# UNIVERSITY OF SOUTHAMPTON

FACULTY OF LAW, ART & SOCIAL SCIENCES

School of Social Sciences


# Essays on Total Factor Productivity, International Trade, Business Cycles and Mark-up

by


**Abdol Samad Nawi**


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ABSTRACT

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# ESSAYS ON TOTAL FACTOR PRODUCTIVITY, INTERNATIONAL TRADE, BUSINESS CYCLE AND MARK-UP

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Recently, the relationship between total factor productivity (TFP), economic growth and other macroeconomics activities has generated intense research interest. This thesis, which consists of three papers, makes a further contribution to the empirical literature in this area. This thesis begins with an empirical study of the relationships between primal and dual TFP growth in the presence of market power (MP) and non constant returns to scale (NCRTS) in the context of Malaysia's manufacturing industry.

In Chapter 2, the major findings are first, that primal and dual TFP accounting are proved to be equal mainly because the factor shares in value added are relatively constant. This finding is based on both theoretical and empirical arguments. Second, the assumptions of constant returns to scale (CRTS) and perfect competition (PC) are essential for both primal and dual TFP in measuring TFP growth. If these assumptions are violated, both accounting methods could underestimate TFP growth. Third, this research sheds light on the debate between Young (1992, 1995) and Hsieh (1999, 2002) who argued that the discrepancies at the aggregate level for primal and dual TFP are mainly driven by data issues. Finally, this research shows that returns to scale (RTS) and the mark-up are strongly positive correlation.

Chapter 3 investigates the impact of international trade on the strength of the mark-up (price over marginal cost). The estimation is based on the Dynamic Heterogeneous Panel Data Estimation technique. The major findings are first, that mark-ups are statistically significant greater than one, implying the existence of MP. Second, increased import penetration ratios serve to decrease industry mark-ups. Third, the overall effects of import penetration ratios on the mark-up lead to an increase in price competition, thus decreasing the size of the mark-ups. Finally, increased tariffs seem to have a significant positive impact on the mark-up.

Chapter 4 assesses the behaviour of the mark-up, and the effect of the business cycle and turnover rate on the mark-up. The major findings are first, that the cyclical character of the mark-up suggests a counter-cyclical variation. Second, the introduction of the cyclical variable (i.e. *Lerner Index*) does not have much effect the mark-up. Finally, demand fluctuations and turnover rates seem to have a significant negative impact on the mark-up.

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# Chapter 1

# Introduction

This thesis consists of three chapters analyzing the relationship between primal and dual total factor productivity (TFP) growth approaches, international trade and the mark-up and business cycle, turnover rate and the mark-up. There are three issues that are empirically analysed using data on Malaysian manufacturing industries. The study in Chapter 2 provides evidence on the relationship between primal and dual TFP growth approaches. Chapter 3 investigates the impact of international trade on the strength of the mark-up of price over marginal cost. Chapter 4 provides evidence on the behaviour of the mark-up of price over marginal cost under different business cycle situations. This chapter also investigates the effect of the business cycle and turnover rate on the strength of the mark-up.

Traditionally, the measurement of the Solow residual has been based on standard neoclassical assumptions. This dates back to Solow (1956, 1957), in which an aggregate production function was identified with a Hicks-neutral shift parameter and constant returns to scale (CRTS) $(Q_t = \Theta_t F(K_t, N_t))_t$ where $t$ denotes time, aggregate gross output ($Q$) is produced from aggregate inputs consisting of capital ($K$) and Labour ($N$). The level of the Solow residual is represented in the Hicks-neutral ($\Theta$) parameter and is almost always characterised as "output augmenting" and "technical change".

Among the first papers that challenged some of the standard neoclassical assumptions was the seminal work by Hall (1988). He questioned the assumption of perfect competition (PC) in product markets, and tested the equality of prices and marginal costs (under the assumption of CRTS) using longitudinal industry-level data for this purpose. His empirical results provided strong evidence against the joint hypothesis of PC and CRTS. He also showed that the primal Solow residual based on quantities of factor inputs can be decomposed into two parts: price mark-up and technological change components. In another seminal paper, Roeger (1995) further elaborated Hall's approach, preserving the assumption of CRTS. He established that, similarly to the primal, the dual Solow residual based on prices and quantities of factor inputs can also be decomposed into two components. Moreover, he argued that the presence of market power (MP) - a violation of the conditions of PC - induces a wedge between the primal and the dual residuals.

Meanwhile, under the assumptions of CRTS and PC, unobserved TFP growth has been measured in the literature using traditional primal TFP measurement (Solow, 1957) and traditional dual TFP measurement (Christensen, Jorgenson and Lau, 1973). The TFP measurements based on primal and dual approaches should be equivalent because of the duality of production functions and cost functions. With a production function and output prices, one can find the best use of given level of inputs in order to maximise production subject to resource constraints, whereas with a cost function, one can find the least cost means of producing a given level of output in order to minimise cost subject to providing the desired level of output.

Furthermore, it is a well-established result in production theory that under perfect competition in efficient product and factor markets, firms producing homogeneous products set their prices at their marginal costs. These conditions do not necessarily hold in a world of imperfect competition: thus the incidence of a monopolist endowed with market power may result in a shift of the equilibrium point away from its would-be position under perfect competition.

While price mark-ups over marginal costs are considered to be important characteristics of firms' behaviour in imperfect markets, they are not directly observable. Robert and Supina (1996, 2000) have undertaken research by using relevant data on the firm's output price and marginal cost to analyze the price mark-ups charged by different producers on a set of 13 homogeneous products. Morrison (1992) uses a similar approach based on generalised Leontief cost and expenditure functions to analyze the mark-up behaviour of U.S. and Japanese firms. However, Justman (1987) and Shapiro (1987) explored the price mark-ups based on the demand elasticity.

Another strand in the empirical literature originates in the seminal paper by Hall (1986) who analyzed the implications of market power on productive efficiency, factor demand and pricing behaviour. Using a two-factor production function, Hall showed that under imperfect competition the primal Solow residual is not solely attributed to autonomous technical change, but may partly reflect monopolistic pricing behaviour. He used his derivation to estimate average industry mark-ups using for this purpose longitudinal industry-level data. Hall's approach was tested and extended in a number of subsequent studies (Shapiro, 1987; Domowitz, Hubbard and Petersen, 1988, among others).

Roeger (1995) established that in the presence of market power (violating the conditions for PC), the dual Solow residual can also be decomposed into two such components: one attributed to autonomous technical change and the other to the mark-up charged by the monopolistic firm. Importantly, he derived an easily estimable equation from the emerging wedge between the primal and dual Solow residuals that can be used for direct estimation of price mark-ups. One of the most attractive features of Roeger's approach is the fact that it is exceptionally undemanding with respect to data: thus in the case of a two-sector production function its application only requires (firm-or industry-level) nominal values of value added, labour and capital costs.

Hall's work and, especially, Roeger's result inspired a series of empirical studies. While in principle this approach is perfectly feasible for the estimation of the mark-ups charged by individual firms, most of the related empirical studies seek to measure average industry-level mark-ups, the main constraint apparently being the significant level of noise in the data of individual firms. In addition, most of the related empirical work has been based on longitudinal sectoral data (time series of aggregated sectoral data), rather than firm data proper. Thus Oliveira-Martins *et al.* (1996, 1999) estimated sectoral mark-up ratios on the basis of longitudinal data for OECD economies. Several studies related variations in mark-up ratio to the business cycle (Bloch and Olive, 2001; Linnemann, 1999); Weiss, 2000; Wu and Zhang, 2000). In a cross-country study, Hoekman, Kee and Olarreaga (2001) analyzed the impact of import competition and domestic market regulation of the formation of industry-level mark-ups. Chapter 2 in this paper used an extension of Roeger's approach for the case of non-constant returns to scale (both Hall and Roeger assume constant returns to scale) to compute TFP, mark-ups and returns to scale for Malaysia's manufacturing industry, on the basis of longitudinal sectoral data 1975-1999.

Most recently the same method has been applied to firm-level data (using either cross-sectional or pooled enterprise data), which in principle opens wider opportunities to analyze micro behaviour. Basu and Fernald (1997) emphasise the importance of inter-sectoral heterogeneity when analysing the relationship of mark-ups and returns to scale, even from the macroeconomic viewpoint. This also facilitates the resolution of one rigid assumption incorporated in studies based on industry-level data, namely that the mark-ups are either time-invariable or directly related to the business cycle. Using this type of data some studies have not only attempted to estimate mark-up ratios but have also tried to assess the impact of competitive pressure on their formation (Dobrinsky, Markov and Nikolov, 2001; Halpern and Korosi, 2001a; Konings, Van Cayseele and Warzynski, 2003). In a similar vein, Konings, Van Cayseele, and Warzynski (2001) seek to identify whether competition policy matters in shaping the firms' pricing behaviour.

Both the main theoretical results and most of the empirical studies refer to the case of a two-factor of production technology with output defined as value added. However, Norrbin (1993) pointed out that defining the mark-up over value added might induce an upward bias in estimations. Basu and Fernald (1997) emphasise that value added can only be interpreted as an output measure under perfect competition, and its use suffers from omitted variable bias under imperfect competition. Noting this, Oliveira-Martins *et al.* (1996) proposed an extension of Roeger's model for a production function defined over sales and incorporating material inputs as well (but preserving the assumption of constant returns to scale). In this extension the main features remain intact while the data requirement only rises slightly to include nominal material costs.

Meantime much has happened in the Malaysian economy since its independence in 1957. Over the period, the Malaysian economy grew at a rate of approximately 7% per annum, a relatively impressive growth rate as compared to other countries in the region such as Indonesia (less than 6% per annum) and the Philippines (less than 4% per annum) (Economic Report, various issues). At the same time, the economy has experienced a series of economic transformations: from being agricultural-based at the early stage of its independence to being manufacturing-based (1970s and 1980s), later to being a service-based (1990s) and starting from the new millennium (2000s), to being a knowledge-based economy.

In the early days of Malaysian's independence, the economy relied to a large extent on the exports of primary commodities such as rubber and tin. Rubber accounted for two-thirds and tin for one-fifth of the total exports in the 1960s. During the last three decades from 1960s to 1990s, economic growth in Malaysia has been accompanied by considerable changes in the sectoral composition of GDP (Gross Domestic Product). Whilst agriculture remained a less significant sector in the economy, the manufacturing sector has emerged as the most important sector to the country since the implementation of the Pioneer Industries Ordinance in 1958. The contribution of agriculture to GDP fell from 31.5% in

1963 to 0.6% in 2000 while for the manufacturing sector, its contribution to GDP increased from 8.3% in 1963 to 67.3% in 2000 (Economic Report, various issues).

This period also witnessed a significant change in the Malaysian economy in terms of its greater integration into the world economy. The Malaysian government has understood very well the importance of trade and foreign investment and their contributions to the progress of the economy. For that reason, Malaysia has adopted more liberal trade policies with minimal tariffs mainly to protect domestic infant industries. It is believed that higher economic growth can be achieved with an open economic policy, as trade and foreign investments encourage higher productivity and greater returns due to technology diffusion, cost reductions, better market access, extended consumption capacities, better access to scarce resources and worldwide markets for products. This increased openness of the economy is expected to intensify competitive pressure, and thus affect the mark-up of price over marginal cost. As a consequence Chapter 3 analyses empirically the impact of international trade on the strength of the mark-up of price over marginal cost for the Malaysian Manufacturing industries.

However, by opening the economy to inter-country trade and commerce and by looking outward to the rest of the world, trade also invites development of other elements such as surging price level. However, the international interactions through trading and foreign investment activities transmitted successive influence that interrupting government's effort to control domestic price level. In other words, the business cycles in an individual economy become more contingent on the fluctuations in the international economy. Whether an individual economy would benefit from the changes or not very much depends on the ability of the nation to adjust and adapt to changes. According to Artis *et al.* (1995a), there were five troughs and four peaks in the Malaysia economy during 1981 to 2002. The average duration of downturns is about 24 months and of upturns is 32 months.

For instance, according to Pillay (2000), the 1984-1987 downturn in the Malaysian economy was quite severe. "Exporting earnings suffered a massive contraction, with commodity prices plunging to unprecedented lows due to lower demand in the developed countries. The government was unable to engage in countercyclical spending due to its earlier investment in heavy industry. This investment had been financed by external borrowings. In the early 1980s, given its petroleum resources, banks had lined up to lend to Malaysia. Therefore, when the recession hit, Malaysia had exhausted its borrowing capacity."

Another significant downturn was associated with the 1997 Asian financial crisis that was triggered initially by the speculative attack on the Thai currency (Baht). This led to deterioration in market sentiments and erosion in investor confidence, which in turn resulted in the massive outflow of short-term capital, a drastic decline in the value of the Malaysian Ringgit and a fall in the stock market. Despite the adverse effects on sections of society, Malaysia successfully avoided the extreme effects experienced by some regional economies, such as high unemployment, mass poverty, massive bankruptcies and civil unrest. This was made possible by strong initial conditions, both in terms of the real economy and the financial sector, as well as the swift, pragmatic and innovative measures introduced by the Government (Economic Report 2002/2003). As a result, Chapter 4 analyses empirically the impact of the business cycle and turnover rate on the strength of the mark-up of price over marginal cost for the Malaysian Manufacturing industries. Chapter 4 investigates the behaviour of the mark-up of price over marginal cost under different business cycle situations.

Despite the possibilities of inviting negative effects, including negative cultural effects, Malaysia is one of the most active participants in the world market in terms of exports and imports of goods and services as well as in terms of foreign direct investments (FDI). The openness of the Malaysian economy as measured by the total trade (exports of goods and services plus imports of goods and services) to GDP ratio has increased substantially, for instance from 0.82 in 1957 to 2.19 in 1999 (International Monetary Fund, various issues).

Of all the sectors in the economy, the manufacturing sector has played the most critical role in the total trade of Malaysia. For example, manufacturing goods accounted for approximately 86% of the total value of exports in the year 2000 whilst the share of primary commodity exports has declined to 11.4% in 2000 (Economic Report 2000/2001). The most important manufacturing exporters are electronic producers, food companies, textiles and apparel producers (International Monetary Funds, various issues). In terms of imports, intermediate goods constitute 73.7% of total imports while capital goods constituted 15.1% in 2000 (Economic Report 2000/2001).

The nature of the Malaysian economy can be further understood by looking at the structure of its exports. As given in Economic Report 2000/2001, the total value of exports for the year 2000 is RM369, 472 million. Manufactured products made up 85.6% of exports with the electrical and electronic sector contributing 61.1%, the chemical and chemical products contributing 4.5% and other industrial products such as metal and non-metal products and textile products contributing 20.5% to exports. This indicates that the Malaysian economy is quite dependent on the manufacturing of electrical and electronic products. Many of these products require components that are imported from other countries or which use foreign technologies.

Primary commodities made up of 11.4% of exports in 2000. The major contributors to the export of commodities are palm and palm kernel oil, crude petroleum, Liquid Natural Gas, Log, Sawn Timber and Rubber (Economic Report 2000/2001). This represents a significant part of the Malaysian economy. The knowledge and technologies to convert these commodities into higher end products should be developed because such developments may ensure that the Malaysian economy gains maximum benefit from its commodities.

The high economic growth experienced by the Malaysian economy during 1988-1996 was accompanied by tremendous structural transformation of the economy resulting in a gradual shift from one relying mainly on the production and export of primary commodities to a modern industrial economy (Economy Planning Unit, 1996). Since 1996 the economy has entered yet another phase that places new emphasis and demands on more capital intensive, high technology and knowledge-based industries. The transformation of the Malaysian economy to its next phase requires the presence of a larger component of locally generated technologies and knowledge in its exports.

Therefore, in order to maintain Malaysian competitiveness in the global market, the Malaysian government has implemented a series of strategies from time to time to reflect the changing nature of the domestic economic framework as well as the global market conditions so as to achieve the overall success of the economy. For instance, The Seventh (1996 to 2000) and Eighth (2001 to 2005) Malaysian Plans have focused on the growth of TFP as a key variable in its macroeconomic framework to reconcile the objective of sustained high growth and the need to maintain the domestic resource balance. Under the Seventh (1996 to 2000) Malaysian plans, GDP growth is projected to grow at 8 percent per annum despite the lower rate of capital formation that is necessary to close the large saving-investment gap. In the face of constraints imposed by both the need to maintain a resource balance and a declining labour force growth, a TFP growth of 3 percent per annum over the plan period is considered essential to maintain growth at the targeted rate. As a consequence Chapter 2 empirically studies the theoretical relationship between the primal and dual TFP growth from the accounting measurement perspective and assesses their accuracy in measuring unobserved TFP growth in presence of market power (MP) and non constant returns to scale (NCRTS) in the context of Malaysia's manufacturing industry.

Over the last two decades from 1970s to 1990s, the manufacturing sector has been the backbone for Malaysia's continuous economic growth. It is also the main sector that contributed to the active role played by Malaysia in the world market.

So far, we have provided a brief discussion of the Malaysia history and economic development since independence in 1957. Now, we specify how this thesis contributes to the empirical literature in the area of TFP growth, international trade, business cycle and the mark-up. Specifically, in Chapter 2, the main objectives are to study the theoretical relationship between the primal and dual TFP from the accounting measurement perspective and assess their accuracy in measuring unobserved TFP growth in the presence of MP and NCRTS in the case of Malaysia's manufacturing industry. This perspective has been neglected by previous empirical studies on this issue. In order to achieve this objective, this chapter relaxes both the assumption of constant returns to scale (CRTS) and perfect competition (PC) and shows that the wedge between the two TFP accounting measures depends on the growth rates of factor shares in total revenue. Thus, if the shares of labour and capital in total revenue remain constant, then one will expect that the difference between the growth rates of primal and dual TFP will vanish, even in the presence of MP and/or NCRTS.

In support of this, chapter 2 uses an empirical method to estimate TFP growth by using Malaysian manufacturing data at 5-digit SIC (Standard Industrial Classification) level, when both primal and dual TFP accounting measurements fail due to MP and NCRTS. In order to reach this objective, this chapter first tests whether the industries have constant factor shares in total revenue in the sample. The *t*-tests have been used to examine the hypothesis that factor shares in total revenue are constant over time. If the *t*-tests fail to reject a null hypothesis of constant factor shares in total revenue, then this indicates that the growth rate of primal TFP has been equal to the growth rate of dual TFP, even in the presence of MP and/or NCRTS. Secondly, this chapter estimates average TFP growth, industry mark-ups and scale coefficients according to the structural model of production and cost functions. Thirdly, this chapter compares the estimates of TFP growth to those of primal and dual TFP accounting measures. Fourthly, this chapter discusses the relationship between generalised primal TFP and returns to scale, the relationship between generalised dual TFP and returns to scale, the relationship between generalised primal TFP and the mark-up and the relationship between generalised dual TFP and the mark-up and finally, this chapter applies the GMM (Generalised Method of Moments) method to estimate average TFP growth, mark-up and returns to scale at the aggregate level.

Chapter 3 investigates the impact of international trade on the strength of the mark-up of price over marginal cost. International trade can have an impact on the variations of the mark-up since foreign competition makes domestic product markets more competitive. Higher international trade intensity tends to increase the degree of competition that the domestic firm faces. Hence, chapter 3 attempts to investigate the effect on the variations of the mark-up, as measured by sensitivity of the mark-up toward import penetration ratio and tariffs for Malaysian manufacturing industries from 1978 to 1999.

The expectation in chapter 3 is that the impact of international trade and tariffs on the variations of the mark-up in manufacturing industry tends to be greater in an individual-industry dominance of "segmented" industries than in "fragmented" industries. According to Sutton (1991) and a subsequent discussion by Schmalensee (1992), two major types of industries (or type of competition) can be identified. Industries with typical small average establishment size were termed "fragmented" industries (industries with a small average establishment in which the number of firms typically grows in line with the size of the markets) and the existence of large establishments size were termed "segmented" industries. In "segmented" industries (industries characterised by the existence of large establishments, covering a large proportion of employment and output), concentration remains relatively stable or converges towards a finite lower bound. This also seems to lend support to the hypothesis that counter-cyclical pattern of the mark-up is the result of increased foreign competition during economic booms. This is indeed likely to be more apparent for the industries characterised by an individual-industry dominance of large firms or establishments ("segmented" industries) with market power and concentrated industries. For example, data from Mexico show that with the liberalisation of the late 1980s, mark-ups fell dramatically, particularly in industries with greater market concentration and a high dominance of large firms ("segmented" industries). Grether (1996) finds that a reduction in tariffs of 1% would lower mark-ups by up to 1.5% for large firms ("segmented" industries) in more concentrated industries. In addition, Pugel (1980), Melo and Urata (1986), Domowitz *et al.* (1988) and Katics and Petersen (1994) find that import competition reduces average cost mark-ups, particularly in domestically concentrated industries.

From a methodological point of view, the empirical studies in Chapter 3 is based on recent developments in studying economic growth, which entails the usage of panel data, and in the econometrics of dynamic panel data analysis, using the Dynamic Heterogeneous Panel Estimation (DHPE) technique proposed by Pesaran, Shin and Smith (1999), in the form of the Pooled Mean Group (PMG) estimator. The advantage of this technique is that it incorporates the recognition of an explicit long run relationship, as well as short run dynamics. The objection to the use of a panel estimator is the reason motivating an industry-by-industry approach. It is interesting to examine the extent to which the mark-up varies across the industries within a sector. However, it is also helpful to pool the data across all manufacturing industries to gain further insights into the reasons for variations in the mark-up in the whole sample. There are certainly many reasons to expect the mark-up to vary between industries substantially, ranging from the degree of trade liberalisation, developments within labour market institutions, international trade composition, type of market structure, establishment size, market size, entry condition and contestability, amongst others.

The advantage of the PMG estimator is that homogeneity across sectors needs not to be assumed, but tested for. Use of the PMG estimator allows for both dynamics across time periods and heterogeneity across cross-sectional units, since it allows researchers to simultaneously investigate both a homogenous long-run relationship and heterogeneous short-run dynamic adjustment towards equilibrium. The net result is the achievement of substantial statistical power from the panel, without denying the importance of sectoral heterogeneity.

Chapter 4 investigates the behaviour of the mark-up of price over marginal cost under different business cycle situations. This involves the effect of the business cycle and turnover rate on the strength of the mark-up in manufacturing industries in Malaysia over the sample period of 1978 to 1999. This period is particularly interesting because it captures at least two significant downturns in the Malaysian economy, namely the periods of downturns in 1984-1987 (due to lower demand in the developed countries) and in 1997-1998 (due to the Asian financial crisis). It also analyses how the interaction between firms' turnover rates and the business cycle affects the variations in the degree and cyclicality of the mark-up. The empirical studies in Chapter 4 is also based on recent developments in studying economic growth, which entails the usage of panel data, and in the econometrics of dynamic panel data analysis, using the Dynamic Heterogeneous Panel Estimation (DHPE) technique proposed by Pesaran, Shin and Smith (1999), in the form of the Pooled Mean Group (PMG) estimator.

The expectation in chapter 4 is that the cyclical character of the mark-up suggests a counter-cyclical variation of the price-marginal cost ratio over the business cycle for Malaysian manufacturing industry. This is consistent with a growing body of empirical literature such as Bils (1987) and Rotemberg and Woodford (1999) showing that economic booms tend to increase competition due to entry of firms into the industry, thereby creating downward pressure on price cost margins. Hence this leads to a lower mark-up.

In addition in chapter 4 is that incorporating demand fluctuations for an individual and the whole manufacturing industry, this chapter anticipates that demand fluctuations seems to have a significant negative impact on the mark-up. This finding is consistent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up and vice versa.

Additionally, incorporating turnover rate for an individual and the whole manufacturing industry, chapter 4 anticipates that turnover rate for an individual and the whole manufacturing industries seems to have a significant negative impact on the mark-up. This finding is also coherent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up and vice versa.

# Chapter 2

## Total Factor Productivity Growth in the Malaysian Manufacturing Industry 1975-1999: Primal and Dual Approaches

### 2.0 Introduction

Accounting for differences in growth rates between countries has been the focus for a substantial literature in recent years. One branch of this literature has sought to distinguish between growth that can be attributed to increased usage of factor inputs and growth that can be attributed to an increase in total factor productivity (TFP). This literature has been plagued by measurement problems, as it is not possible to observe TFP. One approach has been to use an aggregate production function, from which a measurement of TFP can be generated as a residual (often known as the "Solow Residual"). Alternatively, TFP may be measured by examining the dual of the production function - i.e., the production-cost relationship. The equivalence of these two measures depends critically on some crucial assumptions embedded in neoclassical production theory.

