises are presumed to be establishments employing 200 and more employees.

The Small and Medium Industries Development Corporation (SMIDEC, 1995) defined SMEs as manufacturing establishments that have annual sales turnover not exceeding RM25 million[14] and full-time employees not exceeding 150. A manufacturing establishment that has a paid-up capital of less than RM500,000[15] and employees not exceeding 50 is considered as small, whereas one that has a paid-up capital of RM500,001 to RM2.5 million and employs between 51 and 150 full-time employees is considered as medium-sized.

More recently, the Ministry of International Trade and Industry (MITI) has reclassified the sizes of enterprises[16] as,

1. Small enterprises are manufacturing enterprises that employ less than or equal to 50 full-time employees, and with an annual turnover of not more than RM10 million[17],

[13] Aba-Ibrahim (2003).
[14] Equivalent to US$6.58 million based on Malaysia's pegged exchange rate to the US$, RM3.80/1US$.
[15] Equivalent to US$131,579.
[16] Incentives and funds allocated by the Federal Government are based on this classification.
[17] RM10 million = US$2.63 million (small enterprises).

2. Medium enterprises are manufacturing enterprises that employ between 51 to 150 employees, and with an annual turnover of between RM10 million to RM25 million[18].
3. Large enterprises are manufacturing enterprises that employ more than 150 employees, and with an annual turnover of more than RM25 million.

MITI widened this classification of SMIs to allow for more establishments to benefit from their incentives and funds. Furthermore, by including the turnover sales can sometimes reflect more of the establishments' size rather than the number of full-time employees they employ or the paid-up capital that they have invested into the business.

Appendix IV

List of Industries at 2-digit and 3-digit Level

No.	ISICode	Industries[1]
1.	31	Food and Beverages
2.	32	Textiles and Apparel
3.	331	Wood Products
4.	332	Furniture
5.	34	Paper and Printing
6.	351	Industrial Chemicals
7.	352	Other Chemicals
8.	353	Petroleum Refineries
9.	354	Miscellaneous Petroleum
10.	355	Rubber
11.	356	Plastic
12.	36	Non-metallic Minerals Product
13.	37	Iron and Steel
14.	38	Fabricated Metal and Machinery

Notes : [1] ISIC 390 industry is omitted from this list, due to very low contribution to total output and to avoid dummy variable trap.

[18] Ibid.