The assumptions of perfect competition (PC) and constant returns to scale (CRTS), as well as the theoretical results derived in a framework that incorporates them, are often applied in empirical studies, including microeconomic studies based on firm-level data. However, recent theoretical advances as well as the related empirical research have shown that the departure from these standard assumptions may have important implications with respect to the derived theoretical behavioural characteristics and the validity of the conclusions based on the related empirical analysis. Relaxing some of the assumptions of PC and CRTS has led to various extensions of the standard neoclassical results.

Traditionally, the measurement of the Solow residual has been based on standard neoclassical assumptions. This dates back to Solow (1956, 1957, 1960), in which an aggregate production function was identified with a Hicks-neutral shift parameter and CRTS $(Q_t = \Theta_t F(K_t, N_t))_t$ where $t$ denotes time, aggregate gross output ($Q$) is produced from aggregate inputs consisting of capital ($K$) and Labour ($N$). The level of the Solow residual is represented in the Hicks-neutral ($\Theta$) parameter and is almost always characterised as "output augmenting" and "technical change".

Among the first papers that challenged some of the standard neoclassical assumptions was the seminal work by Hall (1988). He questioned the assumption of PC in product markets, and tested the equality of prices and marginal costs (under the assumption of CRTS) using longitudinal industry-level data for this purpose. His empirical results provided strong evidence against the joint hypothesis of PC and CRTS. He also showed that the primal Solow residual based on quantities of factor inputs can be decomposed into two parts: price mark-up and technological change components. In another seminal paper, Roeger (1995) further elaborated Hall's approach, preserving the assumption of CRTS. He established that, similarly to the primal, the dual Solow residual based on prices and quantities of factor inputs can also be decomposed into two components. Moreover, he argued that the presence of market power (MP) - a violation of the conditions of PC - induces a wedge between the primal and the dual residuals.

The works of Hall and Roeger inspired a series of empirical studies such as Carlaw and Lipsey (2003), Lipsey and Carlaw (2002), Hulten (2000), Basu and Fernald (1997), and Jorgenson, Gallop and Fraumeni (1987). All of them have argued that unobserved TFP growth is not an appropriate measure of technological change as Hall had claimed in his paper.

Under the assumptions of CRTS and PC, unobserved TFP growth has been measured in the literature using traditional primal TFP measurement (Solow,

1957) and traditional dual TFP measurement (Christensen, Jorgenson and Lau, 1973). The TFP measurements based on primal and dual approaches should be equivalent because of the duality of production functions and cost functions. With a production function and output prices, one can find the best use of given level of inputs in order to maximise production subject to resource constraints, whereas with a cost function, one can find the least cost means of producing a given level of output in order to minimise cost subject to providing the desired level of output.

Young (1992, 1995, 1998) and Hsieh (1999, 2002) have undertaken research into the aggregate productivity growth of Singapore, attempting to understand the relationship between the primal and dual TFP growth measurements and also their accuracy in measuring unobserved TFP growth. Young (1992, 1995), by using primal TFP growth accounting, shows that there was in fact no aggregate TFP growth in Singapore. Hsieh (1999, 2002), shows only a 2 percent TFP growth in Singapore by utilising dual TFP growth accounting measurement. The research carried out by Hsieh also shows that primal and dual TFP growth should be equal, when based on national income data. Hsieh and Young's findings however, are different due to the inaccuracy of the data and to differences in the way investment is treated, i.e. whether it is treated as exogenous or endogenous in the production function. Unfortunately, the findings of Hsieh are still not sufficiently convincing to assume that both TFP accounting measures should be equal to unobserved TFP growth.

Hall (1988) and Basu and Fernald (1997), show that MP and non-constant returns to scale (NCRTS) are important factors in influencing aggregate TFP growth and may cause biases in the TFP growth accounting measures. As a consequence, there remains a heated ongoing debate with regard to these issues. Thus, behind all these elements, one is still unable to answer the question of how to measure the unobserved TFP growth when both primal and dual TFP accounting measures fail.

As a result of this, the objectives of this paper are to study the theoretical relationship between the primal and dual TFP from the accounting measurement perspective and assess their accuracy in measuring unobserved TFP growth in the presence of MP and NCRTS in the context of Malaysia's manufacturing industry. In order to achieve this objective, this paper relaxes both the assumption of CRTS and PC and shows that the wedge between the two TFP accounting measures depends on the growth rates of factor shares in total revenue. Thus, if factor shares in total revenue remain constant, then one will expect that the difference between the growth rates of primal and dual TFP will vanish, even in the presence of MP and/or NCRTS.

In support of this, this paper will use an empirical method to estimate TFP growth by using Malaysian manufacturing data at 5-digit SIC (Standard Industrial Classification) level, when both primal and dual TFP accounting measurements fail due to MP and NCRTS. In order to reach this objective, these papers will first tests whether the industries have constant factor shares in total revenue in the sample. The *t*-tests will be used to examine the hypothesis that factor shares in total revenue are constant over time. If the *t*-tests fail to reject a null hypothesis of constant factor shares in total revenue, then this will indicate that the growth rate of primal TFP will be equal to the growth rate of dual TFP, even in the presence of MP and/or NCRTS. Secondly, the paper will estimate average TFP growth, industry mark-ups and scale coefficients according to the structural model of production and cost functions. Thirdly, this paper will compare the estimates of TFP growth to those of primal and dual TFP accounting measures. Fourthly, this paper will discuss the relationship between generalised primal TFP and returns to scale, the relationship between generalised dual TFP and returns to scale, the relationship between generalised primal TFP and the mark-up and the relationship between generalised dual TFP and the mark-up and finally, this paper will apply the GMM (Generalised Method of Moments) method to estimate average TFP growth, mark-up and returns to scale at the aggregate level.

The paper is organised as follows. Section 2.1 discusses review of literature, measurement of productivity and background of theory. Section 2.2 discusses the estimation framework. Section 2.3 discusses data description and analysis. Meanwhile Section 2.4 provides conclusion.

## 2.1 Review of Literature, Measurement of Productivity and Theoretical Background

### 2.1.1 Growth Model and TFP

The first explanation of technological progress is commonly attributed to Solow (1956). In his growth model, technology is something accessible to everybody free of charge. According to this interpretation technical change is neutral, that is independent of the rate of capital accumulation, and it improves the productivity of all factors of production, new and old alike. Technological progress and its implementation are both free (public) goods. A different view of technological progress considered in Solow (1957) and by many others thereafter, suggests that the previous model overlooks the interaction between capital accumulation and technological progress. New technology is usually embodied in new capital goods and there cannot be technological progress without costly investment in new machines. Technical change in this context is investment specific, in the sense that new machines need to be purchased to benefit from technical innovations. That is, technological progress and its implementation are not a public good. In this perspective, research and development (R & D) is just another way through which embodied technological progress can be implemented. Like other kinds of investments, it leads to either product or process improvements, which are embodied into physical and human capital owned by the firm. In general, the embodied technical progress view claims that improvement of TFP always come as consequence of some explicit expenditure/investment at the firm level.

Other scholars (Beckers, 1964; Lucas, 1988) have highlighted the importance of human capital in explaining technological progress. Models of embodiment suggest that capital goods can be considered as physical units characterised by different indexes of technical efficiency. Using a parallel argument, the quality of adjusted labour input can be decomposed into pure labour (hours of work) plus human capital. In this perspective, failing to adjust the labour input for its skill/education quality merely buries human capital in the residual.

More recently, various authors (Romer, 1986, 1990; Grossman and Helpman, 1991) have claimed that technological progress can be better modelled by a combination of external effects and increasing returns. This view implies that increments in productivity come partly from intentional investments in R & D, and partly from an unintentional external effect of capital accumulation or R & D itself. The empirical predictions of this class of models are, when it comes to investment and R & D, not different from those of the embodiment model.

There is a vast empirical literature dealing with TFP. Based on growth accounting measures Abramovitz (1956) carried out one of the first attempts in determining the sources of TFP. His results indicated that the main sources of the U.S.A. productivity growth were still unidentified. This finding leaded to Abramovitz's (1956, p.11) famous comment: "Since we know little about the cause of productivity increase, the indicated importance of this element may be taken to be some sort of measure of our ignorance about the causes of economic growth". At roughly the same time, Solow (1957) provided an analytical framework for interpreting the existence of an exogenous residual, and used it to also measure a very large, and unexplained, TFP factor. It was clear that squeezing down the residual was the crucial issue to deal with. Jorgenson and Griliches (1967) argued that, in a growth accounting framework where technological progress was embodied into the measurable inputs, the residual could be eliminated altogether. However, after being criticised by Denison (1967), they retreated from their position (Jorgenson and Griliches, 1972). Adopting a different estimation technique, and, more importantly, making use of much better microeconomic data, many researchers are be able to squeeze the residual down to zero by attributing TFP to its original determinants.

More recently, Greewood, Hercowitz and Krusell (1997) estimate how much of the technological progress is due to the embodied part and how much is due to the neutral part. They find that the investment specific technological progress accounts for 60% of the growth in output. However, they attribute the unexplained 40% of TFP growth to neutral technical progress.

Microeconometric empirical analysis has also explored the sources of productivity, although without discerning the importance of embodied and disembodied sources of growth. Bahk and Gort (1993) estimate model in levels and mainly focus on the effect of 'learning by doing' on firm output.

### 2.1.2 Technological Change Measurement

In Solow's model of economic growth, increases in output per worker are achieved through increases in the amount of employed capital per worker. With increases in capital per worker the marginal product of capital declines, suggesting the eventual convergence of capital per worker to a constant ratio that leads to an ending in the growth of output per worker. However, output per worker has been increasing at a fairly constant rate in the U.S.A. since 1874. This property of the data suggests that an additional factor in the production function is operating that accounts for the constant growth. To deal with this fact, Solow (1957) introduced a multifactor productivity index of technological change into the production function and developed a methodology for extracting a measure of it from the U.S.A. National Income and Product Accounts (NIPA) data. Thus, there are two forces that can result in increases in output growth: 1). Substitution of capital for labour which produces movements along the production function from increases in capital accumulation over time, and 2). Technological change that produces shifts in the production function. However, without knowing the precise functional form of production one cannot identify the relative proportion of the growth in output that can be imputed to these two effects. Thus, some simplifying assumptions that allow for the separation of these two major sources of growth in the data are required.

To obtain his measure, Solow assumed an aggregate Cobb-Douglas production function that converts capital ($K_t$) and labour ($N_t$) inputs into output ($Q_t$). Technological change is assumed to be Hicks-neutral so that shifts in the level of output do not change the marginal rate of substitution of the inputs. With the additional assumption of CRTS, the Cobb-Douglas production function takes the form $Q_t = \Theta_t K_t^{\alpha} N_t^{1-\alpha}$ where $\Theta_t$ is a measure of the cumulative effect of technological change over time, and $\alpha \in (0,1)$ is the share of capital in production. The production function $Q_t$ may be written in per capita terms in the following way:

$$\frac{Q_t}{N_t} = \Theta_t \left(\frac{K_t}{N_t}\right)^{\alpha} \tag{2.1}$$

Letting $q_t = \frac{Q_t}{N_t}$ and $k_t = \frac{K_t}{N_t}$, Solow showed that $\Delta\Theta_t = \Delta q_t - \alpha\Delta k_t$, where the operator $\Delta$ indicates a percentage change and lower case denotes the natural logarithms transform. Consequently, the Solow residual is the difference between a weighted sum of the growth rates of capital and labour inputs and the growth rate of output where the weights are taken to be the share of these inputs in national income. For each period *t,* data on the share of capital in income, output per unit of labour, and employed capital per unit of labour are used to obtain $\Delta\Theta_t$. To compute the index of technical change, the initial value $\Theta_t$ is fixed to be equal to some constant – usually one. Successive values are calculated recursively using the relation $\Theta_t = (1+\Delta\Theta_t)\Theta_{t-1}$. Under the assumption of CRTS and perfect factor markets, the ratio of aggregate capital income to aggregate output is equal to capital's share in production. Hence, the slope parameter $\alpha$ may be taken as given rather than having to estimate it along with $\Delta\Theta_t$, avoiding the identification problem of simultaneous estimation of $\alpha$ and $\Delta\Theta_t$.

Researchers such as Summer (1986), Hall (1987, 1988), Mankiw (1989), and Evans (1992) have argued that the Solow residual is afflicted with various measurement errors. For example, Summer (1986) argues that the Solow residual is contaminated by the phenomenon of labour-hoarding. Hall (1988) on the other hand shows that the Solow residual is not a proper estimate of technological change in the presence of NCRTS due to market power. In particular, Ohta (1975), Denny, Fuss and Waverman (1981) and Bauer (1990) have shown that in the presence of NCRTS, the Solow residual is equal to true technological change plus a bias term that adjusts for the degree of departure from CRTS. Additionally, according to Hall (1990), under the assumption of PC and CRTS, the Solow residual should be uncorrelated with any variable that is uncorrelated with the rate of growth of the true productivity. Using annual data at the industry level, Hall found that the Solow residual was highly correlated with the growth of military expenditure and changes in world oil prices, instruments reasonably thought to be exogenous. He concluded that the failure of the invariance property was due to increasing returns to scale in the production function.

In response to these criticisms, researchers such as Morrison (1992) attempted to correct the aggregate Solow residual measure for scale effects. Finn (1995) calculated an adjusted version of the Solow residual that accounts for varying rate of capital utilisation. Additionally, Denny, Fuss and Waverman (1981), and Domowitz, Hubbard and Petersen (1988) investigated the impact of mark-up behaviour on the Solow residual. Bauer (1990) demonstrated how changes in cost efficiency over time could affect Solow residual measurement. He then adjusted the measured Solow residual both for changes in returns to scale and technical inefficiency.

### 2.1.3 Mark-up Pricing in Imperfect Markets

It is a well-established result in production theory that under perfect competition in efficient product and factor markets, firms producing homogeneous products set their prices at their marginal costs. In addition, if the production technology is characterised by constant returns to scale, and there are no dynamic effects, average costs equal marginal costs and hence the output price. These conditions do not necessarily hold in a world of imperfect competition: thus the incidence of a monopolist endowed with market power may result in a shift of the equilibrium point away from its would-be position under perfect competition. If the demand curved faced by a monopolist producing $Q$ is downward sloping, the equilibrium price $P_Q$ will exceed the marginal cost $mc$ by a mark-up $\mu(\mu > 1)$ which depends on the price elasticity of demand $\eta$ in which $\mu = \frac{P_Q}{mc} = \frac{1}{\left(1+\frac{1}{\eta}\right)}$. In other words, monopolistic firms may use their market power to set prices above their marginal costs. A common measure of market power, which is closely related to the mark-up, is the Lerner Index (Lerner, A., 1934).

Whilst price mark-ups over marginal costs are considered to be important characteristics of firms' behaviour in imperfect markets, they are not directly observable. Apart from the theoretically justifiable expectation that $\mu > 1$ (as the elasticity of demand $\eta$ for a downward sloping demand curve is negative) there are no other priors as to the values of the mark-ups. Their actual measurement has long interested empirical economists and various approaches to their indirect estimation have been suggested in the literature. The differences in approaching the measurement issue stem both from the underlying theoretical methodology and from the specific objective of the measurement exercise (e.g. to quantify the mark-ups charged by individual firms on individual products, or to measure the average mark-ups of individual firms, or to estimate the average mark-ups across specific industries).

The definition of mark-up $\mu = \frac{P_Q}{mc} = \frac{1}{\left(1+\frac{1}{\eta}\right)}$ according to this equation offers two possible straightforward approaches to the measurement of the firm's mark-ups: one of them requires relevant data on the firm's output prices and marginal costs; the second necessitates the quantification of the price elasticity of demand faced by the firm. Robert and Supina (1996, 2000) have applied the first of these approaches to analyze the price mark-ups charged by different producers on a set of 13 homogeneous products. To do that they specify and estimate a cost function using plant level data and then construct estimates of the marginal cost that vary by plant. The individual firm-level mark-ups can be then calculated using plant level output price data. Morrison (1992) uses a similar approach based on generalised Leontief cost and expenditure functions to analyze the mark-up behaviour of the U.S.A. and Japanese firms. The second approach (based on the demand elasticity) has been explored in Justman (1987) and Shapiro (1987), among others. The main practical problem of these two approaches (and the reason why their application has been relatively limited) is that they require detailed firm-level price and cost information, which, in general, is not readily available and may be difficult to obtain.

Another strand in the empirical literature originates in the seminal paper by Hall (1986) who analyzed the implications of market power for productive efficiency, factor demand and pricing behaviour. Using a two-factor production function, Hall showed that under imperfect competition the primal Solow residual is not solely attributed to autonomous technical change, but may partly reflect monopolistic pricing behaviour. He used his derivation to estimate average industry mark-ups using for this purpose longitudinal industry-level data. Hall's approach was tested and extended in a number of subsequent studies (Shapiro, 1987; Domowitz, Hubbard and Petersen, 1988, among others).

Roeger (1995) established that in the presence of market power (violating the conditions for PC), the dual Solow residual can also be decomposed into two such components: one attributed to autonomous technical change and the other to the mark-up charged by the monopolistic firm. Importantly, he derived an easily estimable equation from the emerging wedge between the primal and dual Solow residuals that can be used for direct estimation of price mark-ups. One of the most attractive features of Roeger's approach is the fact that it is exceptionally undemanding with respect to data: thus in the case of a two-sector production function its application only requires (firm-or industry-level) nominal values of value added, labour and capital costs.

Hall's work and, especially, Roeger's result inspired a series of empirical studies. While in principle this approach is perfectly feasible for the estimation of the mark-ups charged by individual firms, most of the related empirical studies seek to measure average industry-level mark-ups, the main constraint apparently being the significant level of noise in the data of individual firms. In addition, most of the related empirical work has been based on longitudinal sectoral data (time series of aggregated sectoral data), rather than firm data proper. Thus Oliveira-Martins *et al.* (1996, 1999) estimated sectoral mark-up ratios on the basis of longitudinal data for OECD economies. Several studies related variations in mark-up ratio to the business cycle (Bloch and Olive, 2001; Linnemann, 1999); Weiss, 2000; Wu and Zhang, 2000). In a cross-country study, Hoekman, Kee and Olarreaga (2001) analyzed the impact of import competition and domestic market regulation of the formation of industry-level mark-ups. Kee (2002, 2004) used an extension of Roeger's approach to compute mark-ups for Singapore's manufacturing industry, again on the basis of longitudinal sectoral data 1974-1990.

Most recently the same method has been applied to firm-level data (using either cross-sectional or pooled enterprise data), which in principle opens wider opportunities to analyze micro behaviour. Basu and Fernald (1997) emphasise the importance of inter-sectoral heterogeneity when analysing the relationship between mark-ups and returns to scale, even from the macroeconomic viewpoint. This also facilitates the resolution of one rigid assumption incorporated in studies based on industry-level data, namely that the mark-ups are either time-invariable or directly related to the business cycle. Using this type of data some studies have not only attempted to estimate mark-up ratios but have also tried to assess the impact of competitive pressure on their formation (Dobrinsky, Markov and Nikolov, 2001; Halpern and Korosi, 2001a; Konings, Van Cayseele and Warzynski, 2003). In a similar vein, Konings, Van Cayseele, and Warzynski (2001) seek to identify whether competition policy matters in shaping firms' pricing behaviour.

Both the main theoretical results and most of the empirical studies refer to the case of a two-factor production technology with output defined as value added. However, Norrbin (1993) pointed out that defining the mark-up over value added might induce an upward bias in estimations. Basu and Fernald (1997) emphasise that value added can only be interpreted as an output measure under perfect competition, and its use suffers from omitted variable bias under imperfect competition. Noting this, Oliveira-Martins *et al.* (1996) proposed an extension of Roeger's model for a production function defined over sales and incorporating material inputs as well (but preserving the assumption of CRTS). In this extension the main features remain intact while the data requirement only rises slightly to include nominal material costs.

### 2.1.4 Price Mark-ups and Returns to Scale

Most empirical studies so far have neglected one specific aspect of mark-up pricing, namely the existing link between the mark-up ratio and the returns to scale index in the case of non-constant returns to scale. This link can be illustrated in the following simplified theoretical setup. Assume that the production technology of a representative firm is characterised by a production function $Q = f(X)$, where X is the vector of inputs. Alternatively, it can also be defined by the dual cost function $C$=$C$ (Q, **P**), where **P** is the vector of factor prices. It is assumed that both $f$ and $C$ possess all the conventional properties that validate the duality theorem. Let the production technology be characterised by a returns to scale index $Z$ which in accordance with the theory of production duality (see more detail, e.g. Fare and Primont, 1995) can be expressed as:

$$Z = \frac{\left(\sum X_i \left(\frac{\partial f}{\partial X_i}\right)\right)}{f(X)} = \frac{\left(\frac{C}{Q}\right)}{mc} \tag{2.2}$$

where $C/Q$ is the average cost of producing one unit of output and $mc$, as before, denotes the marginal production cost $mc = \partial C / \partial Q$. From this equation (2.2), marginal cost can be determined as $mc = \frac{C}{Q} / Z$. Substituting the latter in $\mu = P_Q / mc = 1/(1 + 1/\eta)$ will establish a direct relationship between mark-up and the returns to scale indices:

$$\frac{\mu}{Z} = \frac{P_Q Q}{C} \tag{2.3}$$

The right-hand side of this expression is nothing else than the firm's average profit margin. Hence the above equation suggests that a monopolist operating a production technology characterised by a returns to scale index Z will achieve an average profit margin which equals the mark-up $\mu$ divided by the returns to scale index. From a theoretical point of view equation (2.3) establish a direct structural relationship between (the unobservable) returns to scale and mark-up indices and the (observable) average profit margin.

It should be pointed out that while equation (2.3) is established as a structural relationship, it does not imply anything as regards the direction of causality between the two structural parameters. Besides, the non-linear nature of this relationship prevents its direct use for empirical purposes: thus one and the same average profit margin may be consistent with an infinite number of combinations of Z and $\mu$. Hence, while this relationship sets up an issue, it offers little help in resolving the problems associated with it.

Similarly to the measurement of the price mark-up, the actual quantification of the returns to scale index is essentially an empirical issue. But one of the important implications of equation (2.3) is that the link between these parameters is of a structural nature which should in principle be incorporated in the actual estimation procedure. It should be noted that while this qualification also applies to the estimation of the returns to scale index, this has so far been widely neglected in the related empirical literature.

The empirical literature dealing with returns to scale is very extensive (for a comprehensive overview of issues and problems see Quinzii, 1992). The mainstream approach starts with an assumption about the functional form of the underlying production technology and seeks to estimate the resultant production function (characterised by a specific returns to scale index). Alternatively, the starting point can be the dual cost function: assuming a functional form of the cost function and estimating it also yields the returns to scale index on the basis of the duality property.

The returns to scale index is present (explicitly or implicitly) in all empirical estimations of price mark-ups. However, most of these studies do not take into account the relationships between returns to scale and mark-ups, often assuming constant returns to scale (CRTS). Only in a very few studies note the structural nature of the relationship between the mark-up and returns to scale index which requires that the two parameters be jointly considered in a broader structural framework.

Roberts and Supina (2000) estimate a cost function that is characterised by returns to scale and factor prices, and the latter, in turn, is implicitly present in their estimates of price mark-ups. Among the problems associated with this approach they note that unobserved efficiency differences may lead to upward biased estimates of returns to scale and hence may cause an upward bias in the mark-ups. Both Hall's and Roeger's models assume CRTS. This may be a rather restrictive assumption for empirical applications while the departure from the assumption of CRTS invalidates some of the theoretical results of these two models. Moreover, disregarding these implications in the case of NCRTS may involve an important estimation bias and may lead to erroneous empirical conclusions.

### 2.1.5 Measurement of TFP Growth from the traditional Neo-classical Production Function (Primal approaches)

The traditional framework for the measurement of TFP growth was developed by Solow (1956,1957,1960) and furthered by Denison (1967,1979), Grilliches and Jorgenson (1966) and Jorgenson *et al.* (1987).

According to the growth accounting framework, TFP is defined as the difference in the growth of output and the weighted rates of growth of the inputs.

Assume that each sector, indexed by *i,* has at time *t* the following production function,

$$Q_{it} = \Theta_{it} F_i (K_{it} N_{it}) \tag{2.4}$$

where;

$Q_{it}$ = Output at time *t* in sector *i*

$K_{it}$ = Capital input at time *t* in sector *i*

$N_{it}$ = Labour input at time *t* in sector *i*

$\Theta_{it}$ = Solow residual TFP at time *t* in sector *i* or an index of Hicks-neutral technical change.

The logarithmic differential with respect to *t* can be written as,

$$\frac{\partial \ln Q_{it}(K_{it}, N_{it}, t)}{\partial t} = \left( \frac{\partial (\ln Q)}{\partial (\ln K)} \bullet \frac{\ln K}{\ln Q} \right) \bullet \frac{\partial (\ln K)}{\partial t} + \left( \frac{\partial (\ln Q)}{\partial (\ln N)} \bullet \frac{\ln N}{\ln Q} \right) \bullet \frac{\partial (\ln N)}{\partial t}$$
$$+ \frac{\partial (\ln Q)}{\partial (\ln \Theta)} \bullet \frac{\partial (\ln \Theta)}{\partial t}$$

where;

$\Phi_K = \left( \frac{\partial(\ln Q)}{\partial(\ln K)} \bullet \frac{\ln K}{\ln Q} \right)$ is the relative share of capital input

$\Phi_N = \left( \frac{\partial(\ln Q)}{\partial(\ln N)} \bullet \frac{\ln N}{\ln Q} \right)$ is the relative share of labour input

$\hat{\Theta} = \frac{\partial(\ln Q)}{\partial(\ln \Theta)}$ is unity since it is a Hicks-neutral shift parameter

$\hat{Q} = \frac{\partial(\ln Q)}{\partial t}$ is the growth rate of output

$\hat{K} = \frac{\partial(\ln K)}{\partial t}$ is the growth rate of capital input

$\hat{N} = \frac{\partial(\ln N)}{\partial t}$ is the growth rate of labour input

Thus given hats indicate time derivatives; the rate of growth of output can be shown as

$$\hat{Q} = \Phi_K \hat{K} + \Phi_N \hat{N} + \hat{\Theta} \tag{2.5}$$

Therefore, TFP growth is measured as the residual of output growth after accounting for the growth of the inputs.

$$\hat{\Theta} = \hat{Q} - \Phi_K \hat{K} - \Phi_N \hat{N} \tag{2.6}$$

or

$$\text{Solow Residual (SR)}_{\text{primal}} = \hat{Q} - \Phi_K \hat{K} - \Phi_N \hat{N} \tag{2.7}$$

This Equation (2.7) is the measurement of TFP growth based on the quantities information approach, otherwise known as the primal approach.

### 2.1.6 Measurement of inputs and outputs

#### 2.1.6.1 Output

Measurement of productivity can be based on many different sources such as output, gross output and value-added. Gross output measures the goods that are produced within an economic unit and which become available for use outside the unit. Value-added takes gross output as a starting point and subtracts the purchase of intermediate inputs. The following discussion is based on the Organisation of Economic Cooperation and Development's (OECD) Productivity Manual (2001).

The following production function can be considered as showing the maximum quantity of output (Q) that can be produced within a given level of all inputs.

$$Q = H(\Theta, K, N, M) = \Theta_t F(K, N, M)$$

as a result

$$\Theta_t = \frac{Q}{F(K, N, M)} \qquad (2.8)$$

Inputs comprise of labour (*N*), capital (*K*) and intermediate inputs (*M*). $\Theta_t$ is referred to by the OECD as disembodied technology, and according to Carlaw and Lipsey (2002), it is more appropriate to consider this as TFP and not technology. Technological change could also be thought of as the growth in TFP and this term has been assumed to be `Hicks-neutral'.

The OECD productivity manual measures TFP as the difference between the growth rate of a Divisia index of output and a Divisia index of input. The Divisia index of inputs is made up of the logarithmic rates of change of capital, labour and intermediate inputs, weighted by their respective shares of total input cost (denoted $W_K$ ,$W_N$, and $W_M$).

So,

$$\%\Delta TFP_{GO} = \frac{\partial(\ln Q)}{\partial t} - W_K \frac{\partial(\ln K)}{\partial t} - W_N \frac{\partial(\ln N)}{\partial t} - W_M \frac{\partial(\ln M)}{\partial t} \qquad (2.9)$$

in which percentage $\Delta TFP_{GO}$ is the percentage growth rate in TFP based on gross output. The value added function can also be defined to illustrate the maximum amount of current price value added that can be produced, given a set of capital and labour inputs and prices of intermediate inputs $(P_M)$ and output $(Q)$. Therefore, the value added function will be

$$G = G(\Theta_t, K, N, P_M, Q) \qquad (2.10)$$

If the definition of productivity change is accepted as the shift in the value added function and one measures this as the difference between the growth rate of Divisia volume index of value-added and the growth rate of the Divisia index of capital and labour inputs, then the formula for this change can be written as;

$$\%\Delta TFP_{VA} = \frac{\partial(\ln G)}{\partial t} = \frac{\partial(\ln VA)}{\partial t} - \frac{\partial(\ln K)}{\partial t} - \frac{\partial(\ln N)}{\partial t} \qquad (2.11)$$

in which percentage $TFP_{VA}$ is the percentage growth rate of TFP based on a value added measure of output.

#### 2.1.6.2 Capital

Measuring capital and TFP requires tangible measurements of physical capital inputs. As the flow of physical capital services is not directly observable, productivity analysts would usually assume that the flow of capital services is proportional to the capital stock. Ideally, the capital stock measure should be assessed by taking into account the loss in productive capacity of capital assets that occurs over time.

Conventionally there are two methods to measure the capital stock; productive capital stock and net capital stock.

Productive capital stock endeavours to measure the total productive capacity of different types of capital assets in existence at a given point in time. Suppose information on investments in a particular asset type is available for period *t-s* to period *t* for *s*=0,....,*S* and is denoted by the vector $I \equiv (I_{t-s}, I_{t-s+1}, ...., I_{t-1}, I_t)$. Furthermore, assume that the productive capacity of an asset in period *t* that is now *s* period old (that is, the *s*-vintage asset) is given by:

$$R_{t,s} = \Psi_s I_{t-s}$$

where $\Psi_s$ denotes the relative productive capacity of a *s*-vintage asset to the productive capacity of a new asset.

The series $\Psi_s$ is known as the age-efficiency schedule and is usually normalised so that $\Psi_0 = 1$. The age-efficiency schedule shows the decline in the productive capacity of an asset over its economic life.

Furthermore, productive capital stock can be expressed in the following equation;

$$K_t = \sum_{s=0}^{s} \Psi_s I_{t-s} \qquad (2.12)$$

where $K_t$ represents the productive capital stock at the beginning of year *t*, $I_{t-s}$ the gross fixed capital formation in the year $_{t-s}$.

Three commonly used age-efficiency patterns are the linear, rectangular and geometric age-efficiency schedules. The linear age-efficiency schedule assumes that the productive capacity of an asset depreciates linearly over the asset's economic life. The rectangular efficiency pattern assumes that the productive capacity of an asset remains constant over its economic life but then falls to zero when the asset's economic life ends. The geometric age-efficiency pattern, however, assumes that the productive capacity of an asset declines at a constant rate. Equation (2.12) is known as the perpetual inventory model of the productive capital stock.

Net capital stock measures allow the service flow from an asset to fall over time as the asset depreciates. This can be expressed in the following equation; $K_t$ is capital stock in time, equal to the previous period's net capital stock less depreciation plus any additional capital investment made;

$$K_t = (1-d)K_{t-1} + I_t \tag{2.13}$$

where $d$ is the depreciation rate or proportion of the capital stock that is retired each period. To construct a net capital stock series, a starting value for the net capital stock is required.

#### 2.1.6.3 Labour

It is important to have an appropriate measurement of labour input in order to produce meaningful productivity statistics, so information is required on both quantity and quality of labour. To measure the quantity of labour, there are various questions that have been raised concerning the appropriate measurement. The normal unweighted measure of labour input is the number of full-time equivalent workers or the total number of hours worked. Full-time equivalent employment is an improvement over total employment as it incorporates changes in the mix of full- and part-time employment. This gross measure of labour does not reflect the efficiency in the use of labour inputs and hence may bias the estimation of TFP growth. However, full-time equivalent measures will not reflect changes in average full-time employment hours. In order to regulate this, researchers such as Jorgenson, Gollop and Fraumeni (1987) constructed a Divisia quality index of labour inputs by using different weights for different qualitative aspects of labour including skill levels, effective hours of work, educational attainment, age distribution and sex composition.

The issue at hand is that more skilled labour with high qualifications represents a larger number of input units per unit of time worked, and therefore it is argued that it makes for a better measure of factor input in a production function. The choice of method used to measure the quantity of labour is important, as normally the different measures employed result in different growth rates in the quantity of labour used over a given period of time. The greater the measure of labour growth, the lower the productivity measure will be, given that more of the growth in output will be accounted for by the growth in the labour input.

### 2.1.7 Measurement of TFP Growth from the traditional Neoclassical Cost Function (Primal and Dual approaches)

The primal and dual approaches of TFP growth can be derived either from the production function or from cost function. Initially, it can be look at the cost function approach in which output is equal to the payments to the factors of production.

$$PQ = rK + wN \tag{2.14}$$

where

r = price of capital

w = price of labour

PQ = Total Revenue

K = Capital inputs

N= Labour inputs

If differentiating both side of equation (2.14) with respect to time, the equation will be:

$$\frac{\partial PQ}{\partial t} = \left( r \bullet \frac{\partial K}{\partial t} + K \bullet \frac{\partial r}{\partial t} \right) + \left( N \bullet \frac{\partial w}{\partial t} + w \bullet \frac{\partial N}{\partial t} \right) \tag{2.15}$$

Now dividing equation (2.15) by *PQ*, the result is;

$$\frac{\frac{\partial PQ}{\partial t}}{PQ} = \left( \frac{r}{PQ} \bullet \frac{\partial K}{\partial t} + \frac{K}{PQ} \bullet \frac{\partial r}{\partial t} \right) + \left( \frac{N}{PQ} \bullet \frac{\partial w}{\partial t} + \frac{w}{PQ} \bullet \frac{\partial N}{\partial t} \right) \tag{2.16}$$

Rearrange equation (2.16) as;

$$= \frac{rK}{PQ} \left( \frac{\frac{\partial K}{\partial t}}{K} + \frac{\frac{\partial r}{\partial t}}{r} \right) + \frac{wN}{PQ} \left( \frac{\frac{\partial w}{\partial t}}{w} + \frac{\frac{\partial N}{\partial t}}{N} \right) \tag{2.17}$$

where;

$\frac{rK}{PQ}$ = shares of capital in total revenue.

$\frac{wN}{PQ}$ =shares of labour in total revenue.

Now, replacing the terms involving the growth rates of factor quantities on the left-hand side of the equation, obtaining;

$$\frac{\frac{\partial PQ}{\partial t}}{PQ} - \frac{rK}{PQ}\left(\frac{\frac{\partial K}{\partial t}}{K}\right) - \frac{wN}{PQ}\left(\frac{\frac{\partial N}{\partial t}}{N}\right) = \frac{rK}{PQ}\left(\frac{\frac{\partial r}{\partial t}}{r}\right) + \frac{wN}{PQ}\left(\frac{\frac{\partial w}{\partial t}}{w}\right) \tag{2.18}$$

Then, the primal estimate of the Solow (1957) residual is the growth rate of output minus the share-weighted growth in capital and labour inputs.

$$\frac{\frac{\partial PQ}{\partial t}}{PQ} - \frac{rK}{PQ}\left(\frac{\frac{\partial K}{\partial t}}{K}\right) - \frac{wN}{PQ}\left(\frac{\frac{\partial N}{\partial t}}{N}\right) \tag{2.19}$$

The dual estimate of Solow (1957) residual is the share-weighted growth in capital and labour prices.

$$\frac{rK}{PQ}\left(\frac{\frac{\partial r}{\partial t}}{r}\right) + \frac{wN}{PQ}\left(\frac{\frac{\partial w}{\partial t}}{w}\right) \tag{2.20}$$

Both Equations (2.19 & 2.20) are based on prices and quantities of factor inputs information, so these being known as the dual approach.

### 2.1.8 The Relationship Between Primal and Dual TFP from the Traditional Neoclassical Model

The traditional assumptions of a neoclassical model of production are:

1. Producers are in long-run equilibrium
2. Technology exhibits CRTS
3. Output and input markets are perfectly competitive
4. Factors are utilised at a constant rate

According to the assumptions, let $i$ be the industry index and $t$ be the time index; therefore, the relationship between growth rate of output, $\hat{Q}_{it}$, the growth rate of labour input, $\hat{N}_{it}$, and the growth rate capital input, $\hat{K}_{it}$, can be represented by Equation (2.21)

$$\hat{Q}_{it} = \Phi_{iK}\hat{K}_{it} + \Phi_{iN}\hat{N}_{it} + \hat{\Theta}_{it} \tag{2.21}$$

where $\hat{\Theta}_{it}$ is the growth rate of Hicks neutral productivity, $\Phi_{iK}$ and $\Phi_{iN}$ are the elasticity of output with respect to capital and labour input.

Hence according to Hall (1988), rewriting equation (2.21) gives (see more detailed in the appendix 2.5 and 2.8):

$$\hat{\Theta}_{it} = \widehat{\left(\frac{Q_{it}}{K_{it}}\right)} - (1-\Omega_{iK})\widehat{\left(\frac{N_{it}}{K_{it}}\right)} \tag{2.22}$$

where the left hand side of equation (2.22) is the rate of Hicks-neutral technical progress $(\Delta\log(\Theta))$. Solow recommended evaluating the left hand side in order to measure the rate of growth of TFP. This measure has come to be known as TFP growth because, unlike measures that consider only output and labour input, it accounts for capital input and, in a more general form, for all other types of inputs.

The first term on the right hand side of equation (2.22) $\widehat{\left(\frac{Q}{K}\right)}$ is the growth rate of output per capital $\left(\Delta\log\left(\frac{Q}{K}\right)\right)$ and in the second term, $\Omega_{iK}$ is the share of capital in total revenue (ratio of compensation *rK* to total revenue *PQ*), and $\widehat{\left(\frac{N}{K}\right)}$ is the rate of growth of the labour per capital $\left(\Delta\log\left(\frac{N}{K}\right)\right)$. Whilst $\Omega_N = \frac{wN}{PQ}$ is the share of labour in total revenue.

Therefore, the right hand side of equation (2.22) has become known as the "Solow Residual" (SR). The economics of the residual are straightforward. Under PC and CRTS, the observed shares of labour to capital inputs are an actual measure of the elasticity of the production function. This elasticity can be obtained directly from the data on compensation and revenue. Once the elasticity is known, the rate of TFP growth can be obtained simply by subtracting the rate of growth of labour per capital, adjusted by the elasticity, from the rate of growth of output per capital.

According to the dual approach of production theory, a similar relationship also exists between the growth rate of the output price, $\hat{P}_{it}$, the growth rate of wages, $\hat{w}_{it}$, and the rental price, $\hat{r}_{it}$:

$$\hat{P}_{it} = \Omega_{iK}\hat{r}_{it} + \Omega_{iN}\hat{w}_{it} - \hat{\Theta}_{it} \qquad (2.23)$$

Thus,

$$\hat{\Theta}_{it} = (1-\Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} - \widehat{\left(\frac{P_{it}}{r_{it}}\right)} \qquad (2.24)$$

where the first right hand side (RHS) of equation (2.24) $\widehat{\left(\frac{r_{it}}{w_{it}}\right)}$ is the growth rate of rental price per wage $\left(\Delta\log\left(\frac{r}{w}\right)\right)$ multiplied by $(1-\Omega_{iK})$ is the share of labour in total revenue (or 1 minus the ratio of compensation $rK$ to total revenue $PQ$) and the second RHS, $\widehat{\left(\frac{P_{it}}{r_{it}}\right)}$ is the growth rate of output price per rental price $\left(\Delta\log\left(\frac{P}{r}\right)\right)$.

Therefore, defining the growth rate of primal TFP and the growth rate of dual TFP according to the following equation by Hall (1988) definition:

$$\widehat{TFP_{it}}\,primal \Rightarrow \hat{\Theta} = \widehat{\left(\frac{Q_{it}}{K_{it}}\right)} - \left(1-\Omega_{iK}\right)\widehat{\left(\frac{N_{it}}{K_{it}}\right)}$$

re-expressing equation (2.22) with the convention that

$$x = \frac{X}{K}$$

where

$$q = \frac{Q}{K}$$

and

$$\pi = \frac{N}{K}$$

obtain

$$\widehat{TFP_{it}}primal \Rightarrow \hat{\Theta}_{it} = \hat{q}_{it} - (1-\Omega_{iK})\hat{\pi}_{it} \tag{2.25}$$

Primal TFP growth is measured by the difference between the growth rate of output and the revenue share-weighted average of inputs.

$$\widehat{TFP_{it}}dual \Rightarrow \hat{\Theta}_{it} = (1-\Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} - \widehat{\left(\frac{P_{it}}{r_{it}}\right)} \tag{2.26}$$

Dual TFP growth is measured by the difference between the growth rate of wage rental ratio and rental price ratio.

Under the assumptions of CRTS and PC, the growth rate of the two TFP (primal and dual) measures are theoretically identical, and they measure the unobserved TFP growth, $\hat{\Theta}_{it}$, precisely.

## 2.2 The Estimation Framework

### 2.2.1 Moving from the Traditional to Generalised Neoclassical Approach

#### 2.2.1.1 Primal Analysis

Returning to equation (2.4) in which it was assumed that each sector, indexed by $i$, to has at time $t$, the following production function,

$$Q_{it} = \Theta_{it} F_i(K_{it}, N_{it}) \tag{2.27}$$

By substitution and manipulating, Equation (2.27) can be further manipulated to achieve the following (see more detailed in the appendix 2.5 and 2.8),

$$\widehat{TFP_{it}}\, primal = \hat{\Theta}_{it} + (\omega_i - 1)(1 - \Omega_{iK})\hat{\pi}_{it} + (Z_i - 1)\hat{K}_{it} \tag{2.28}$$

Equation (2.28) leads to the following proposition:

**Proposition 1**

Let $\hat{N}_{it} > 0$ and $\hat{K}_{it} > \hat{N}_{it}$. The growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP if the mark up is greater than 1 and the organisation faces decreasing returns to scale. If the organisation faces increasing returns to scale and mark up > 1, the growth rate of traditional primal TFP will be less than or more than the growth rate of generalised primal TFP, depending on the values of the second and third terms of Equation (2.28). The growth rate of traditional primal TFP will still be less than the growth rate of generalised primal TFP, if the negative value in the second term is bigger than the positive value of the third term of Equation (2.28).

**Proof**

Given $\hat{N}_{it} > 0$ and $\hat{K}_{it} > \hat{N}_{it}$, then $\hat{\pi}_{it} < 0$, followed by $\omega_i > 1$ (MP) and $Z_i < 1$. So $\widehat{TFP}_{it}\,primal < \hat{\Theta}_{it}$ by Equation (2.28).

Intuitively, if the firm is capital intensive relatively to labour, the existence of MP and decreasing returns to scale implies that the growth rate of traditional primal TFP growth will be lower than the generalised primal TFP growth. The above proposition restates the results of Hall (1988, 1990), where he shows that MP may cause the Solow residual to be procyclical and correlated with some aggregate demand variables.

#### 2.2.1.2 Dual Analysis

Initially start with the Homogeneity of the Cost Function.

$C\left(w, r, F\left(N, K\right)\right) = wN + rK$ is a general cost function, and $Q = \Theta F(N, K)$,

if F is homogeneous of degree Z in (N,K),
as a result

i. C is homogeneous of degree $\frac{1}{Z}$ in F

ii. C is homogeneous of degree $\frac{1}{Z}$ in Q

iii. Let $m = \frac{\partial C}{\partial Q}$, then $m = \frac{1}{Z}\frac{C}{Q}$

Therefore, confirming the above properties (see more detailed in the appendix 2.6 and 2.8).

Based on the above properties, Homogeneity of the Cost Function can be rewritten as general cost function,

$$C\left(w_{it}, r_{it}, F_i\left(N_{it}, K_{it}\right)\right) = w_{it} N_{it} + r_{it} K_{it} \tag{2.29}$$

By substitution and manipulation, Equation (2.29) can be further manipulated to achieve the following (see more detailed in the appendix 2.6 and 2.8),

$$\widehat{TFP}_{it}dual = \hat{\Theta}_{it} + (\omega_i - 1)(1 - \Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \tag{2.30}$$

Equation (2.30) leads to the following proposition:

**Proposition 2**

Let $\hat{w}_{it} > \hat{r}_{it} > 0$ and $\widehat{P_{it}Q_{it}} > \hat{r}_{it}$. The growth rate of traditional dual TFP will be less than the growth rate of generalised TFP, if the mark-up is greater than 1 and returns to scale less than 1. However, if the organisation faces increasing returns to scale and mark up > 1, the growth rate of traditional dual TFP will be less than or more than the growth rate of generalised dual TFP, depending on the values of the second and third terms of Equation (2.30). The growth rate of traditional dual TFP will still be less than the growth rate of generalised dual TFP, if the negative value in the second term is bigger than the positive value of the third term of Equation (2.30).

**Proof**

Given $\hat{w}_{it} > \hat{r}_{it} > 0$, and $\widehat{P_{it}Q_{it}} > \hat{r}_{it}$

Thus $\widehat{\left(\frac{r_{it}}{w_{it}}\right)}$< 0 and $\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)}$>0, therefore $\omega_i > 1$(MP) and $Z_i < 1$ or > 1.

Therefore

$\widehat{TFP}_{it}dual < \hat{\Theta}_{it}$ by Equation (2.30)

Intuitively, the above proposition shows that, with the right conditions, both MP and decreasing returns to scale may result in traditional dual TFP growth underestimating the generalised TFP growth. Notice that by maintaining the assumption of CRTS, that is setting $Z_i = 1$, Roeger (1995) shows that MP causes the traditional dual TFP growth to underestimate generalised dual TFP growth. In other words, Roeger considers only one of the scenarios of proposition 2 that of MP. However, by considering both conditions, MP and NCRTS, it can also cause the traditional dual TFP to underestimate the generalised TFP growth.

### 2.2.2 The Difference

The difference between the two measured growth rates of TFP can be derived by subtracting Equation (2.30) from Equation (2.28) (see the appendix 2.7 and 2.8 for more detail).

$$\widehat{TFP}_{it}primal - \widehat{TFP}_{it}dual = (\omega_i - 1)(1 - \Omega_{iK})\left(\widehat{\frac{w_{it}N_{it}}{r_{it}K_{it}}}\right) + \left((Z_i - 1)\left(\widehat{\frac{r_{it}K_{it}}{P_{it}Q_{it}}}\right)\right) \quad (2.31)$$

Intuitively, in theory, the presence of MP and NCRTS creates a possible wedge (Roeger, 1995) between the two measures. However, given that the factor shares in total revenue are mostly constant in the real world, the right-hand side of the above equation is practically nil even in the presence of MP and NCRTS.

**Proposition 3**

If the shares of labour and capital in total revenue are constant, then the growth rate of traditional or generalised primal TFP will be equal to the growth rate of traditional or generalised dual TFP, even in the presence of MP and/or NCRTS.

**Proof**

Input share of labour in total revenue = $\widehat{\left(\frac{w_{it}N_{it}}{P_{it}Q_{it}}\right)}$ (2.32)

Input share of capital in total revenue = $\widehat{\left(\frac{r_{it}K_{it}}{P_{it}Q_{it}}\right)}$ (2.33)

If the input shares of labour and capital in total revenue are constant, so

$$\widehat{\left(\frac{w_{it}N_{it}}{P_{it}Q_{it}}\right)} = \widehat{\left(\frac{r_{it}K_{it}}{P_{it}Q_{it}}\right)} \tag{2.34}$$

Thus $\widehat{\left(\frac{w_{it}N_{it}}{r_{it}K_{it}}\right)} = 0$ or the ratio of shares of labour and capital will be practically nil.

Then $\widehat{TFP}_{it}primal - \widehat{TFP}_{it}dual = 0$.

### 2.2.3 Robustness Checks

#### 2.2.3.1 Adjustment for capacity utilisation of capital input

In the real world, utilisation of capital input may fluctuate over the business cycle. Therefore, by adjusting the rate of utilisation of capital input, an error in variable problem can be avoided.

Let $K_{it}$ denote a unit of physical capital input and $\phi_{it}$ be the rate of utilisation of capital input.

Thus, the service of capital input is

$$K_{it}^{S} = \phi_{it} K_{it}$$

Now, modify Equation (2.27) to incorporate utilisation of capital input, obtaining

$$Q_{it} = \Theta_{it} F\left(N_{it}, K_{it}^{S}\right) \tag{2.35}$$

So Equation (2.35) can be modified to

$$Q_{it} = \hat{\Theta}_{it} + \Phi_{iN}\hat{N}_{it} + \Phi_{iK}\hat{K}_{it}^{S}$$
$$\hat{Q}_{it} = \hat{\Theta}_{it} + \Phi_{iN}\hat{N}_{it} + \Phi_{iK}\left(\hat{K}_{it} + \hat{\phi}_{it}\right) \tag{2.36}$$

Or

$$\widehat{TFP}_{it} primal = \hat{\Theta}_{it} + (\omega_i - 1)(1 - \Omega_{iN})\hat{\phi}_{it} + (\omega_i - 1)(1 - \Omega_{iK})\hat{\pi}_{it} + (Z_i - 1)\hat{K}_{it}$$

(2.37)

and

$$\widehat{TFP_{it}dual} = \hat{\Theta}_{it} + (\omega_i - 1)(1-\Omega_{iN})\hat{\phi}_{it} + (\omega_i - 1)(1-\Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)}$$

(2.38)

**Proposition 4**

The growth rate of traditional TFP will be equal to the growth rate of generalised TFP, if and only if the firm is competitive $(\omega = 1)$ and faces CRTS (Z =1). In the presence of MP, NCRTS and adjusting for capacity utilisation of capital input, the growth rate of traditional TFP will be less than the growth rate of generalised TFP.

Intuitively, the inclusion of the period-specific effect will take care of the business cycle fluctuation.

#### 2.2.3.2 Adjustment for labour input

Data on the growth rate of labour input are constructed from the growth rate of the number of workers in the industry. Thus, implicitly, the assumption of homogeneous labour input is imposed. However, it is reasonable to assume that one unit of labour input in the 1990's would have resulted in a higher productivity than one such unit in the 1970's, due to the accumulation of human capital. The homogeneous labour input assumption may bias the estimated coefficient, due to an error in measurement. Therefore, it is necessary to adjust the level of labour efficiency according to the improvement in productivity.

Let $N_{it}$ denote the unit in physical labour input and $N_{it}^{e}$ denote the unit of efficient labour.

Then,

$$N_{it}^{e} = e_{it} N_{it}$$

where $e_{it}$ = level of efficiency of labour input in industry $i$ and in period $t$.

Now, modify Equation (2.27) to incorporate labour efficiency, to obtain

$$Q_{it} = \Theta_{it} F\left(N_{it}^{e}, K_{it}\right) \qquad (2.39)$$

Therefore, Equation (2.39) can be modified to obtain

$$\hat{Q}_{it} = \hat{\Theta}_{it} + \Phi_{iN} \hat{N}_{it}^{e} + \Phi_{iK} \hat{K}_{it}$$

$$= \hat{\Theta}_{it} + \Phi_{iN}\left(\hat{N}_{it} + \hat{e}_{it}\right) + \Phi_{iK} \hat{K}_{it}$$

or

$$\widehat{TFP}_{it} primal = \hat{\Theta}_{it} + \Phi_{iN} \hat{e}_{it} + \Phi_{iN} \hat{\pi}_{it} + \left(Z_i - 1\right) \hat{K}_{it}$$

$$= \hat{\Theta}_{it} + \left(\omega_i - 1\right)\left(1 - \Omega_{iK}\right) \hat{e}_{it} + \left(\omega_i - 1\right)\left(1 - \Omega_{iK}\right) \hat{\pi}_{it} + \left(Z_i - 1\right) \hat{K}_{it}$$

(2.40)

$$\widehat{TFP}_{it} dual = \hat{\Theta}_{it} + \left(\omega_i - 1\right)\left(1 - \Omega_{iK}\right) \hat{e}_{it} + \left(\omega_i - 1\right)\left(1 - \Omega_{iK}\right) \widehat{\left(\frac{r_{it}}{w_{it}}\right)} + \left(Z_i - 1\right) \widehat{\left(\frac{P_{it} Q_{it}}{r_{it}}\right)}$$

(2.41)

**Proposition 5**

The growth rate of traditional TFP will be equal to the growth rate of generalised TFP, if and only if the firm is competitive $(\omega = 1)$ and faces CRTS (Z =1). In the presence of MP, NCRTS and adjusting for labour input, the growth rate of traditional TFP will be less than the growth rate of generalised TFP.

Intuitively, the inclusion of period-specific and industry specific effects will reduce the potential bias of the estimates due to the mis-measurement of labour input.

### 2.2.4 Estimation Strategy

The endogeneity problem will be faced, if the $\alpha_{iN}$ and $\beta_{iK}$ parameters are estimated using the Ordinary Least Squares (OLS) regression method. TFP growth initially will be estimated in the presence of MP and NCRTS by using OLS regression methods. This can be done by applying Equations (2.28) and (2.30), which are extensions of the primal and dual Hall regressions, in order to estimate mark-up and returns to scale coefficients with regard to the model specified,

$$\hat{q}_{it} = \hat{\Theta}_{i1} + \alpha_{i2}\left(1-\Omega_{iK}\right)\hat{\pi}_{it} + \alpha_{i3}\hat{K}_{it} \quad (2.42)$$

$$\widehat{\left(\frac{r_{it}}{P_{it}}\right)} = \hat{\Theta}_{i1} + \beta_{i2}\left(1-\Omega_{iK}\right)\widehat{\left(\frac{r_{it}}{w_{it}}\right)} + \beta_{i3}\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \quad (2.43)$$

where

$\hat{q}_{it}$ is the growth rate of output, $\hat{\pi}_{it}$ is growth rate of the labour per capital ratio, $\widehat{\left(\frac{r_{it}}{P_{it}}\right)}$ is the growth rate output price per rental price ratio, $\widehat{\left(\frac{r_{it}}{w_{it}}\right)}$ is the growth rate of rental price per wage ratio, $\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)}$ is the growth rate total revenue per rental price ratio, $\hat{\Theta}_{it}$ is the growth rate of Hicks neutral productivity and $\Omega_{iK}$ is the share of capital in total revenue.

Meanwhile $\alpha_{i2}$ and $\beta_{i2}$ will be the estimated values of the industry-specific mark-ups, and $\alpha_{i3}$ and $\beta_{i3}$ will be the estimated values of the industry-specific returns to scale coefficients. In order for the primal and dual regressions to be equivalent, the following constraints must hold:

$$\alpha_2 = \beta_2$$

$$\alpha_3 = \beta_3$$

Subsequently, Equations (2.42) and (2.43) will display an endogeneity problem. The growth rate of technological progress, $\hat{\Theta}_{it}$, enters a firm's first-order condition for profit maximisation (as well as that of cost minimisation), which determines the input demand and also output of the firm. So, without overcoming this problem, $\hat{\Theta}_{it}$, the least squares estimates for the coefficients of the growth rate of labour per unit of capital and the growth rate of capital will be biased upward. This problem was first initially discussed by Marschak and Andrew (1944). Firms choose inputs knowing their own level of productivity, which is unobservable to the econometrician. A least squares regression of output on inputs will give inconsistent estimates of the production function coefficients.

Furthermore, as shown in Olley and Pakes (1996), there will be a selection bias in the model because of the pattern of firms' entry and exit. Productive firms will stay in the business, while unproductive firms choose to exit. However, larger firms may be better able to survive short periods of low productivity, so without overcoming the problem of surviving probability of firms in the industry, least squares estimates for capital growth will be biased downwards. According to Olley and Pakes (1996) for estimating productivity effects of restructuring in the U.S. telecommunications equipment industry, they not only addressed the simultaneity of inputs and unobserved productivity, but also argued that correlation of exit from the sample with inputs would lead to an additional sample selection bias. In other words, if low productivity firms tend to exit and the exit-thresholds show a decrease in capital, selection will bias the least squares estimate of the capital coefficient downward.

One mechanism that creates such dependency is a profit function that increases with capital. Firms with more capital expect a higher future profitability for a given level of productivity and will support larger falls in productivity before exiting the industry. An alternative mechanism that generates the same result is imperfect competition, i.e. if a bankrupt firm incurs a loss proportional to the capital stock. So Olley and Pakes (1996) use a polynomial of investment and capital of firms as a control mechanism to obtain a consistent estimate of $\alpha_{iN}$. For a consistent estimate of $\alpha_{iK}$ they use a selection model based on firm's entry and exit decision.

Therefore, there are three different techniques to overcome the endogeneity problem that could be implemented. The most straightforward solution is to use instrumental variables that are uncorrelated with productivity, for example see Syverson (2001), Blundell and Bond (1998) and (2000). Secondly, the stochastic frontier literature makes explicit distributional assumptions about the unobserved productivity factor and estimates the primitives of the distribution, examples can be found with Aigner *et al.* (1977), Maeusen and van den Broeck (1977) and Battese and Coelli (1992). Thirdly, Olley and Pakes (1996) invert the investment function nonparametrically to obtain an expression for unobserved productivity.

The major innovation of Olley and Pakes (1996) is to bring to light a new equation, the investment equation, as a proxy for productivity, the unobserved transmitted component of white noise ($u$). Attempting to proxy for the unobserved productivity has several advantages over the usual internal estimators (or the more general Chamberlain and GMM type estimators): it does not assume that productivity reduces itself to a "fixed" (over time) firm effect; it leaves greater identifying variances in input and hence is a less costly solution to the omitted variable and/or endogeneity problem; and it should also be substantively more informative.

Therefore, to overcome the problems of endogeneity and selection bias by using OLS regression method above, a simple fixed effect approach can be adopted by modelling productivity growth as the sum of industry fixed effect and year fixed effect, then applying an instrumental variables approach to estimate the average industry mark-up and returns to scale.

It is also possible to use the one-year lagged values of all the right-hand side variables in Equation (2.47) as instrumental variables, because these variables are already stacked by construction and may not be correlated with the dependent variables. Included in these variables are the aggregate labour share multiplied by the growth rate of aggregate employment-capital ratio in the primal regression, stacked with the aggregate labour share multiplied by the growth rate of aggregate rental-wage ratio in the dual regression and the growth rate of capital stocks in the primal regressions, stacked with the growth rate of revenue rental ratio in the dual regressions.

### 2.2.5 Fixed Effect Correction

Assume that the Hicks neutral technological progress parameter is a random variable of the following form:

$$\Theta_{it} = \Theta_{i0^{e^{\varphi_{it'}}}}$$

$$\hat{\Theta}_{it} = \varphi_{it} = \sigma_i + \lambda_t + u_{it} \qquad (2.44)$$

in which $\Theta_{i0}$ is the technological level of industry $i$ at the beginning, period 0, and $\varphi_{it}$ is the growth rate of technological progress. So, the growth rate of the technological progress of industry $i$ in period $t$ consists of an industry-specific growth rate, $\sigma_i$, and a period-specific growth rate, $\lambda_t$, which captures the macroeconomic shock that is common across industries in the same period, plus a white noise, $u_{it}$, that is a classical random error with zero mean and $\sigma^2$ variance.

Substitute Equation (2.44) into Equation (2.28) and (2.30), to obtain

$$\hat{q}_{it} = \sigma_i + \lambda_t + (\omega_i - 1)(1-\Omega_{iK})\hat{\pi}_{it} + (Z_i - 1)\hat{K}_{it} + u_{it}^P \tag{2.45}$$

$$\widehat{\left(\frac{r_{it}}{P_{it}}\right)} = \sigma_i + \lambda_t + (\omega_i - 1)(1-\Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} + u_{it}^D \tag{2.46}$$

where $u_{it}^P$ and $u_{it}^D$ will capture both additive measurement errors specific to $\hat{q}_{it}$ and $\widehat{\left(\frac{r_{it}}{P_{it}}\right)}$ and the white noise productivity shock, $u_{it}$.

Applying the cross equation restriction, Equation (2.45) and (2.46) may be stacked to give

$$\begin{bmatrix} \hat{q}_{i1} \\ \vdots \\ \hat{q}_{iT} \\ \widehat{\left(\frac{r_{i1}}{P_{i1}}\right)} \\ \vdots \\ \widehat{\left(\frac{r_{iT}}{P_{iT}}\right)} \end{bmatrix} = \sigma_{i1} + \sum_{t=2}^{T} \lambda_t D_t + (\omega_i - 1) \begin{bmatrix} (1-\Omega_i)\hat{\pi}_{i1} \\ \vdots \\ (1-\Omega_i)\hat{\pi}_{iT} \\ (1-\Omega_i)\widehat{\left(\frac{r_{i1}}{w_{i1}}\right)} \\ \vdots \\ (1-\Omega_i)\widehat{\left(\frac{r_{iT}}{w_{iT}}\right)} \end{bmatrix} + (Z_i - 1) \begin{bmatrix} \hat{K}_{i1} \\ \vdots \\ \hat{K}_{iT} \\ \widehat{\left(\frac{P_{i1}Q_{i1}}{r_{i1}}\right)} \\ \vdots \\ \widehat{\left(\frac{P_{iT}Q_{iT}}{r_{iT}}\right)} \end{bmatrix} + \mathbf{u}_i$$

or, $\hat{Q}_i = \sigma_{i1} + \sum_{T=2}^{T} \lambda_t D_t + (\omega_i - 1) NK_i + (Z_i - 1) KPQr_i + u_i$ (2.47)

where bold characters denote vectors. $D_t$ is a 2T x 1 indicator vector that has an entry equal to one for period *t*, and zero otherwise.

There are two benefits to stacking the two equations. The first is that the sample size is doubled, which is desirable given the small sample. The second benefit is that it is possible to use the existing theory on panel data regression on a single equation to estimate Equation (2.47), avoiding the complication of estimating a system of panel equations.

### 2.2.6 Instrumental Variables

The instrumental variable procedures are as follows:

First, introduce Equation (2.47) by stacking all industries and years and introducing the growth rates of investment and capital stock as controls for productivity, industry and the year fixed effects. Controls for investment growth rate will reduce the upward bias on industry mark-up. Provided that the growth rate of investment is positively correlated with the growth rate of productivity, then the estimated coefficient on labour input, which represents the industry mark-up, would be consistent.

Second, introduce the ratio of the number of entering firms plus exiting firms divided by total firms in each industry (turnover rate) on the Equation (2.47) of the growth rates of investment and capital stock, this can control industry and year fixed effects. Controlling for the turnover rate will increase the downward bias on the scale coefficients. The fitted value of regression gives one a consistent estimate of survival probability due to productivity growth.

Third, apply the one-year lagged values of all the right-hand side variables as instrumental variables in Equation (2.47). These instrumental variables are already stacked by construction and may not be correlated with the dependent variables.

And finally by regress all the variables together, so with consistent estimates of mark-ups and scale coefficients, the growth rate of industry productivity can be derived according to Equation (2.28) and (2.30).

## 2.3 Data Description and Analysis

This paper utilised the data that has been collected and reported to the Department of Statistics, Malaysia from census of Manufacturing Industries, for the period 1975-1999. The reporting unit for the census is the establishment. An Establishment is defined as "An economic unit that engages, under a single ownership or control, that is, under single legal entity, in one, or predominantly one, kind of economic activity at a single physical location". The number of establishments in the sample ranges from some 3819 establishments in 1975 to 17,570 establishments in 1999. The total number of establishments during the period of study from 1975 to 1999 is 187,193 establishments.

The sample that has been studied was categorised into three size categories of an average establishment. Average establishments refer to as an industry according to the employment size group established by Department of Statistics, Malaysia: 1). "small size industry" (industries on average with less than 50 employees per establishment); 2). "medium size industries" (industries on average with more than 50 but less than 150 employees per establishment) and 3). "large size industries" (industries on average with more than 150 employees per establishment).

Table 2.1, Table 2.2 and Table 2.3 presents the summary of mean values of the main variables that have been used in the computation of traditional primal and dual TFP growth based on Equation (2.25) and Equation (2.26). Table 2.1, Table 2.2 and Table 2.3 tables have also been used to estimate generalised primal and dual TFP growth, returns to scale and mark-up based on Equation (2.42) and Equation (2.43) for small, medium and large size of the industry in Malaysian manufacturing at 5-digit SIC level from 1975-1999. The values represent the average annual growth rates from 1975 to 1999 in percentage terms.

[Table 2.1, 2.2 and 2.3]

Table 2.1
Data at a Glance in Malaysian Manufacturing at 5-digit industry with Small Size Industries

AVERAGE ANNUAL GROWTH RATE (%) OF

| Industry (1) | ln Output Capital Ratio (2) | ln Real Rental Price Ratio (3) | ln Labour Capital Ratio (4) | ln Wage Rental Ratio (5) | ln Capital (6) | ln Revenue Rental Ratio (7) | ln Output (8) |
|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.08 | -0.24 | -0.02 | -0.01 | 0.24 | -0.13 | 0.14 |
| Textiles, Apparel & Leather | -0.01 | -0.33 | -0.02 | -0.04 | 0.24 | -0.19 | 0.17 |
| Wood Products | -0.08 | -0.15 | -0.02 | -0.06 | 0.36 | -0.16 | 0.29 |
| Chemical, Petroleum, Coal, Rubber and Plastics | -0.03 | -0.13 | -0.01 | 0.00 | 0.27 | 0.09 | 0.26 |
| Non-Metallic Mineral Products | -0.16 | 0.05 | -0.06 | 0.03 | 0.44 | 0.30 | 0.28 |
| Metallic Mineral Products | 0.01 | -0.07 | -0.02 | 0.00 | 0.13 | 0.05 | 0.14 |
| Machinery & Equipment | -0.04 | -0.22 | -0.03 | -0.02 | 0.34 | -0.17 | 0.23 |
| Other Manufacturing | -0.03 | -0.14 | -0.01 | -0.01 | 0.14 | -0.05 | 0.12 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

Table 2.2
Data at a Glance in Malaysian Manufacturing at 5-digit industry with Medium Size Industry

| | AVERAGE ANNUAL GROWTH RATE (%) OF | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry (1) | ln Output Capital Ratio (2) | ln Real Rental Price Ratio (3) | ln Labour Capital Ratio (4) | ln Wage Rental Ratio (5) | ln Capital (6) | ln Revenue Rental Ratio (7) | ln Output (8) |
| Food, Beverages and Tobacco | -0.02 | -0.03 | 0.00 | 0.00 | 0.16 | 0.08 | 0.14 |
| Textiles, Apparel & Leather | -0.04 | -0.15 | -0.01 | -0.01 | 0.18 | -0.03 | 0.16 |
| Wood Products | -0.02 | -0.03 | -0.01 | 0.00 | 0.12 | 0.04 | 0.10 |
| Paper Product, Printing and Publishing | -0.04 | -0.06 | -0.01 | 0.00 | 0.19 | 0.06 | 0.15 |
| Chemical, Petroleum, Coal, Rubber and Plastics | -0.11 | -0.08 | -0.01 | 0.00 | 0.23 | 0.03 | 0.13 |
| Non-Metallic Mineral Products | 0.01 | -0.04 | -0.01 | 0.00 | 0.16 | 0.10 | 0.17 |
| Metallic Mineral Products | -0.05 | -0.09 | -0.01 | 0.00 | 0.18 | 0.02 | 0.14 |
| Machinery & Equipment | -0.05 | -0.31 | -0.03 | -0.02 | 0.34 | -0.05 | 0.30 |
| Other Manufacturing | 0.32 | -0.13 | -0.01 | -0.07 | 0.33 | -0.01 | 0.15 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

Table 2.3
Data at a Glance in Malaysian Manufacturing at 5-digit industry with Large Size Industry

AVERAGE ANNUAL GROWTH RATE (%) OF

| Industry (1) | ln Output Capital Ratio (2) | ln Real Rental Price Ratio (3) | ln Labour Capital Ratio (4) | ln Wage Rental Ratio (5) | ln Capital (6) | ln Revenue Rental Ratio (7) | ln Output (8) |
|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.03 | -0.17 | 0.00 | -0.01 | 0.08 | -0.21 | 0.07 |
| Textiles, Apparel & Leather | 0.01 | -0.36 | -0.01 | -0.02 | 0.18 | -0.19 | 0.20 |
| Wood Products | -0.01 | -0.05 | -0.01 | 0.00 | 0.17 | 0.09 | 0.17 |
| Paper Product, Printing and Publishing | -0.04 | -0.08 | -0.35 | 0.03 | 0.17 | 0.13 | 0.26 |
| Chemical, Petroleum, Coal, Rubber and Plastics | -0.07 | -0.10 | -0.01 | 0.00 | 0.21 | 0.01 | 0.14 |
| Non-Metallic Mineral Products | -0.07 | 0.01 | -0.01 | 0.00 | 0.19 | 0.11 | 0.13 |
| Metallic Mineral Products | -0.08 | 0.22 | -0.01 | 0.01 | 0.31 | 0.68 | 0.48 |
| Machinery & Equipment | -0.02 | -0.10 | -0.02 | -0.01 | 0.46 | 0.00 | 0.33 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

Output of an industry is defined as the gross value of output at 5-digit SIC code for each industry, obtained from the Annual Industrial Survey Department of Statistics (Malaysia) and is deflated with the 1989 sectoral Producer Price Index (PPI) in order to get the real value.

Labour is measured by the number of full-time and part-time employees. Salaries and wages paid refer to cash payments, including bonuses, commissions, overtime payments, cost of living allowances and other allowances made to all paid employees during the year in question. In this paper, the assumption of homogeneous labour input is imposed. However, in Section 2.2.3.2, robustness checks of adjustment for labour input have been discussed including period and industry specific effects, thus this will reduce the potential bias of the estimation by adjusting the level of labour efficiency according to the improvement in productivity.

For this paper, capital stock data is not available for Malaysia. Thus, capital input is measured as the value of fixed assets as at the end of a calendar year. Assets cover all goods, new or used, tangible or intangible, that have a normal economic life span of more than one year (e.g. land, building, machinery and equipment, including transport equipment). The values of these fixed assets are deflated with the 1989 sectoral PPI in order to get the real value.

Rental prices are incorporated according to a user costs method. An estimate of the user cost of physical capital, r is thus required. Following Hall and Jorgensen (1967), the following formula is applied:

$$r_t = P_{t-1} + P_t d_t - \left(P_t - P_{t-1}\right)$$

where r is the rental price, P is the price index for new capital goods , q is the net rate of return and d is the rate of depreciation.

The rate of depreciation used is 0.03 for non-residential structures (Hulten and Wyckoff, 1996), 0.0152 for other structures (Fraumeni, 1997), 0.3 for transportation equipment (Hulten and Wyckoff 1996) and 0.12 for other machinery and equipment (Hulten and Wyckoff, 1966). Defining capital income to equal nominal value added less labour compensation, and given information about depreciation, holding gains and capital stock, the net rate of return is estimated residually as:

$$q_t = \frac{capitalincome - \left(P_t d_t - \left(P_t - P_{t-1}\right)\right) K_{t-1}}{P_{t-1} K_{t-1}}$$

where K is the real capital stock and PK the nominal capital stock.

Unless otherwise stated, most of the data needed for the regression has been obtained from various years of the Report of the Department of Statistics, Malaysia.

### 2.3.1 Average Growth of Factor Shares in Value Added

#### 2.3.1.1 Average Growth of factor shares in Value Added for Small, Medium and Large size Industry

Table 2.4, 2.5 and 2.6 presents the time series data and statistics of the average growth of the labour share in value added for small, medium and large size Malaysian manufacturing industries from 1975 to 1999. According to proposition 3, if the factor shares in total revenue are constant, then the growth rate of primal TFP will be equal to the growth rate of dual TFP, even in the presence of MP and/or NCRTS. The t-tests have been used to formally examine the proposition that the factor shares in value added are constant over time. If the factor shares in total revenue have not trend or have not been changing over time, then the ratio growth rate of factor shares in value added will be nil. Subsequently, if t-tests fail to reject a null hypothesis of constant, the factor shares in value added, then this will indicate that the growth rate primal TFP will be equal to the growth rate of dual TFP, even in the presence of MP and/or NCRTS.

The last two columns of Table 2.4, 2.5 and 2.6 presents the value of t-tests and average growth factor shares in value added for small, medium and large size industry. In detail, the last columns of Table 2.4, 2.5 and 2.6 demonstrates a constant average growth of the factor shares in value added. The second last column of Table 2.4, 2.5 and 2.6 presents the value of t-tests and it shows that the constant average growth of the factor shares in value added cannot be rejected for any of the industries in the sample. This indicate that all industries in the sample accept a nil growth in labour and capital shares in total revenue, therefore, the null hypotheses of constant average growth of labour and capital in value added are not being rejected. The last column of Table 2.4, 2.5 and 2.6 shows that the average growth of the labour share in value added ranges from nil to 0.04 percent, showing similar patterns to those that Roeger (1995) has found using U.S.A. manufacturing data.

In addition to providing a support of this hypothesis, according to Roeger (1995) using U.S.A. manufacturing data, the average growth in labour share of all countries is about 0.2 percent. This labour share data is constructed using the UNIDO (United Nations Industrial Development Organisation) data set, which covers manufacturing industries from more than 100 countries from 1965 to 2000. In all countries, growth is not statistically different from zero. Therefore, this is consistent with what Roeger (1995) has found and what this paper will expect from proposition 3.

Furthermore by using the NBER-CES (National Bureau of Economic Research-U.S. Census Bureau's Centre for Economic Studies) manufacturing industry database, which covers 459 4-digit SIC industries, only 24 out of the 459 industries, about 5 percent of the sample, rejected the constant growth of factor share in value added hypothesis. The remaining 95 percent of industries do not reject the constant growth of factor share in value added hypothesis. Therefore, the finding of NBER-CES is consistent with the finding of this paper according to proposition 3.

[Table 2.4, 2.5 and 2.6]

Table 2.4
Average Growth Labour Share in Value Added with Small Size Industry, 1975-1999

| | **1975-1979** | **1981-1985** | **1986-1990** | **1991-1995** | **1996-1999** | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.01 | -0.01 | 0.01 | 0.02 | 0.06 | -0.41 | 0.34 | 0.01 | 0.16 | -0.20 | 0.01 |
| Textiles, Apparel & Leather | -0.02 | 0.03 | 0.00 | 0.07 | 0.01 | -0.31 | 0.32 | 0.02 | 0.16 | -0.36 | 0.02 |
| Wood Products | -0.07 | 0.07 | 0.02 | 0.04 | 0.05 | -0.48 | 0.32 | 0.02 | 0.18 | -0.56 | 0.02 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 0.05 | -0.02 | -0.03 | 0.00 | 0.02 | -0.28 | 0.19 | 0.00 | 0.14 | -0.71 | 0.00 |
| Non-Metallic Mineral Products | 0.05 | -0.05 | 0.06 | -0.01 | 0.13 | -0.49 | 0.83 | 0.03 | 0.29 | -0.33 | 0.03 |
| Metallic Mineral Products | -0.06 | 0.01 | 0.05 | 0.05 | 0.11 | -0.27 | 0.22 | 0.02 | 0.14 | -0.56 | 0.03 |
| Machinery & Equipment | 0.03 | -0.01 | 0.01 | 0.07 | 0.02 | -0.50 | 0.40 | 0.02 | 0.20 | -0.33 | 0.03 |
| Other Manufacturing | 0.04 | -0.02 | 0.02 | -0.05 | 0.10 | -0.52 | 0.35 | 0.01 | 0.20 | -0.73 | 0.01 |

Table 2.5
Average Growth Labour Share In Value Added with Medium Size Industry, 1975-1999

| | **1975-1979** | **1981-1985** | **1986-1990** | **1991-1995** | **1996-1999** | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.01 | 0.02 | 0.01 | 0.01 | 0.06 | -0.37 | 0.44 | 0.02 | 0.20 | -0.33 | 0.02 |
| Textiles, Apparel & Leather | -0.07 | 0.03 | 0.01 | 0.09 | 0.03 | -0.33 | 0.46 | 0.02 | 0.19 | -0.76 | 0.02 |
| Wood Products | 0.05 | -0.01 | 0.06 | 0.04 | -0.01 | -0.27 | 0.30 | 0.03 | 0.14 | -0.05 | 0.03 |
| Paper Product, Printing and Publishing | 0.01 | 0.03 | 0.03 | 0.05 | 0.02 | -0.30 | 0.30 | 0.03 | 0.13 | 0.09 | 0.03 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 0.04 | 0.00 | 0.01 | 0.05 | 0.00 | -0.36 | 0.44 | 0.02 | 0.19 | -0.01 | 0.03 |
| Non-Metallic Mineral Products | 0.06 | -0.06 | 0.03 | 0.06 | 0.05 | -0.53 | 0.43 | 0.03 | 0.19 | -0.71 | 0.03 |
| Metallic Mineral Products | -0.03 | -0.13 | 0.04 | 0.08 | 0.10 | -0.54 | 0.29 | 0.00 | 0.18 | 0.30 | 0.00 |
| Machinery & Equipment | 0.04 | -0.01 | 0.00 | 0.03 | 0.04 | -0.40 | 0.44 | 0.02 | 0.20 | -0.16 | 0.02 |
| Other Manufacturing | -0.09 | -0.05 | 0.08 | 0.08 | 0.08 | -0.38 | 0.57 | 0.02 | 0.23 | -1.19 | 0.02 |

Table 2.6
Average Growth Labour Share In Value Added with Large Size Industry, 1975-1999

| | 1975-1979 | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1999 | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | 0.09 | -0.07 | 0.06 | 0.01 | 0.02 | -0.54 | 0.51 | 0.02 | 0.28 | 0.08 | 0.02 |
| Textiles, Apparel & Leather | -0.09 | -0.02 | 0.00 | 0.08 | 0.05 | -0.62 | 0.44 | 0.00 | 0.23 | -0.85 | 0.00 |
| Wood Products | 0.11 | -0.07 | 0.02 | 0.05 | 0.09 | -0.24 | 0.51 | 0.03 | 0.15 | 1.34 | 0.04 |
| Paper Product, Printing and Publishing | 0.03 | 0.09 | 0.09 | -0.06 | -0.17 | -0.37 | 0.35 | 0.01 | 0.20 | 0.27 | 0.02 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 0.02 | 0.02 | 0.01 | 0.03 | 0.01 | -0.51 | 0.52 | 0.02 | 0.24 | -0.20 | 0.02 |
| Non-Metallic Mineral Products | 0.06 | -0.06 | 0.09 | 0.10 | -0.25 | -0.59 | 0.54 | 0.01 | 0.26 | -0.41 | 0.02 |
| Metallic Mineral Products | 0.05 | -0.11 | 0.06 | 0.06 | 0.02 | -0.60 | 0.51 | 0.02 | 0.25 | -1.53 | 0.02 |
| Machinery & Equipment | 0.00 | 0.03 | 0.00 | 0.02 | 0.04 | -0.44 | 0.41 | 0.02 | 0.20 | 0.12 | 0.02 |

### 2.3.2 Decomposition and Estimation of TFP growth

#### 2.3.2.1 Decomposition and estimation of TFP growth for small size industry

The primary purpose of this paper is to decompose the sources of traditional primal and dual TFP and generalised primal and dual TFP growth into scale and mark-up effects in the hope of isolating a better measure of technical progress. The decomposition of traditional primal and dual TFP is carried out using Equations (2.25) and (2.26) from the theoretical part of the paper in Section 2.2, respectively. The results are presented in columns 2 and 3 of Table 2.7.1.

In columns 2 and 3 of Table 2.7.1, the traditional primal and dual TFP growth measures (Solow framework) are presented where TFP is measured under the assumptions of CRTS and PC. In columns 4 and 5 of Table 2.7.1, the adjusted primal and dual TFP growth is presented where TFP is OLS estimated using Equation (2.42) and Equation (2.43) under the assumptions of CRTS and MP.

Meanwhile in column 6 and 7 of Table 2.7.1, the generalised primal and dual TFP growth is presented where TFP growth is also OLS estimated using Equation (2.42) and (2.43) but under the assumptions of NCRTS and MP.

By stacking both regressions together (Equation (2.45) and Equation (2.46)) to estimate primal and dual TFP growth jointly (Equation (2.47)) using GMM estimation regression, the result is presented in column 8 and 9, however in column 8, TFP is estimated under the assumptions of CRTS and MP but in column 9, TFP is estimated under the assumptions of NCRTS and MP.

A comparison of the different TFP growth measures (columns 2, 3, 6, and 7) in Table 2.7.1 reveals that the contributions for the different biases resulting from scale and mark-up are statistically important. By comparing columns 2 and 3 with columns 6 and 7, respectively, the traditional primal and dual TFP growth underestimate the generalised primal and dual TFP growth when relaxing the assumptions of NCRTS and MP. This finding is provide a support to the propositions 1 and 2, that the growth rate of traditional primal and dual TFP will be less than the growth rate of generalised primal and dual TFP, respectively.

To further illustrate the relationship between the traditional primal and dual TFP, and the generalised primal and dual TFP, this paper has constructed a scatter diagram to present the relationship by plotting these two measurements against each other. The scatter diagrams are as presented in Figure 2.1 and Figure 2.2. The scatter diagram in Figure 2.1 clearly indicates that the relationship between the traditional primal and dual TFP is robustly (positively) related with correlation coefficient of 0.96, 0.95 and 0.99 for small, medium and large size industry as shown in Table 2.7.2, Table 2.8.2 and Table 2.9.2. Second, a similar pattern can also be observed in the relationship between the generalised primal and dual TFP as shown in Figure 2.2 for small, medium and large size industry with correlation coefficient of 0.98, 0.99 and 0.99 as indicated in Table 2.7.3, Table 2.8.3 and Table 2.9.3. Third, Figure 2.1 and Figure 2.2 also show that how many industries are below, above or on the 45 degree line between traditional primal and dual TFP estimation, and generalised primal and dual TFP estimation. Fourth, Figure 2.1 and Figure 2.2 also show there is not a consistent tendency for the primal TFP to produce higher or lower estimates than the dual TFP in either traditional or generalised cases. The finding from the scatter diagram and correlation coefficient indicates that scale and mark-up magnitude is important in determining the rate of TFP growth. This finding is in line with Hall (1988), Roeger (1995) and Basu & Fernald (1997) in their study.

Moreover, the first observation from Table 2.7.1 is that the differences between traditional primal and dual TFP growth (columns 2 and 3) and generalised primal and dual TFP growth (columns 6 and 7) are almost negligible, which is evident from proposition 3, since factor shares in value added have been relatively constant.

The second observation from Table 2.7.1 is that by relaxing assumption of NCRTS and MP, the estimated growth rates of generalised primal and dual TFP growth (columns 6 and 7) are higher than the traditional growth rates of primal and dual TFP growth (columns 2 and 3). This indicates the important contribution of returns to scale and the mark-up to the rate of TFP growth. This finding is also consistent with Hall (1988), Roeger (1995) and Basu & Fernald (1997) in which they have found that MP and NCRTS are important in determine TFP growth and may cause biases in the TFP growth accounting.

The third observation from Table 2.7.1, Table 2.7.2, and Table 2.7.3 as we move from small to medium to large scale firms and beyond are that the difference between traditional primal and dual TFP growth (column 2 and 3) and generalised primal and dual TFP growth (column 6 and 7) are also negligible. This is due to the factor shares in value added have also been relatively constant. Furthermore by relaxing assumption of NCRTS and MP, the estimated growth rates of generalised primal and dual TFP growth (column 6 and 7) are higher than the traditional growth rates of primal and dual TFP (column 2 and 3). This is as a result of the important contribution of RTS and the mark-up to the growth rate of TFP. This finding is also coherent with Hall (1988), Roeger (1995) and Basu and Fernald (1997).

The fourth observation from Table 2.7.1 is that, first by controlling the endogeneity problem as well as period and industry fixed effects and white noise arising from Equation (2.42) and Equation (2.43) using OLS regression. And second by stacking both regressions together (Equation (2.45) and Equation (2.46)) to jointly estimate growth rates of TFP (Equation (2.47)) using GMM estimation, the estimated growth rate of TFP presented in columns 8 and 9 are substantially lower than OLS regression in column 6 and 7. The finding of this paper is consistent with Marschak and Andrew (1944), that an OLS regression of output in inputs will give inconsistent estimates of the production function coefficients due to the endogeneity problem.

[Table 2.7.1, Table 2.7.2 and Table 2.7.3]

[Figure 2.1 and 2.2]

Table 2.7.1
Decomposition of TFP growth in Malaysia Manufacturing Industry with Small Size Industry:1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.02 | -0.02 | 0.06 | 0.07 | 0.06 | 0.06 | 0.03 | 0.04 |
| Textiles, Apparel & Leather | -0.02 | -0.03 | 0.07 | 0.08 | 0.09 | 0.11 | 0.04 | 0.05 |
| Wood Products | -0.01 | -0.02 | 0.06 | 0.06 | 0.04 | 0.05 | 0.03 | 0.04 |
| Chemical, Petroleum, Coal, Rubber and Plastics | -0.03 | -0.03 | 0.04 | 0.04 | 0.13 | 0.14 | 0.00 | 0.00 |
| Non-Metallic Mineral Products | -0.02 | -0.02 | 0.10 | 0.10 | 0.08 | 0.09 | 0.02 | 0.02 |
| Metallic Mineral Products | -0.05 | -0.06 | 0.06 | 0.06 | 0.03 | 0.04 | 0.00 | 0.00 |
| Machinery & Equipment | -0.04 | -0.04 | 0.05 | 0.05 | 0.07 | 0.08 | 0.02 | 0.02 |
| Other Manufacturing | -0.02 | -0.02 | 0.07 | 0.07 | 0.07 | 0.07 | 0.00 | 0.01 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

Table 2.7.2
Correlation Coefficient between Traditional Primal TFP and Traditional Dual TFP

| | Traditional Primal TFP(Small Size Industry) | Traditional Dual TFP(Small Size Industry) |
|---|---|---|
| Traditional Primal TFP(Small Size Industry) | 1.00 | 0.963*** |
| Traditional Dual TFP(Small Size Industry) | 0.963*** | 1.00 |
| Number of Observations | 35 | 35 |

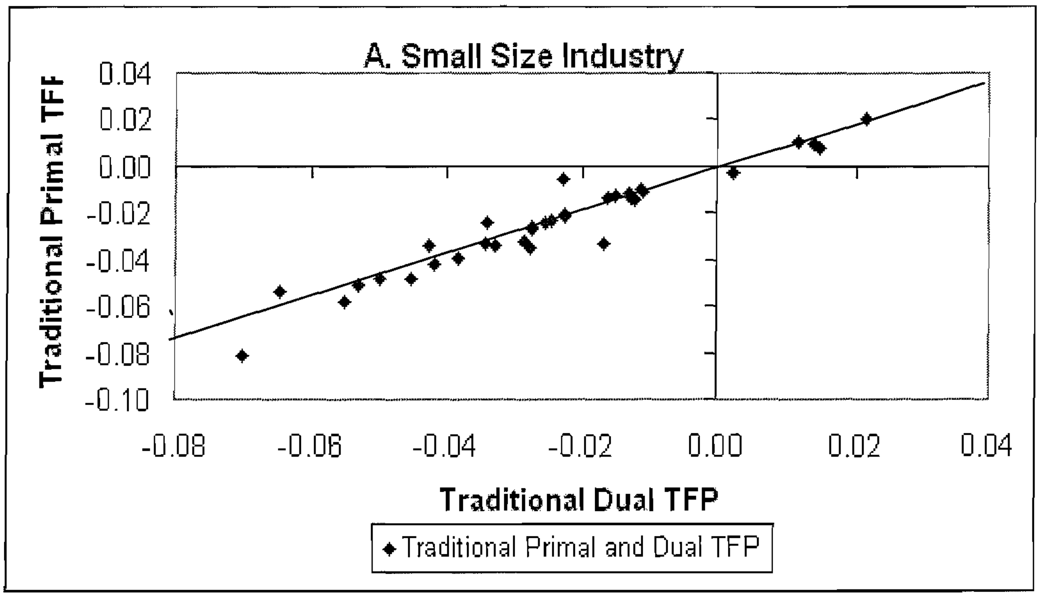
*** correlation is significant at the 0.01 level

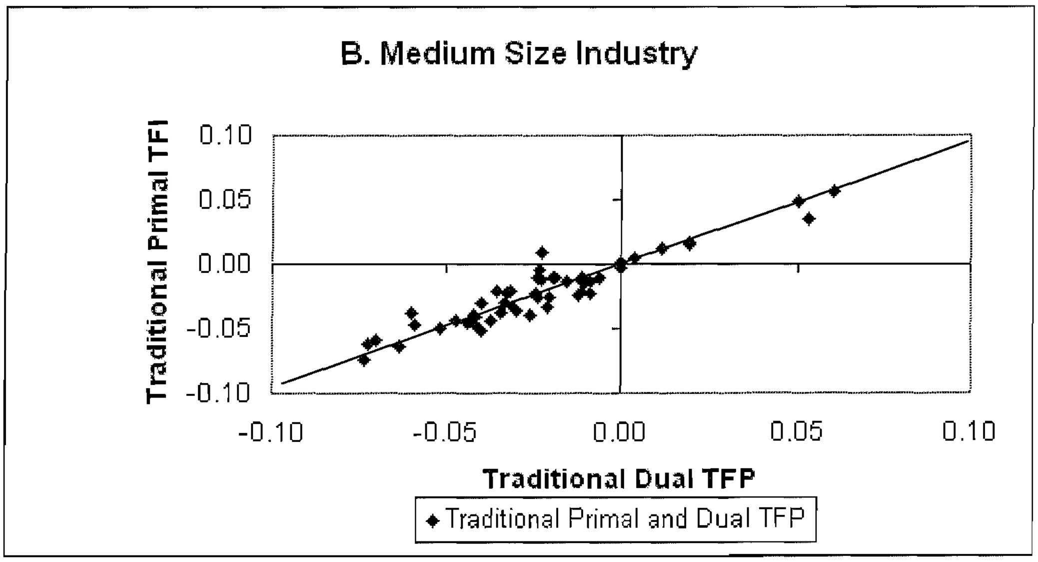
Table 2.7.3
Correlation Coefficient between Generalised Primal TFP and Generalised Dual TFP

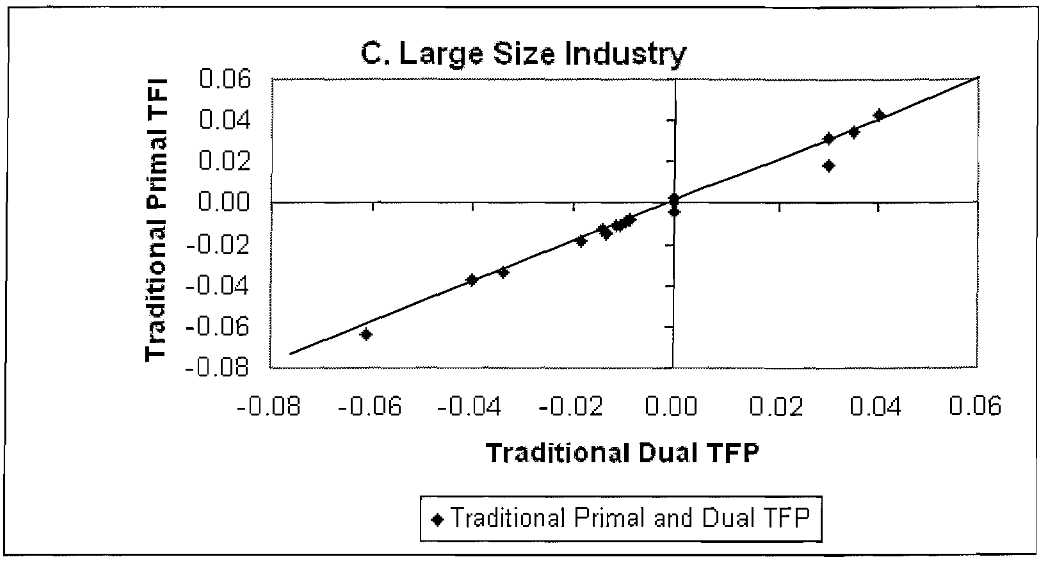
| | Generalised Primal TFP(Small Size Industry) | Generalised Dual TFP(Small Size Industry) |
|---|---|---|
| Generalised Primal TFP(Small Size Industry) | 1.00 | 0.984*** |
| Generalised Dual TFP(Small Size Industry) | 0.984*** | 1.00 |
| Number of Observations | 35 | 35 |

*** correlation is significant at the 0.01 level

Figure 2.1: Traditional Primal and Dual TFP in Malaysian Manufacturing at 5-digit Industry and size of the industry




C. Large Size Industry
Traditional Primal TFI
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06
Traditional Dual TFP
◆ Traditional Primal and Dual TFP

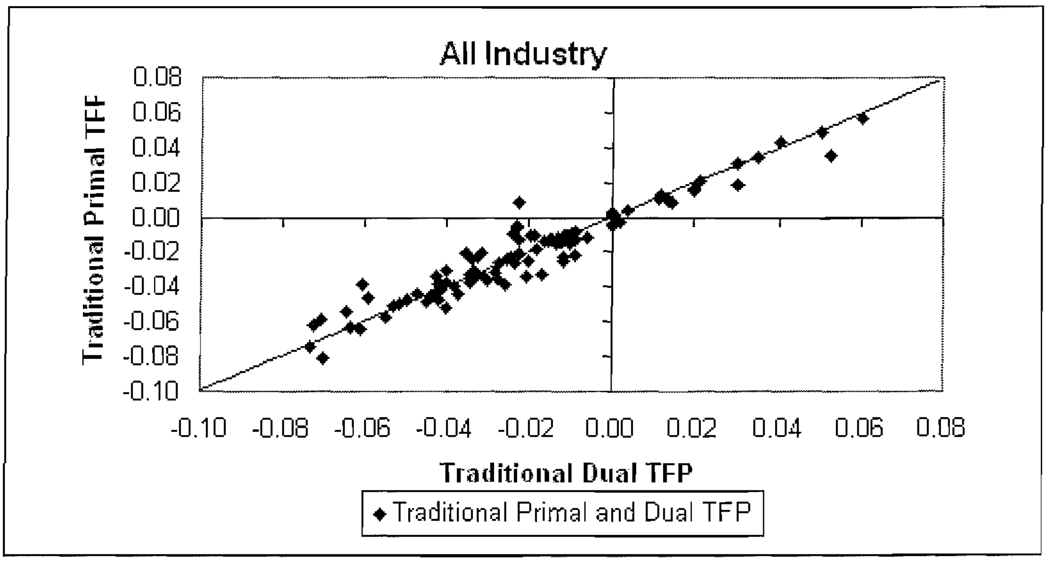
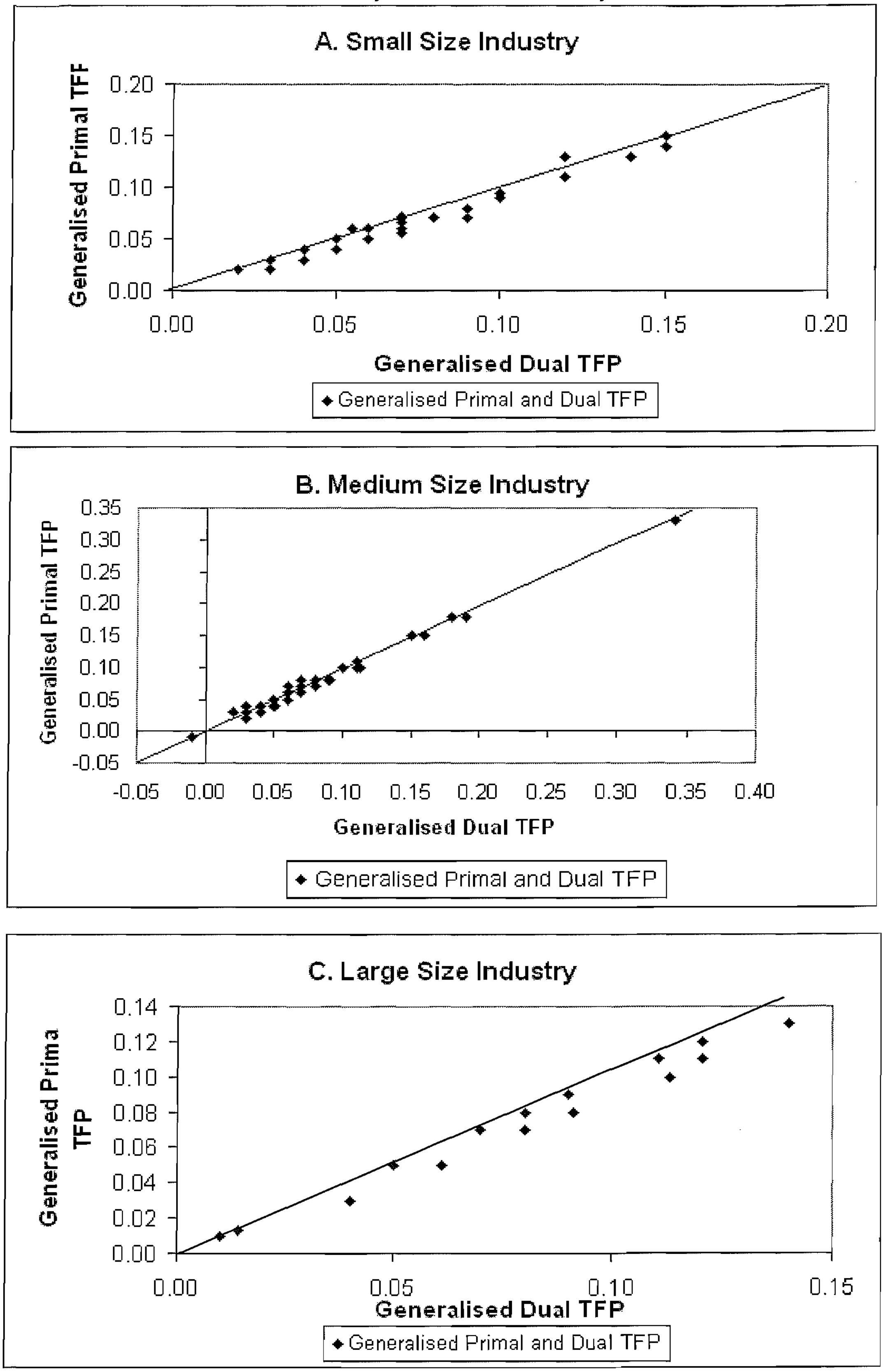
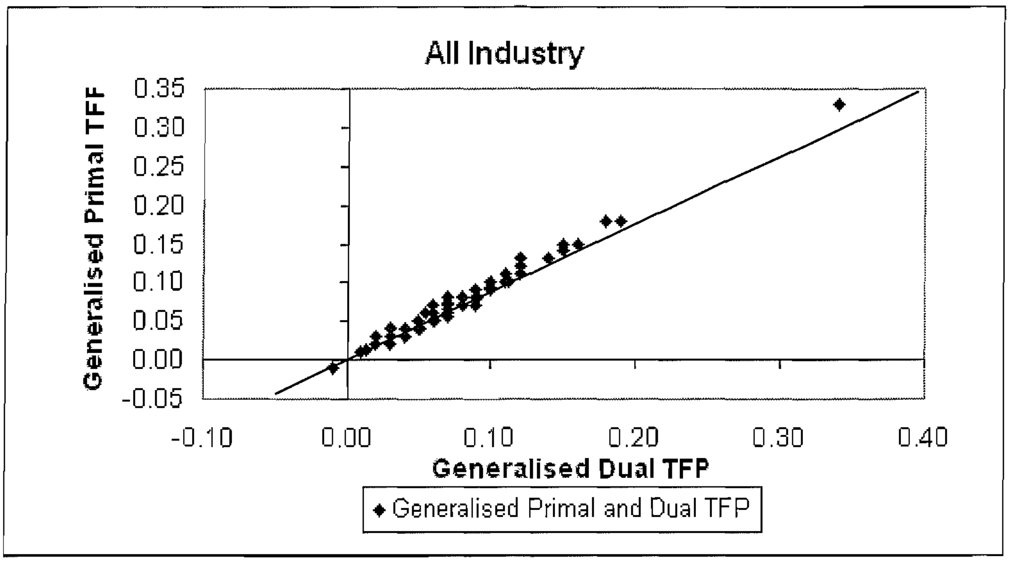

All Industry
Traditional Primal TFF
0.08
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
-0.10 -0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06 0.08
Traditional Dual TFP
◆ Traditional Primal and Dual TFP

Figure 2.2: Generalised Primal and Dual TFP in Malaysian Manufacturing at 5-digit Industry and size of the industry





All Industry
Generalised Primal TFF
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.05
-0.10
0.00
0.10
0.20
0.30
0.40
Generalised Dual TFP
◆ Generalised Primal and Dual TFP

#### 2.3.2.2 Decomposition and estimation of TFP growth for medium size industry

The decomposition of traditional primal and dual TFP is also carried out by using Equation (2.25) and Equation (2.26) from the theoretical part of the paper in Section 2.2, respectively. The results are presented in column 2 and 3 of Table 2.8.1.

In columns 2 and 3 of Table 2.8.1, the traditional primal and dual TFP growths (Solow framework) are presented where TFP is measured under the assumptions of CRTS and PC. In columns 4 and 5 of Table 2.8.1, the adjusted primal and dual TFP growth is presented where TFP has been obtained from the OLS estimation by using Equation (2.42) and Equation (2.43) under the assumptions of CRTS and MP.

Meanwhile in columns 6 and 7 of Table 2.8.1, the generalised primal and dual TFP growth is presented where TFP growth is also estimated using Equation (2.42) and Equation (2.43) but under the assumptions of NCRTS and MP.

By stacking both regression together (Equation (2.45) and Equation (2.46)) to estimate primal and dual TFP growth jointly (Equation (2.47)) using GMM estimation regression, the results are presented in columns 8 and 9 of Table 2.8.1, however in columns 8, TFP is estimated under the assumptions of CRTS and MP but in columns 9, TFP is estimated under the assumptions of NCRTS and MP.

Table 2.8.1 illustrates a similar finding as compared to Table 2.7.1 if comparing the TFP growth by using traditional primal or dual TFP and generalised primal or dual approaches. This indicates that the traditional primal and dual TFP (columns 2 and 3) underestimate the rate of TFP growth for generalised primal and dual TFP (columns 6 and 7) in the presence of MP and NCRTS as evident from propositions 1 and 2. [Table 2.8.1, Table 2.8.2 and Table 2.8.3]

Table 2.8.1
Decomposition of TFP growth in Malaysia Manufacturing Industry with Medium Size Industry: 1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.03 | -0.03 | 0.05 | 0.06 | 0.07 | 0.08 | 0.04 | 0.04 |
| Textiles, Apparel & Leather | -0.02 | -0.02 | 0.06 | 0.08 | 0.08 | 0.08 | 0.04 | 0.04 |
| Wood Products | -0.01 | 0.00 | 0.03 | 0.04 | 0.05 | 0.05 | 0.00 | 0.01 |
| Paper Product, Printing and Publishing | -0.03 | -0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.02 | 0.02 |
| Chemical, Petroleum, Coal, Rubber and Plastics | -0.03 | -0.03 | 0.04 | 0.05 | 0.06 | 0.06 | 0.01 | 0.01 |
| Non-Metallic Mineral Products | -0.02 | -0.03 | 0.05 | 0.06 | 0.05 | 0.05 | 0.00 | 0.01 |
| Metallic Mineral Products | -0.05 | -0.06 | 0.04 | 0.05 | 0.08 | 0.09 | 0.00 | 0.00 |
| Machinery & Equipment | -0.01 | -0.01 | 0.07 | 0.08 | 0.09 | 0.09 | 0.02 | 0.02 |
| Other Manufacturing | -0.05 | -0.05 | 0.05 | 0.06 | 0.19 | 0.20 | 0.02 | 0.02 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

Table 2.8.2
Correlation Coefficient between Traditional Primal TFP and Traditional Dual TFP

| | Traditional Primal TFP (Medium Size Industry) | Traditional Dual TFP (Medium Size Industry) |
|---|---|---|
| Traditional Primal TFP (Medium Size Industry) | 1.00 | 0.947*** |
| Traditional Dual TFP (Medium Size Industry) | 0.947*** | 1.00 |
| Number of Observations | 51 | 51 |

*** correlation is significant at the 0.01 level

Table 2.8.3
Correlation Coefficient between Generalised Primal TFP and Generalised Dual TFP

| | Generalised Primal TFP (Medium Size Industry) | Generalised Dual TFP (Medium Size Industry) |
|---|---|---|
| Generalised Primal TFP (Medium Size Industry) | 1.00 | 0.993*** |
| Generalised Dual TFP (Medium Size Industry) | 0.993*** | 1.00 |
| Number of Observations | 51 | 51 |

*** correlation is significant at the 0.01 level

#### 2.3.2.3 Decomposition and estimation of TFP growth for large size industry

The decomposition of traditional primal and dual TFP has also been computed by using Equation (2.25) and Equation (2.26) of Section 2.2, respectively. The results are presented in columns 2 and 3 of Table 2.9.1. In detail, columns 2 and 3 of Table 2.9.1 present the traditional primal and dual TFP growth (Solow framework) that measured under the assumptions of CRTS and PC. Meanwhile, in columns 4 and 5 of Table 2.9.1 the adjusted primal and dual TFP growth are presented, however, in this case the TFP growth was obtained from the OLS estimation based on Equation (2.42) and Equation (2.43), and also under the assumptions of CRTS and MP.

The generalised primal and dual TFP growth is presented in columns 6 and 7 of Table 2.9.1. The generalised primal and dual in columns 6 and 7 provides the TFP growth from the OLS estimation based on Equation (2.42) and Equation (2.43). The estimations have been carried out assuming NCRTS and MP.

In order to overcome the problem of endogeneity in OLS estimation, the regression has also been conducted by stacking both regression together as suggested by Olley and Pakes (1996). To do this, this paper has jointly estimated primal and dual TFP growth as in the Equation (2.45) and Equation (2.46) by using GMM estimation based on Equation (2.47). The results from estimation are presented in columns 8 and 9 of Table 2.9.1. In columns 8 of Table 2.9.1, TFP is estimated under the assumptions of CRTS and MP but, in columns 9, TFP is estimated under the assumptions of NCRTS and MP.

Comparing the results of Table 2.9.1 to Table 2.7.1 and Table 2.8.1, respectively, clearly shows that all estimations produce a similar pattern of the TFP growth. Specifically, the traditional primal and dual TFP (columns 2 and 3) underestimate the rate of TFP growth for generalised primal and dual TFP (columns 6 and 7) in the presence of MP and NCRTS. This finding provides evidence to support propositions 1 and 2 that the growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP and the growth rate of traditional dual TFP will be less than the growth rate of generalised dual TFP, respectively. This is consistent in what Roeger (1995) and Hall (1988) have found in their study by relaxing MP and preserving CRTS and what this paper will expect from propositions 1 and 2 by relaxing both MP and NCRTS assumptions.

[Table 2.9.1, Table 2.9.2 and Table 2.9.3]

Table 2.9.1
Decomposition of TFP growth in Malaysia Manufacturing Industry with Large Size Industry: 1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.03 | -0.03 | 0.04 | 0.05 | 0.03 | 0.03 | 0.01 | 0.02 |
| Textiles, Apparel & Leather | 0.02 | 0.02 | 0.06 | 0.06 | 0.08 | 0.08 | 0.01 | 0.02 |
| Wood Products | 0.00 | 0.00 | 0.06 | 0.06 | 0.07 | 0.07 | 0.00 | 0.00 |
| Paper Product, Printing and Publishing | -0.01 | -0.01 | 0.09 | 0.10 | 0.11 | 0.12 | 0.02 | 0.03 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 0.00 | 0.00 | 0.03 | 0.04 | 0.10 | 0.11 | 0.01 | 0.02 |
| Non-Metallic Mineral Products | -0.06 | -0.06 | 0.02 | 0.03 | 0.05 | 0.05 | 0.01 | 0.01 |
| Metallic Mineral Products | -0.01 | -0.01 | 0.09 | 0.10 | 0.13 | 0.13 | 0.05 | 0.05 |
| Machinery & Equipment | 0.00 | 0.00 | 0.06 | 0.07 | 0.06 | 0.06 | 0.03 | 0.03 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

Table 2.9.2
Correlation Coefficient between Traditional Primal TFP and Traditional Dual TFP

| | Traditional Primal TFP (Large Size Industry) | Traditional Dual TFP (Large Size Industry) |
|---|---|---|
| Traditional Primal TFP (Large Size Industry) | 1.00 | 0.990*** |
| Traditional Dual TFP (Large Size Industry) | 0.990*** | 1.00 |
| Number of Observations | 18 | 18 |

*** correlation is significant at the 0.01 level

Table 2.9.3
Correlation Coefficient between Generalised Primal TFP and Generalised Dual TFP

| | Generalised Primal TFP (Large Size Industry) | Generalised Dual TFP (Large Size Industry) |
|---|---|---|
| Generalised Primal TFP (Large Size Industry) | 1.00 | 0.990*** |
| Generalised Dual TFP (Large Size Industry) | 0.990*** | 1.00 |
| Number of Observations | 18 | 18 |

*** correlation is significant at the 0.01 level

### 2.3.3 Estimation of Returns to scale and Mark-up

#### 2.3.3.1 Estimation of returns to scale and the mark-up for small size industry

The generalised primal and dual returns to scale and mark-up, and adjusted primal and dual mark-up have been estimated by using Equation (2.42) and Equation (2.43) of Section 3.4, and Equation (2.47) of Section 3.5. The results are presented in Table 2.10.1. Columns 2, 3, 4 and 5 of Table 2.10.1 present estimated values of the generalised primal and dual mark-up, and generalised primal and dual returns to scale under the assumption of NCRTS and MP. Columns 6, 7 and 8 of Table 2.10.1 provides estimates of the adjusted primal and dual mark-up, and the combination adjusted primal-dual mark-up under the assumptions of CRTS and MP. Meanwhile, in columns 9 and 10, the estimation that combined both generalised primal and dual is presented. The estimations are based on Equation (2.47) and under the assumptions of NCRTS and MP.

With regard to mark-up, close inspection of statistics in Table 2.10.1 shows that, in almost all cases, the estimation values of the mark-up are greater than one. This indicates that small size industries in the sample are operating in the MP environment. This finding provides evidence to support propositions 1 and 2, that the growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP and the growth rate of traditional dual TFP will be less than the growth rate of generalised dual TFP. The finding from this study is consistent with the finding from Roeger (1995) and Hall (1988), which found that the primal and dual of Solow's residual can be used to estimate mark-up precisely.

Columns 3, 5 and 10 of Table 2.10.1 present the estimation results of generalised primal and dual returns to scale and combination of generalised primal-dual returns to scale that were estimated based on Equation (2.42), Equation (2.43) and Equation (2.47) in Section 2.2.4 and 2.2.5, respectively. The results in columns 3, 5 and 10 demonstrate a mixed result. In some cases, there is evidence of increasing returns to scale, whilst in other cases there is evidence of decreasing returns to scale. One of the important empirical outcomes of this exercise is the finding that small firms in many manufacturing sectors on average tend to display decreasing returns to scale. This finding is in line with the empirical literature on small firms which generally finds that such firms tend to operate with decreasing returns to scale. Although some industries in the sample show decreasing or increasing returns to scale, the result shows that it does not contradict propositions 1 and 2. This is due to the fact that the growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP and the growth rate of traditional dual TFP will be less than the growth rate of generalised dual TFP if returns to scale are less or more than 1. Therefore, the finding of this paper coincides with propositions 1 and 2.

Moreover, another related and relevant question that could be addressed in the context of this paper is whether there exists any relation between the estimated values of generalised primal mark-up and generalised primal returns to scale, and generalised dual mark-up and generalised dual returns to scale. To test this relationship, scatter diagrams have been plotted in Figure 2.3 and Figure 2.4 for the small, medium, and large size industries in panel A, B, C and all industries. The scatter diagram in Figure 2.3 and Figure 2.4 shows there is a robust (positive) correlation between returns to scale and mark-up. Notably, the relation is present for all categories of industry and in all these cases its shape is similar. This is in line with the theoretical prior and also confirms the theoretical prediction of Basu and Fernald (1997) that returns to scale and mark-up should be strongly (positively) correlated. Table 2.10.2, Table 2.11.2 and Table 2.12.2 show that correlation coefficient between generalised primal mark-up and generalised primal returns to scale is 0.26, 0.57 and 0.63 for small, medium and large size industry. In Table 2.10.3, Table 2.11.3 and Table 2.12.3 also show that correlation coefficient between generalised dual mark-up and generalised dual returns to scale is 0.19, 0.29 and 0.41.

[Table 2.10.1, Table 2.10.2 and Table 2.10.3]

[Figure 2.3 and 2.4]

Table 2.10.1
Returns to scale and Mark-ups for Malaysian Manufacturing Industry with Small Size Industry

| Industry (1) | Generalised Primal Markup[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Markup[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup (Hall)[b] (6) | Adjusted Dual Markup (Roeger)[b] (7) | Adjusted Primal & Dual Markup (Roeger)[b] (8) | Generalised Primal & Dual Markup[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | 1.36 | 0.83 | 1.46 | 0.75 | 1.52 | 1.63 | 1.62 | 1.47 | 0.87 |
| Textiles, Apparel & Leather | 1.77 | 0.91 | 1.60 | 0.69 | 1.63 | 1.75 | 1.62 | 1.59 | 0.71 |
| Wood Products | 1.66 | 0.99 | 1.70 | 0.66 | 1.40 | 1.59 | 1.76 | 1.63 | 0.52 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 1.45 | 0.72 | 1.55 | 0.70 | 1.63 | 1.72 | 1.81 | 1.35 | 0.44 |
| Non-Metallic Mineral Products | 1.34 | 1.15 | 1.85 | 1.12 | 1.53 | 1.65 | 1.84 | 1.74 | 1.15 |
| Metallic Mineral Products | 1.94 | 1.45 | 1.19 | 1.27 | 1.57 | 1.05 | 1.86 | 1.38 | 1.66 |
| Machinery & Equipment | 1.46 | 0.97 | 1.66 | 1.01 | 1.65 | 1.62 | 1.70 | 1.38 | 0.79 |
| Other Manufacturing | 1.58 | 0.72 | 1.77 | 0.43 | 1.83 | 1.92 | 1.49 | 1.80 | 0.78 |

Note: [a] Generalised Mark-up and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Mark-up and Returns to Scale assume existing market power and constant returns to scale

Table 2.10.2
Correlation Coefficient between Generalised Primal Mark-up and Generalised Primal Returns to Scale

| | Generalised Primal Mark-up (Small Size Industry) | Generalised Primal Returns to Scale (Small Size Industry) |
|---|---|---|
| Generalised Primal Mark-up (Small Size Industry) | 1.00 | 0.258** |
| Generalised Primal Returns to Scale (Small Size Industry) | 0.258** | 1.00 |
| Number of Observations | 35 | 35 |

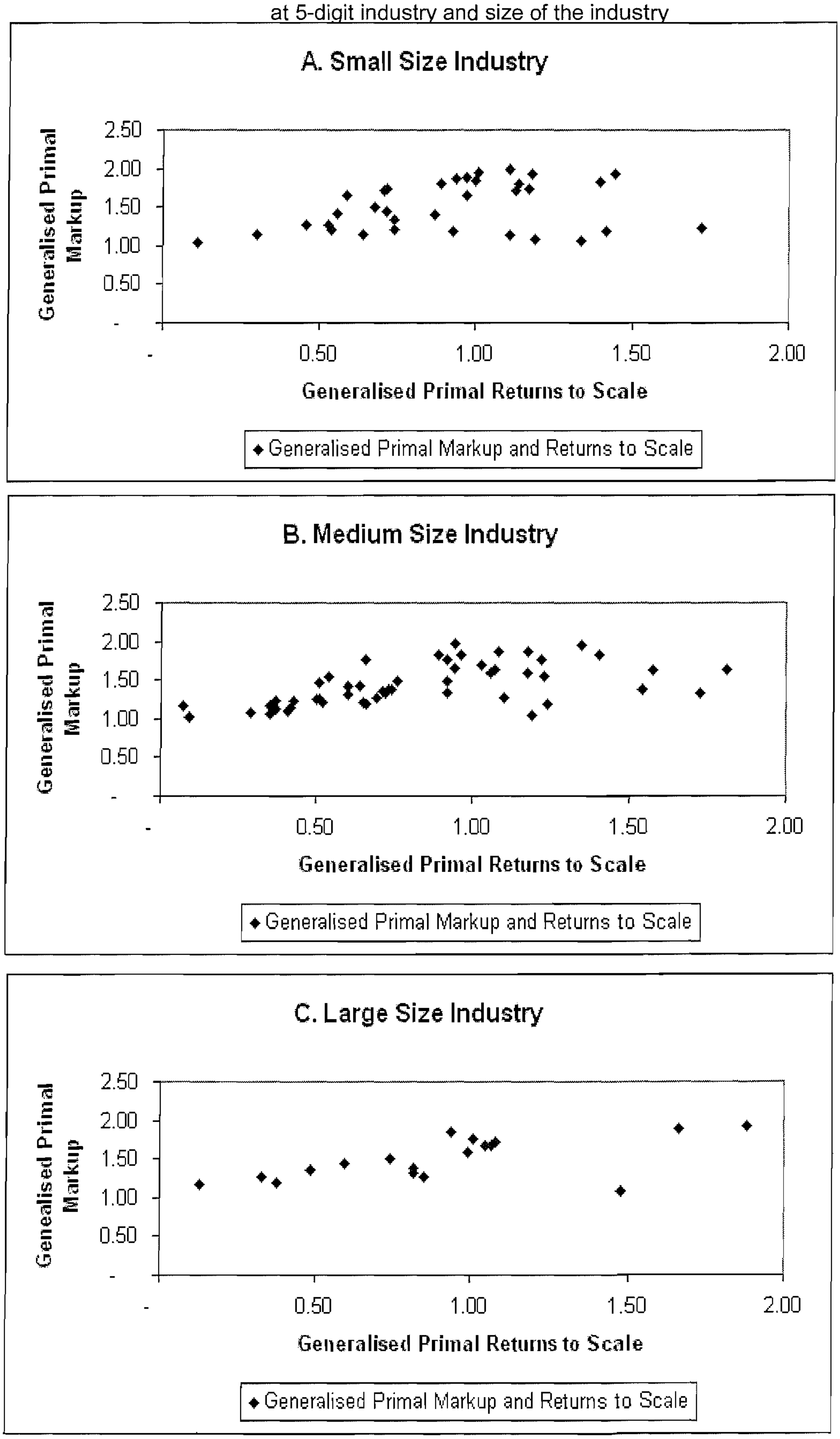
** correlation is significant at the 0.05 level

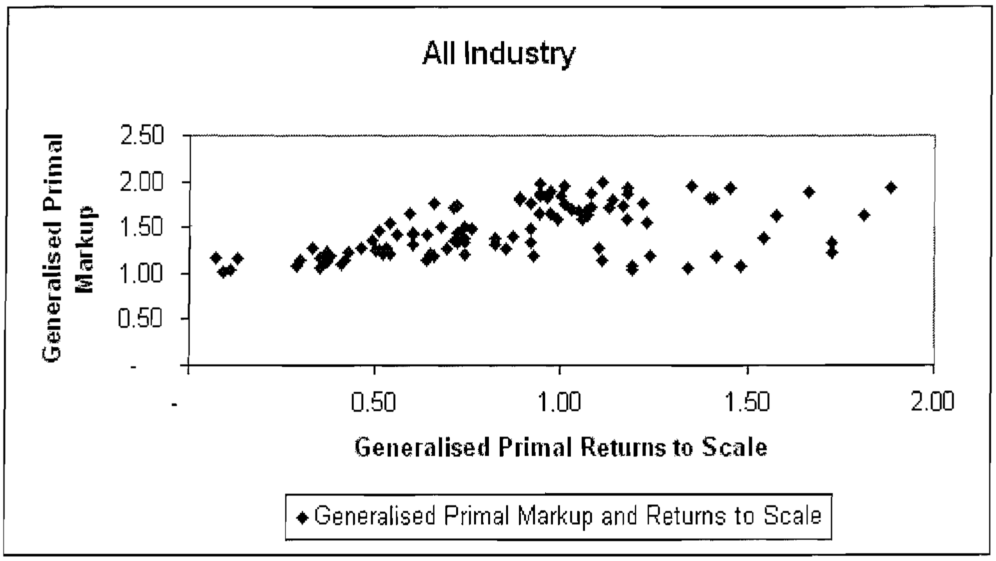
Table 2.10.3
Correlation Coefficient between Generalised Dual Mark-up and Generalised Dual Returns to Scale

| | Generalised Dual Mark-up (Small Size Industry) | Generalised Dual Returns to Scale (Small Size Industry) |
|---|---|---|
| Generalised Dual Mark-up (Small Size Industry) | 1.00 | 0.194** |
| Generalised Dual Returns to Scale (Small Size Industry) | 0.194** | 1.00 |
| Number of Observations | 35 | 35 |

** correlation is significant at the 0.05 level

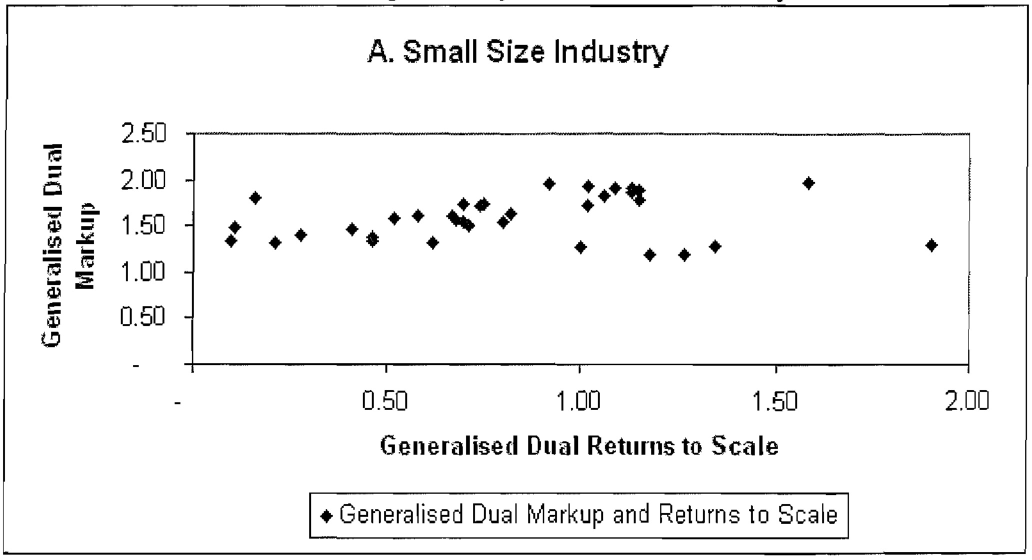
Figure 2.3:Generalised Primal Mark-up and Returns to Scale in Malaysian manufacturing at 5-digit industry and size of the industry

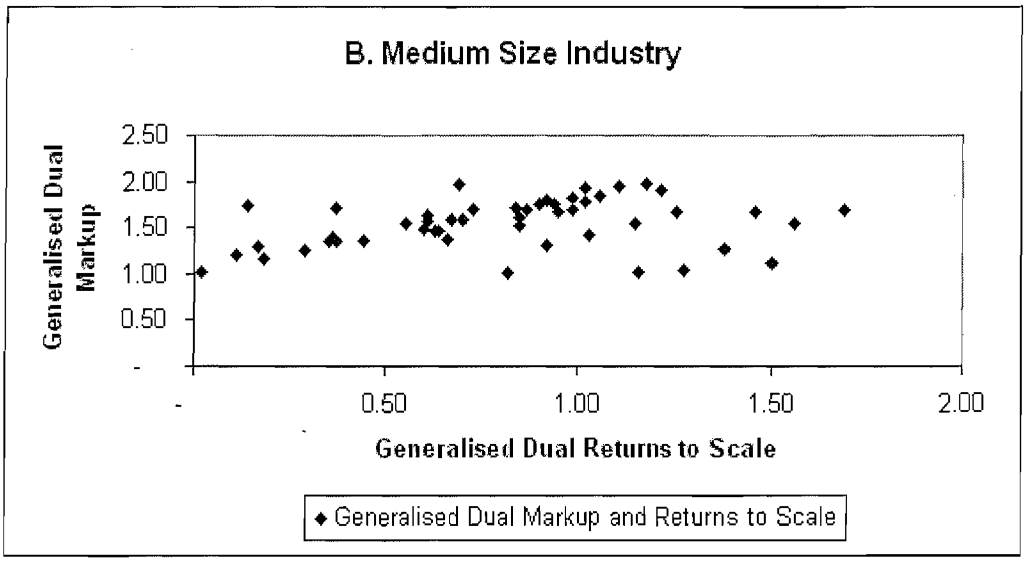


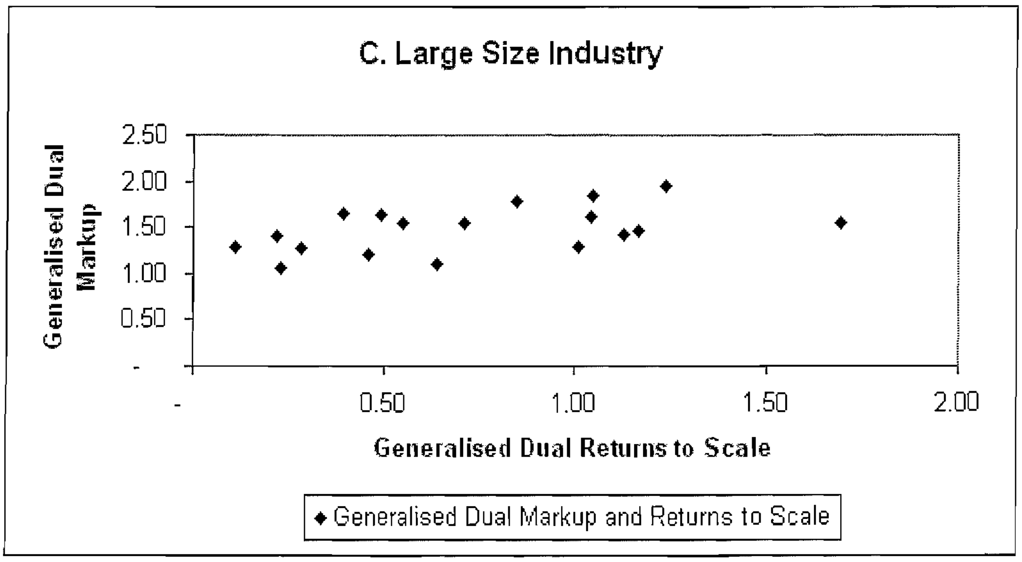


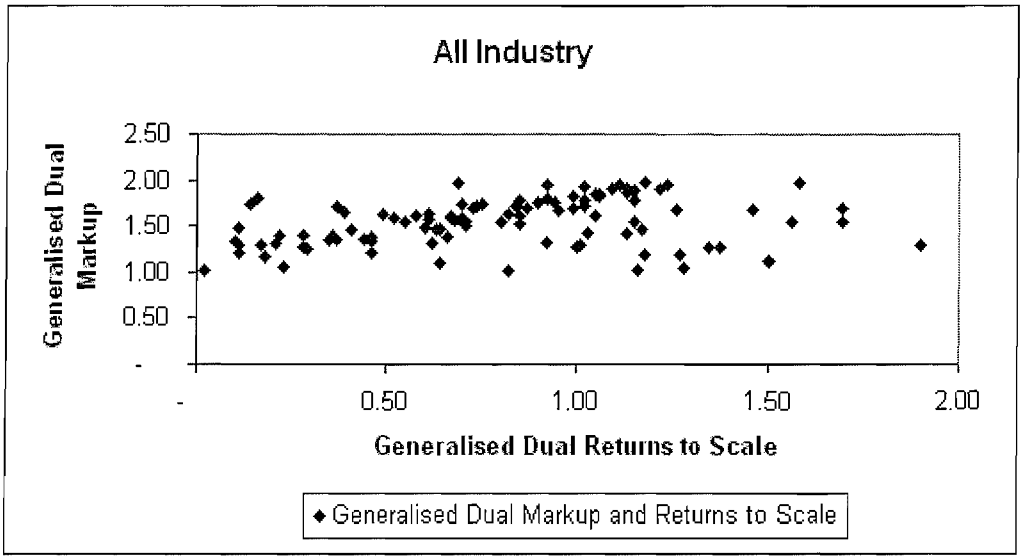
All Industry
Generalised Primal Markup
2.50
2.00
1.50
1.00
0.50
-
-
0.50
1.00
1.50
2.00
Generalised Primal Returns to Scale
Generalised Primal Markup and Returns to Scale

Figure 2.4:Generalised Dual Mark-up and Returns to Scale in Malaysian manufacturing at 5-digit industry and size of the industry




All Industry
Generalised Dual Markup
2.50
2.00
1.50
1.00
0.50
-
-
0.50
1.00
1.50
2.00
Generalised Dual Returns to Scale
Generalised Dual Markup and Returns to Scale

### 2.3.3.2 Estimation of returns to scale and the mark-up for medium size industry

In Table 2.11.1, the estimation results of generalised primal and dual returns to scale and mark-up, and adjusted primal and dual mark-up have also been estimated by using Equation (2.42), Equation (2.43), and Equation (2.47) of Section 2.2.4 and 2.2.5, respectively under the assumption of NCRTS and MP. The results are presented in columns 2, 3, 4 and 5 of Table 2.11.1.

Columns 6, 7 and 8 of Table 2.11.1 also provide the adjusted primal and dual mark-up, and the combination adjusted primal-dual mark-up under the assumptions of CRTS and MP. Meanwhile, in columns 9 and 10, the estimation that combined both generalised primal and dual are presented. The estimations are based on Equation (2.47) and under the assumptions of NCRTS and MP.

Table 2.11.1 shows that, in all cases, the estimation values of the mark-up are greater than one. This indicates that medium size industries in the sample are also operating in a MP environment. This finding provides evidence to support propositions 1 and 2, that the growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP and the growth rate of traditional dual TFP will be less than the growth rate of generalised dual TFP.

Columns 3, 5 and 10 of Table 2.11.1 present the estimation results of generalised primal and dual returns to scale and combination of generalised primal-dual returns to scale that were estimated based on Equation (2.42), Equation (2.43) and Equation (2.47) in Section 2.2.4 and 2.2.5, respectively. The results in columns 3, 5 and 10 also demonstrate mixed results. In some cases, one can find evidence of increasing returns to scale, while in other cases there is evidence of decreasing returns to scale.

[Table 2.11.1, Table 2.11.2 and Table 2.11.3]

Table 2.11.1
Returns to scale and mark-ups for Malaysian Manufacturing Industry with Medium Size Industry

| Industry (1) | Generalised Primal Markup[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Markup[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup (Hall)[b] (6) | Adjusted Dual Markup (Roeger)[b] (7) | Adjusted Primal & Dual Markup (Roeger)[b] (8) | Generalised Primal & Dual Markup[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | 1.33 | 0.66 | 1.53 | 0.76 | 1.47 | 1.62 | 1.57 | 1.55 | 0.80 |
| Textiles, Apparel & Leather | 1.63 | 0.76 | 1.71 | 0.74 | 1.52 | 1.74 | 1.62 | 1.68 | 0.76 |
| Wood Products | 1.53 | 0.87 | 1.80 | 0.99 | 1.33 | 1.81 | 1.42 | 1.72 | 0.87 |
| Paper Product, Printing and Publishing | 1.53 | 0.84 | 1.48 | 0.75 | 1.68 | 1.81 | 1.78 | 1.38 | 0.64 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 1.29 | 0.60 | 1.47 | 0.67 | 1.70 | 1.62 | 1.75 | 1.49 | 0.69 |
| Non-Metallic Mineral Products | 1.63 | 1.08 | 1.75 | 1.05 | 1.55 | 1.76 | 1.63 | 1.67 | 1.17 |
| Metallic Mineral Products | 1.12 | 0.37 | 1.16 | 0.18 | 1.82 | 1.91 | 1.10 | 1.15 | 0.19 |
| Machinery & Equipment | 1.49 | 1.04 | 1.56 | 0.97 | 1.52 | 1.62 | 1.83 | 1.65 | 1.01 |
| Other Manufacturing | 1.44 | 1.16 | 1.19 | 0.77 | 1.56 | 1.91 | 1.05 | 1.42 | 0.97 |

Note: [a] Generalised Mark-up and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Mark-up and Returns to Scale assume existing market power and constant returns to scale

Table 2.11.2
Correlation Coefficient between Generalised Primal Mark-up and Generalised Primal Returns to Scale

| | Generalised Primal Mark-up (Medium Size Industry) | Generalised Primal Returns to Scale (Medium Size Industry) |
|---|---|---|
| Generalised Primal Mark-up (Medium Size Industry) | 1.00 | 0.568*** |
| Generalised Primal Returns to Scale (Medium Size Industry) | 0.568*** | 1.00 |
| Number of Observations | 51 | 51 |

*** correlation is significant at the 0.01 level

Table 2.11.3
Correlation Coefficient between Generalised Dual Mark-up and Generalised Dual Returns to Scale

| | Generalised Dual Mark-up (Medium Size Industry) | Generalised Dual Returns to Scale (Medium Size Industry) |
|---|---|---|
| Generalised Dual Mark-up (Medium Size Industry) | 1.00 | 0.287** |
| Generalised Dual Returns to Scale (Medium Size Industry) | 0.287** | 1.00 |
| Number of Observations | 51 | 51 |

** correlation is significant at the 0.05 level

### 2.3.3.3 Estimation of returns to scale and the mark-up for large size industry

In Table 2.12.1, the results in columns 2, 3, 4 and 5 are estimated by using Equation (2.42), Equation (2.43), and Equation (2.47) of Section 2.2.4 and 2.2.5, respectively under the assumption of NCRTS and MP.

Columns 6, 7 and 8 of Table 2.12.1 also provide the adjusted primal and dual mark-up, and the combination adjusted primal-dual mark-up under the assumptions of CRTS and MP. Meanwhile, in columns 9 and 10, the estimation that combined both generalised primal and dual are presented. The estimations are based on Equation (2.47) and under the assumptions of NCRTS and MP.

Table 2.12.1 shows that, in all cases, the estimation values of mark-up are greater than one. This indicates also that large size industries in the sample are experiencing MP environment. This finding provides evidence to support propositions 1 and 2, that the growth rate of traditional primal TFP will be less than the growth rate of generalised primal TFP and the growth rate of traditional dual TFP will be less than the growth rate of generalised dual TFP.

Columns 3, 5 and 10 of Table 2.12.1 present the estimation results of generalised primal and dual returns to scale and combination of generalised primal-dual returns to scale that were estimated based on Equation (2.42), Equation (2.43) and Equation (2.47) in Section 2.2.4 and 2.2.5, respectively. The results in columns 3, 5 and 10 also demonstrate mixed results. In some cases, one can find evidence of increasing returns to scale, while in other cases there is evidence of decreasing returns to scale. The finding indicates that in most cases, Malaysia's industries experience decreasing returns to scale and a few cases experience increasing returns to scale.

[Table 2.12.1, Table 2.12.2 and Table 2.12.3]

Table 2.12.1
Returns to scale and mark-ups for Malaysian Manufacturing Industry with Large Size Industry

| Industry (1) | Generalised Primal Mark-up[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Mark-up[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup (Hall)[b] (6) | Adjusted Dual Mark-up (Roeger)[b] (7) | Adjusted Primal & Dual Mark-up (Roeger)[b] (8) | Generalised Primal & Dual Mark-up[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | 1.24 | 0.77 | 1.48 | 0.82 | 1.62 | 1.61 | 1.67 | 1.54 | 0.57 |
| Textiles, Apparel & Leather | 1.66 | 0.98 | 1.47 | 0.86 | 1.74 | 1.56 | 1.21 | 1.42 | 1.05 |
| Wood Products | 1.85 | 0.94 | 1.79 | 0.85 | 1.91 | 1.88 | 1.69 | 1.69 | 0.99 |
| Paper Product, Printing and Publishing | 1.31 | 0.82 | 1.22 | 0.46 | 1.37 | 1.45 | 1.40 | 1.19 | 0.47 |
| Chemical, Petroleum, Coal, Rubber and Plastics | 1.51 | 0.88 | 1.52 | 0.73 | 1.56 | 1.72 | 1.80 | 1.26 | 0.58 |
| Non-Metallic Mineral Products | 1.68 | 1.05 | 1.84 | 1.03 | 1.63 | 1.85 | 1.69 | 1.25 | 1.02 |
| Metallic Mineral Products | 1.55 | 1.06 | 1.42 | 0.93 | 1.09 | 1.55 | 1.42 | 1.17 | 0.66 |
| Machinery & Equipment | 1.48 | 1.12 | 1.39 | 0.79 | 1.58 | 1.62 | 1.66 | 1.54 | 0.60 |

Note: [a] Generalised Mark-up and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Mark-up and Returns to Scale assume existing market power and constant returns to scale

Table 2.12.2
Correlation Coefficient between Generalised Primal Mark-up and Generalised Primal Returns to Scale

| | Generalised Primal Mark-up (Large Size Industry) | Generalised Primal Returns to Scale (Large Size Industry) |
|---|---|---|
| Generalised Primal Mark-up (Large Size Industry) | 1.00 | 0.626*** |
| Generalised Primal Returns to Scale (Large Size Industry) | 0.626*** | 1.00 |
| Number of Observations | 18 | 18 |

*** correlation is significant at the 0.01 level

Table 2.12.3
Correlation Coefficient between Generalised Dual Mark-up and Generalised Dual Returns to Scale

| | Generalised Dual Mark-up (Large Size Industry) | Generalised Dual Returns to Scale (Large Size Industry) |
|---|---|---|
| Generalised Dual Mark-up (Large Size Industry) | 1.00 | 0.412** |
| Generalised Dual Returns to Scale (Large Size Industry) | 0.412** | 1.00 |
| Number of Observations | 18 | 18 |

** correlation is significant at the 0.05 level

### 2.3.4 Relationship between TFP, Returns to scale and Mark-up

In Appendices 2.1, 2.2, 2.3 and 2.4 are scatter diagrams that show the relationship between generalised primal TFP and returns to scale, the relationship between generalised dual TFP and returns to scale, the relationship between generalised primal TFP and mark-up and the relationship between generalised dual TFP and mark-up. In all cases, the relationships for small, medium and large size industry are randomly scattered. Therefore there is no relationship between generalised primal TFP and returns to scale, generalised dual TFP and returns to scale, generalised primal TFP and mark-up, and generalised dual TFP and mark-up. This finding suggests good measurement of returns to scale and mark-up.

### 2.3.5 Aggregate Estimation of TFP growth, Mark-up and Returns to Scale

Table 2.13 reports the estimation results for the average TFP growth, mark-up and returns to scale at the aggregate level of Malaysia's industries from 1975 to 1999. The second and the third columns in Table 2.13 present the result from the OLS estimation for primal and dual TFP, mark-up and returns to scale based on Equation (2.42) and Equation (2.43) of Section 2.2.4. The coefficients for mark-up and scale in the primal regression are 1.61 and 0.93, respectively. However in the dual regression, the coefficients for these two variables are 1.51 and 0.90, respectively. Not only are these estimates significant, but there are not too many differences between the two regressions. Thus, it is not surprising that both regressions produce an identical estimated average productivity growth of 8 percent per annum for primal and 8 percent per annum for dual at the aggregate level.

In order to overcome the problem of endogeneity in OLS estimation as well as period and industry fixed effects and white noise, the regression was also conducted at the aggregate level by stacking both regressions together based on Equation (2.45) and Equation (2.46) to jointly estimate (Equation (2.47)) aggregate mark-up and scale coefficients by using GMM estimation. Results of the GMM estimation are presented in the last column of Table 2.13. Based on the GMM estimates, the aggregate mark-up is about 1.42 and the returns to scale coefficient is about 0.75. These results indicate that the assumption of CRTS and PC are violated in the aggregate Malaysian manufacturing industry at the aggregate level. As a result, the estimated average aggregate TFP growth of Malaysian manufacturing industry for period of study from 1975 to 1999 is 6 percent per annum.

At the aggregate level, in the context of Malaysia, it appears that almost all industries experience decreasing returns to scale. This finding is consistent which Basu and Fernald (1997) show that the degree of decreasing returns to scale diminishes at a higher level of aggregation.

[Table 2.13]

**Table 2.13**
Average TFP Growth, Average RTS and Average Mark-up

| | | OLS Primal | OLS Dual | GMM |
|---|---|---|---|---|
| Estimated | Mark-up | 1.61***<br>(27.5) | 1.51***<br>(18.4) | 1.42***<br>(6.47) |
| | Returns to Scale Coefficients | 0.93***<br>(28.0) | 0.90**<br>(2.15) | 0.75**<br>(2.08) |
| | Total Factor Productivity Growth | 0.08***<br>(6.57) | 0.08*<br>(1.90) | 0.06***<br>(9.87) |
| Sample size | | 23 | 23 | 46 |

Notes: *, **, and *** indicate significance at 90%, 95%, and 99% confidence level, respectively.

t-values in parentheses

## 2.4 Conclusion

This paper has made the following contributions to the literature. Firstly, the paper has proved theoretically (as in Section 2.2.1 and 2.2.2) and shown empirically (as in Section 2.3), that even in the presence of MP and NCRTS in Malaysian manufacturing industry during the period of study from 1975 to 1999, primal and dual TFP accounting measures are proved to be equal mainly because the factor shares in value added in all industries are relatively constant. Differences between primal and dual TFP, however, still can be observed in a few cases. Similar findings were found in the studies by Young (1995) and Hsieh (2002). This difference was considered as white noise by Young (1995) and could also be due to data inaccuracy as argued by Hsieh (2002). If the factor shares in value added are not constant, then the differences should depend on MP (Roeger, 1995) and/or NCRTS (as suggested by this paper) as well as the changes in factor shares and how investment is treated in the production model, as being either endogenous or exogenous (Hall, 1988). The finding from this paper is in contrast with the result from Roeger (1995), which shows that MP alone could explain the differences between primal and dual TFP accounting measures in the U.S.A. manufacturing sector.

Secondly, this paper demonstrates that the assumptions of CRTS and PC are essential for both primal and dual TFP in measuring TFP growth for Malaysian manufacturing industry. If these assumptions are violated, both accounting methods could underestimate TFP growth. In the case of Malaysian manufacturing industry, results from the GMM estimation that has been used to estimate TFP growth of Malaysia's industries from 1975 to 1999, found a strong result. The results from the GMM estimation supported the argument if the assumption of CRTS and PC are not violated; in that case the accounting measures will underestimate the TFP growth. Furthermore, the results for all industries in the sample reject the two assumptions of CRTS and PC, respectively and as a result, the estimated productivity growths in Malaysia's industries are relatively higher due to the impact on the magnitudes of the scale and mark-up. The finding is consistent with Aklilu A.Z. *et al* (2000).

How accurate are the estimates on mark-up and returns to scale for Malaysian manufacturing industry compared to other studies? Whilst various authors have found mark-ups greater than 1 in the U.S.A. and European industries, decreasing returns to scale technology may be regarded as more questionable. However, in the recent published papers, such as Harrison (1994) for plant level evidence of Turkey, Burnside, Eichenbaum and Rebelo (1996), Burnside (1996), and Basu and Fernald (1997) for industry level evidence of the U.S.A., have documented similar findings. In particular, for the nondurable industries in the U.S.A. manufacturing sector, the estimated returns to scale coefficients of Basu and Fernald (1997) are in the range of 0.26 to 0.73, very similar to the findings in this paper, although in few cases of Malaysia's industries, there is an estimated return to scale coefficient of more than 1. However, Basu and Fernald (1997) also show that the degree of decreasing returns to scale diminishes at a higher level of aggregation. They explain that the observed puzzles as aggregation bias due to a firm heterogeneity in the industries. For this paper, particularly at the aggregate level of estimation for returns to scale coefficient, the finding is still significantly less than 1 for the industries and this finding is in line with Basu and Fernald (1997).

Thirdly, this paper sheds light on the debate between Young (1992, 1995) and Hsieh (1999, 2002) who argued that the discrepancies at the aggregate level for primal and dual TFP growth are mainly driven by data issues, since factor shares in value added are relatively constant. Thus, Young and Hsieh rejected the possibility that this discrepancy is related to the assumptions used in the estimation. However, from Hsieh and Young papers, they found that even at the aggregate level, the two essential assumptions (CRTS and PC) should be supported to show that the primal and dual TFP growth be equal. Nevertheless, Hsieh and Young findings are different. For this reason, both Young (1992, 1995) and Hsieh (1999, 2002) might have underestimated the aggregate TFP growth of Singapore. The finding of this paper shows that if we can allow for NCRTS and MP estimating the TFP growth, the TFP growth is substantially higher than the accounting measures using either primal or dual methods. Thus, this paper strongly recommends that both assumptions should be taken into consideration in measuring TFP growth.

Fourthly, by analysing empirically the relationship between returns to scale and their mark-up in Malaysian manufacturing industry from 1975 to 1999, this paper shows empirically that there is a strong positive correlation between the estimated returns to scale (RTS) and the mark-up for the industries in the sample during period of study. This is consistent with theoretical prediction of Basu and Fernald (1997) that RTS and the mark-up should be strongly positively correlated.

Fifthly, this paper has not addressed the determination of the sources of returns to scale and mark-up over the twenty three-year period of the study from 1975 to 1999. Whilst the mark-up is determined by the behaviour of manufacturing firms, returns to scale are largely technologically driven. Therefore in context of Malaysia manufacturing industries, the decreasing returns to scale and mark-up in almost all industries (small, medium or large size industry), for example are due to, increasing competition, the degree of concentration, the prevailing regulations, the openness of an economy to international competition, the share of goods traded, the existence of anti-competitive or collusive behaviour, government subsidies or restrictive government procurement policies, trade policy, the strictness and enforcement of competition policy (See more detail in Ben J.R, 2001). All of these factors will reduce domestic mark-ups and returns to scale in Malaysian manufacturing industry and then replacing them by some other important source of growth such as technical change, is a question for further research.

Finally, by applying OLS regression with the extension of primal and dual Hall method to estimate the TFP, mark-up and RTS, the estimation will display an endogeneity problem. The growth rate of technological progress enters a firm's first-order condition for profit maximisation (as well as that of cost minimisation), which determines the input demand and also output of the firm. So, without overcoming this problem, technological progress, the least squares estimates for the coefficients of the growth rate of labour per unit of capital and the growth rate of capital will be biased upward. Hence a least squares regressions of output on inputs will give inconsistent estimates of the production function coefficients. As a result to overcome the endogeneity problem, instrumental variables (IV) will be used. However choosing a right proxy of IV is not easy because IV should correlate which the factor inputs but not with technological progress. Therefore in Chapter 3 and 4 a difference approach will be applied to estimate the mark-up. Roeger (1995) has suggested an alternative approach to avoid the endogeneity bias and IV problem. Roger's insight was that subtraction the dual from the primal of the Solow residual would give the nominal Solow residual in which the productivity shocks will be cancelled out, removing the endogeneity problem and leaving only observable variables.

# Chapter 3

## International Trade and the Mark-up: Evidence from Malaysian Manufacturing Industries from 1978 to 1999

### 3.0 Introduction

This paper investigates the impact of international trade on the strength of the mark-up of price over marginal cost. International trade can have an impact on the mark-up since foreign competition makes domestic product markets more competitive. Higher international trade intensity tends to increase the degree of competition that the domestic firm faces. International trade, therefore, is expected to have an effect on the variations of the mark-up. This paper attempts to investigate the effect of trade on the mark-up, as measured by the sensitivity of the mark-up to import penetration ratios and tariffs for Malaysian manufacturing industries from 1978 to 1999.

The Solow residual is a measure of the contribution of technical change to economic growth using an aggregate production function approach (Solow, 1957). In a series of papers, Hall (1986, 1988, and 1990) concludes that the Solow residual is a flawed measure, as it does not take into account imperfect competition, and that market power is a major reason for the empirical observation that the Solow residual is pro-cyclical. In Hall's paper (1990), he devises a method for estimating the industry mark-up of price over marginal cost as a parameter in a single equation regression, thus avoiding the need to directly measure marginal cost. He finds that the mark-up is significantly greater than one in most of the two-digit U.S.A. industries.

Developments on the Hall method include adding intermediate inputs into the production function, simultaneously measuring mark-up in the one estimating equation, and estimating the impact of cyclical and structural variables on the mark-up. Intermediate inputs are the goods that are used in the production process of other goods and are not sold in final-demand market. Domowitz *et al.* (1988) find that the estimated mark-ups in the U.S.A. are not as great when intermediate inputs are included; however they are still significantly greater than one. This is the conclusion of most studies of this type when taken over a range of countries, although Norrbin (1993) finds that mark-up is not significantly different from one in nearly all the U.S.A. industries when non-wage compensation is added to labour costs.

In this paper, mark-ups are estimated for Malaysian manufacturing industries using a Nominal Solow Residual (NSR) Roeger (1995) type model. This paper will employ the Dynamic Heterogeneous Panel Estimation (DHPE) technique proposed by Pesaran, Shin and Smith (1999), in the form of the Pooled Mean Group (PMG) estimator. The advantage of this technique is that it incorporates the recognition of an explicit long run relationship, as well as short run dynamics. The objection to the use of a panel estimator is the reason motivating an industry-by-industry approach. It is interesting to examine the extent to which the mark-up varies across the industries within a sector. However, it is also helpful to pool the data across all manufacturing industries to gain further insights into the reasons for variations in the mark-up in the whole sample. There are certainly many reasons to expect the mark-up to vary between industries substantially, ranging from the degree of trade liberalisation, developments within labour market institutions, international trade composition, type of market structure, establishment size, market size, entry condition and contestability, amongst others.

The advantage of the PMG estimator is that homogeneity across sectors needs not to be assumed, but tested for. Use of the PMG estimator allows for both dynamics across time periods and heterogeneity across cross-sectional units, since it allows researchers to simultaneously investigate both a homogenous long-run relationship and heterogeneous short-run dynamic adjustment towards equilibrium. The net result is the achievement of substantial statistical power from the panel, without denying the importance of sectoral heterogeneity.

These papers also present an alternative result from the Mean Group (MG) estimator, as well as the standard Ordinary Least Square (OLS) approach to sectoral estimation. Note that as long as the homogeneity Hausman test is passed in the estimations, the report will be only on PMG estimation results. The advantage of the MG estimation is that the results are obtained from an Autoregressive Distributed Lag (ARDL) estimation, which distinguishes between long run equilibrium and short run dynamics, thereby providing an efficiency gain over OLS.

Extending the analysis further, this paper will examine the impact of import penetration ratio (see the discussion in Hakura, (1998)), and tariffs on variations in the mark-up. The explicit control for import penetration ratio and tariffs presents a further advance on the existing literature. In examining the effects of import penetration ratios and tariffs, this paper will investigate the effects on the mark-up within individual industries and for the sample as a whole.

The plan of this paper is as follows. In Section 3.1, the literature review and theoretical background will be discussed. Section 3.2, the estimation methodology is outlined. Section 3.3, data are described and the regression results are presented and analysed. Section 3.4 concludes the paper by summarising the important findings.

## 3.1 Literature Review and Theoretical Background

### 3.1.1 Foreign competition and Openness

The prospect of substantial firm level productivity gains has been a driving force behind recent trade liberalisation efforts in the developing world. A myriad of empirical studies seem also to support the notion that trade liberalisation induces productivity gains at the firm level (Melo and Urata, 1986; Nishimizu and Page, 1991; Harrison, 1994; Tybout and Westbrook, 1995; Roberts and Tybout, 1995; Krishna and Mitra, 1998), providing a framework for interpreting the conventional wisdom that "in creating competition for domestic products in home markets, imports provide incentive for firms (to invest) to improve their (productivity)" (Balassa, 1988).

The question of how openness to trade affects the domestic firms' decisions has been unexplored in Malaysian manufacturing industries. The manner with which Malaysia has embraced foreign competition since independence in 1957 provides a good opportunity for evaluating how openness to trade affects the decisions of manufacturing firms. The total trade to GDP ratio has increased substantially from 0.82 in 1957 to 2.17 in 1999 (International Financial Statistics).

Olive (2002) derives an industry pricing equation that includes real manufacturing demand as an independent variable. Using Australian manufacturing data for 24 industries, mark-ups are found to be positively related to manufacturing demand when costs are held constant. Bloch, Harry and Olive (1999) use a similar method at the four-digit (International Standard Industry Code) ISIC level and find that aggregate demand only impacts on the mark-up for low import share industries. This suggests that the mark-ups could become less responsive to aggregate demand the more industries are open to the international economy.

Feinberg (1986) found that openness to the international economy is seen to represent the extent of foreign competition, rather than the level of competitiveness in a market. However, mark-ups have still found to be negatively related to openness in most applied studies (see Feinberg and Shannon, 1994; Katics and Petersen, 1994; Lopez and Lopez, 1996; and Ghosal, 2000). This is interpreted as trade increasing competition in the domestic market and thereby reducing domestic market power. As such, it is often used as an argument to support tariff reduction. Freedman and Stonecash (1997) outline the importance of this argument in the development of Australia's competition and trade policies.

Moreover, early econometric studies (see, for example, Pugel (1980), Melo and Urata (1986), Domowitz et al (1988) and Katics and Petersen (1994)) analyzing the impact of trade on market power employ the mark-up of price over average variable cost as a measure of non-competitive behaviour. These studies generally find that import competition reduces average cost mark-ups, particularly in domestically concentrated industries. Economic theory, however, predicts that import competition reduces the mark-up of price over marginal cost, which is not directly observable. More recent studies draw on the work of Roberts (1984) and Hall (1988) to estimate price-marginal cost mark-up from an equation derived from profit maximizing conditions. Three studies apply this approach to plant level data to analyse the impact of trade reform on competition in developing countries. Levinsohn (1993) finds that the price-marginal cost mark-up fell in Turkish industries where trade was liberalised, and increased in industries where trade protection was increased. Similarly, Harrison (1994) finds that mark-ups are negatively related to import competition in the Ivory Coast, and Krishna and Mitra (1998) present evidence that mark-ups fell during the trade reform period in India.

Meanwhile some authors, for instance Levinshon (1993), and Roberts and Tybout, (1995) have found that greater openness to trade leads to lower mark-ups. Levinshon, investigates the relationship between the price mark-up and import penetration in Turkish industries. The study by Roberts and Tybout has tested the "imports as discipline" hypothesis focusing on the changes in the mark-ups as countries gradually liberalise their trade policy. Both types of studies find a negative relationship between openness and mark-ups.

Hoekman *et al.* (2001) examine 41 countries during the 1980s and 1990s. They estimate a single average mark-up for each country based on 29 sectors over the two decades. Even at this level of aggregation, they find a significant negative relationship between average mark-ups and import penetration, controlling for market size, financial depth, intellectual property and barriers to entry.

Data from Mexico show that with the liberalisation of the late 1980s, mark-ups fell dramatically, particularly in industries with greater market concentration and a high proportion of large firms. Grether (1996) finds that a reduction in tariffs of 1% would lower mark-ups by up to 1.5% for large firms in more concentrated industries.

Levinshon (1993) examines five industries in Turkey in the period immediately after trade was liberalised. In all five of the industries he examines, mark-ups changed in the expected way, four of them significantly. In contrast, in more open countries such as Chile and Morocco, there is less correlation between mark-ups and import penetration. However, Melo and Urata (1986) find a fall in industry mark-ups pre and post the 1976 reform in Chile.

In Ivory Coast, trade was liberalised in 1985. Harrison (1994) uses firm level data to estimate the effects on mark-ups and on productivity. She estimates that a 10% fall in tariffs lowered mark-ups of domestic firms by 6%, although they had no significant impact on foreign firms' mark-ups. However, a 10% increase in import penetration lowered mark-ups by about 2% for both domestic and foreign firms. She also makes a strong case for the importance of controlling for changes in the market structure when assessing the impact of trade reform, arguing that ignoring it can lead to underestimation of the productivity gains.

Goh (2000) examines the relationship between trade policies and technological effort, arguing that a firm investing in new technology bears an opportunity cost of not getting their product to the market as quickly. Lopez (2003) introduces a model where domestic firms can choose to respond to foreign tariff liberalisation by investing in the technology of a higher-quality export good.

Traca (2001) provides a theoretical model of the effects of protection on a domestic firm's output, isolating what he calls the direct effect, corresponding to the decreased market share, and the pro-competitive effect, corresponding to a lower mark-up those results in more sales, of import competition on a domestic firm's output. If the domestic market is not perfectly competitive, a decline in import prices has two conflicting effects on the incentives to expand productivity and efficiency, the direct effect and the pro-competitive effect. The direct effect hampers productivity growth, implying the contraction of output from the decline in demand for the domestic good. Conversely, the pro-competitive effect fosters investment in productivity, reflecting the expansion of output due to the decline in domestic mark-ups, from the loss of market power. Roberts and Tybout (1995) argue that simulation models have shown that the pro-competitive effect usually dominates, in particular for the most efficient firms in the industry.

In a dynamic infinite-horizon framework, the domestic firm has to continuously invest in productivity growth, in order to make up for the expansion of its foreign competitors and to avoid exit. Implicitly, the growth of foreign productivity promotes domestic growth, as the decline of the price of imports fosters investment in productivity. Thus, the pro-competitive effect dominates the direct effect, in the steady state of the productivity growth path, if the firm survives import-competition.

However, when the initial productivity gap to foreign competitors is too large, the direct effect dominates, since the firm's market power is too small for the pro-competitive effect to be of first-order. In this case, the pressure of imports may be too intense, leading the domestic firm to concede and exit the market in the long run. The imposition of a temporary tariff in this infant stage persuades the firm to fight and catch up, thus ensuring its long-term competitiveness.

Moreover, given that the direct effect prevails, the temporary protection of an infant industry to ensure survival is welfare increasing, thus suggesting that the firm's incentives to concede and exit are higher than the social optimal. First, protection improves welfare, when it increases the output of a domestic firm with market power, i.e. when the direct effect dominates. Second, protection increases welfare also by expanding productivity, since market power implies that investment is socially sub-optimal.

But, if the pro-competitive effect prevails, free trade is the best policy, as protection decreases output and productivity, thus adding to the distortion created by domestic market power. Given the predominance of the pro-competitive effect in the vicinity of the steady state, this implies that the optimal, time-consistent tariff path entails free trade in the long run (steady state).

The removal of existing tariffs has non-monotone effects. Starting from the steady state, small trade liberalisation yields an increase in the productivity growth of the domestic firm. This increase is temporary, and allows the firm to compensate for the loss of protection by expanding its intrinsic competitiveness, to catch up with its foreign competitors. In the long run, the domestic firm's profitability and market power return to their initial (steady state) level.

However, when the tariff is high, a radical cut leads the firm to concede, cutting down productivity growth and eventually exiting the market. Since a small liberalisation induces the firm to catch up, a gradual approach to tariff reform increases the chances of survival for domestic firms, even if the reform schedule is fully anticipated.

### 3.1.2 Foreign Competition and Market Power Reduction

Greater exposure to foreign competition comes through three principal channels:

1. The first dimension is that of foreign firms locating in the domestic economy.
2. The second channel looks at the effect of greater competition through the opening of the country to more imports. As quantitative restrictions and tariffs continue to fall, import penetration has increased dramatically in the formerly protected economies.
3. A third channel is to look at the expansion of exports and of domestic firms as they enter foreign markets.

For the purposes of this paper, the first and second channel is considered.

Barriers to entry, including explicit restrictions of foreign ownership or trade barriers, can foster conditions where domestic firms retain monopoly power. The opening of the domestic market to imports can thus help to break local abuses of market power. This can have three related effects. One is that the market structure can change, with greater numbers of firms producing goods. Second, if barriers to entry are lower it facilitates the adjustment of resources to the most productive areas and encourages greater innovation. Third, prices are likely to decrease as competition increases. This is of considerable benefit to consumers and to buyers of intermediate goods.

#### 3.1.2.1 Market Structure and barriers to entry

As tariff and investment restrictions fall, previously protected firms will face greater competition and loss of market power. With reduced barriers to entry, new innovative firms face fewer hurdles in starting up operations.

Numerous studies link greater competition to increased incentives to innovate. For example Pavcnik (2000) makes a direct link between greater trade competition and innovation. Using panel data on Chilean firms, she finds the import competing firms were significantly more likely to adopt skill- intensive technology in the face of liberalisation relative to both exporters and non-traded goods producers. Other authors such as Blomstrom and Kokko (1996) look at the issue of incentives to innovate indirectly, trying to capture concentration ratios of industries pre and post reforms. In the short run, the concentration might rise temporarily as exits increase. But new entrants and the inclusion of imported goods should soon lower them.

However, others find that if one controls for other sector characteristics, the relationship is not significant. Blomstrom and Kokko (1996) in their survey conclude that the balance of the evidence indicates Multinational Companies (MNCs) are more likely to crowd out local firms in Less Developed Countries (LDCs), leading to higher concentration ratios. But they go on to point out that some increase in concentration ratios may not be a bad thing – particularly if it means there is better exploitation of scale economies. Provided a significant number of competitors remain, a decrease in the total number may not be detrimental.

There are three sources for this outcome. The first is that if imports are produced more cost effectively than the domestic producers, some domestic producers will be driven out of that range of goods. Thus it is possible that domestic production concentration increases, while the range of goods increases and the price of goods declines. In this case, greater concentration is consistent with greater productivity and lower prices and mark-up.

Second, foreign presence and market structure can be endogenous, making it difficult to separate the effects of foreign entry on competition. A correlation between high concentration and a foreign presence may be due to MNCs being attracted to concentrated industries rather than MNCs serve to lower concentration ratios.

Third, there is also a real danger that market power has been strengthened, particularly if the foreign competition takes the form of foreign direct investment (FDI). A foreign multinational could succeed in out-competing enough domestic rivals to be able to wield market power in the domestic market. Particularly given MNCs' possession of intangible assets, the effect of MNCs on domestic competition should receive close scrutiny.

Such a danger is greatest if protectionist trade policies are in place. Tariffs give MNCs an incentive to 'jump' the tariffs and produce locally. However, once behind the protective barriers, they can then use them to shore up their own monopoly position. Thus, the best means of ensuring such a MNC faces competition is the same as if it was a domestic monopoly: expose it to pressures from rivals abroad. Liberalised trade can be one of the most effective means of insuring against market power. Such a solution is most effective for traded goods. But even in areas such as non-traded services, openness to foreign bids can be a disciplining force. The effectiveness of the approach will also be determined by the strength of the domestic regulatory framework and international cooperation in addressing antitrust concerns.

### 3.1.3 Econometric Analysis of the Mark-ups of Price over Marginal Cost

In theory, the degree of monopoly power of a given producer can be viewed as the mark-up of product price ($P_t$) over marginal cost ($MC_t$). It can be defined as $(P_t-MC_t)/P_t$ which corresponds to the so-called *Lerner Index.* The greater the index, the greater will be the degree of monopoly power.

The main problem associated with the empirical measurement of the *Lerner index* and related measures arise from the fact that while prices can be measured, marginal costs are not directly observable. Therefore, indirect measures have to be developed.

Hall (1988) has suggested mark-up rate estimation based on a model for the Solow residual which has been extensively applied in the empirical literature.

#### 3.1.3.1 The Roeger-approach

Roeger (1995) proposed an alternative method of computing mark-ups founded on both the primal Solow residuals and the dual Solow residuals. For a firm enjoying technical progress in the use of labour and capital respectively, a reasonable approximation of its marginal cost can be given by the following expression:

$$MC_{it} = \frac{w_{it}\Delta N_{it} + r_{it}\Delta K_{it}}{\Delta Q_{it} - \Theta_{it} Q_{it}} \tag{3.1}$$

where $\Theta_{it}$ corresponds to the rate of technical progress for each time period $t$ and sector $i$.

Under the assumption of constant returns to scale and constant mark-up, Equation (3.1) can be rephrased as follows (see more detailed in the appendix 3.1):

$$TFP = SR = \Delta q_{it} - \alpha \Delta n_{it} - (1-\alpha)\Delta k_{it} = (\mu - 1)\alpha(\Delta n_{it} - \Delta k_{it}) + \Theta_{it} \qquad (3.2)$$

where the left hand side of Equation (3.2) has become known as the primal "Solow Residual" (SR, but often termed growth in TFP(Total factor productivity)). The mark-up of price over marginal cost is: $\mu = \frac{P}{MC}$, with $\Delta$ denoting the first difference, lower case denotes the natural logarithms transform, *q, n,* and *k* denote real value added, labour, and capital inputs respectively, $\alpha$ is the labour share in value added, and $\Theta = \frac{\dot{A}}{A}$ denotes exogeneous Hicks-neutral technological progress.

Under perfect competition $\mu = 1$, while imperfectly competitive markets allow $\mu > 1$. Estimation of Equation (3.2) faces the difficulty that the explanatory variables $(\Delta n - \Delta k)$ will themselves be correlated with the productivity shocks, which results in bias and inconsistency in the estimate of $\mu$. One solution is to use an instrument, which in turn raises the requirement that the instruments are correlated with the factor inputs, but not with technological change and hence the error term.

Roeger (1995) has suggested an alternative approach to avoid the endogeneity bias and instrumentation problems. By computing the dual of the Solow Residual (DSR), a relation of the price-based productivity measure to the mark-up can again be obtained as the expression below:

$$DSR_{it} = \alpha \Delta w_{it} + (1-\alpha)\Delta r_{it} - \Delta p_{it} = (\mu - 1)\alpha(\Delta w_{it} - \Delta r_{it}) + \Theta_{it} \qquad (3.3)$$

with w, r and p denoting the natural logarithms of the wage rate of labour, rental price of capital and price of output respectively. Whilst Equation (3.3) is subject to the same endogeneity problems, and hence instrumentation problems as

Equation (3.2), Roeger's insight was that subtraction of Equation (3.3) from Equation (3.2) would give the nominal Solow residual (NSR), given by:

$$\begin{aligned} NSR_{it} &= \Delta(p_{it} + q_{it}) - \alpha\Delta(n_{it} + w_{it}) - (1-\alpha)\Delta(k_{it} + r_{it}) \\ &= (\mu_{it} - 1)\alpha\left\{\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it})\right\} \end{aligned} \tag{3.4}$$

in which the productivity shocks have cancelled out, removing the endogeneity problem, leaving an equation with only observable variables and hence the need only for instrumentation. The NSR is a function of the mark-up, the labour share and the growth rate of the ratio of labour to capital costs.

Equation (3.4) is a rather well mannered expression for the estimation of the mark-up ratio. Adding an error term, the mark-up can be estimated by standard OLS techniques. Alternatively, a mark-up coefficient could even be calculated algebraically in a simple average computed over a given period as follows:

$$\mu_{it} - 1 = \frac{\Delta(p_{it} + q_{it}) - \alpha\Delta(n_{it} + w_{it}) - (1-\alpha)\Delta(k_{it} + r_{it})}{\alpha(\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it}))} \tag{3.5}$$

Oliveira-Martins *et al.* (1999) demonstrate that where the assumption of constant returns to scale is dropped, Equation (3.4) is actually:

$$NSR_{it} = \left(\frac{\mu}{\lambda} - 1\right)\alpha\left\{\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it})\right\} \tag{3.6}$$

where $\lambda > 1$ denotes increasing returns to scale. From Equation (3.6) it can be seen that with increasing returns to scale, Roeger's method produces a downward bias in the estimation mark-up. For example, if the "true" mark-up coefficient is 1.33 and $\lambda$ is equal to 1.2, the mark-up ratio estimated by means of Equation (3.4) would be 1.10. Conversely, the presence of decreasing returns to scale induces an upward bias in the estimation of the mark-up. Thus any estimate of mark-up that follows from Solow residuals should be interpreted as lower bound values of the true mark-ups if increasing returns to scale are present.

Equation (3.4) can be easily extended in order to incorporate intermediate inputs and express the mark-up ratio over gross output (GO) instead of value added (VA). This correction is important, insofar as the mark-up over value added induces a clear upward bias in the estimation. Indeed, Basu and Fernald (1997) show that the measurement of real value added assumes that the elasticity of output with respect to intermediate inputs equals its revenue share, which is only true if there is perfect competition. In the presence of market power, shifts in the intermediate inputs will be incorrectly attributed to shifts in value added and estimates of the mark-ups will be biased.

Taking into account intermediate inputs, Equation (3.6) becomes:

$$\begin{aligned} NSRGO_{it} &= \Delta(\tilde{p}_{it}+\tilde{q}_{it})-\tilde{\alpha}\Delta(n_{it}+w_{it})-\tilde{\beta}\Delta(m_{it}+p^{m}_{it})-(1-\tilde{\alpha}-\tilde{\beta})\Delta(k_{it}+r_{it}) \\ &= \mu_{it}-1\left\{\tilde{\alpha}\Delta(n_{it}+w_{it})+\tilde{\beta}\Delta(m_{it}+p^{m}_{it})-(\tilde{\alpha}+\tilde{\beta})\Delta(k_{it}+r_{it})\right\} \end{aligned} \quad (3.7)$$

where $\tilde{p}$ and $\tilde{q}$ correspond to gross output and its respective price, $m$ and $p^{m}$ correspond to intermediate inputs and their prices, $k$ and $r$ correspond to capital inputs and their price and $\tilde{\alpha}$ and $\tilde{\beta}$ to the share of labour and intermediate inputs in gross output value respectively. This extension for intermediate inputs illustrates an important advantage of Roeger's approach. Equation (3.7) only requires nominal variables, there is no need to gather price indexes for intermediate inputs, information that is not readily available. However, the treatment of capital costs still requires a separate computation for the growth rate of the rental price of capital, r.

#### 3.1.3.2 The Open Economy Context

The discussion thus far has ignored the impact of the open economy context. Yet import and export shares, tariffs, protection rate, subsidy rates and other trade policy clearly carry implications for the degree of international competition to which domestic industry is exposed, and hence the magnitude of the feasible mark-up that domestic industry can maintain. By implication, the suggestion is that trade liberalisation is a means by which inefficiency in production can be remedied.

The growth of foreign competition implies that domestic firms are increasingly exposed to competitive pressure. An increase in the import penetration ratio in an industry means that domestic firms are facing more competition because foreign firms have a bigger presence in the market. Furthermore, changes in foreign competition can permanently reshape the general competitive configuration of an industry; that is, if there are some fixed entry costs, once foreign firms decide to enter the domestic market, they are unlikely to exit (see Baldwin (1988), Dixit (1989) and Baldwin and Krugman (1989)). Thus one can think of the increase in foreign competition in the domestic markets, as an increase in competitive pressure for the industry will lower the mark-up of price over marginal cost. The link between import competition and market power has been extensively investigated in a large body of empirical work. Import competition in the domestic market has been seen as a disciplinary device to constrain market power of domestic firms. Levinsohn (1993), Harisson (1994), Katics and Petersen (1994), Krishna and Mirta (1998), Konings and Vandenbussche (2005), Koning *et al.* (2005) have provided evidence of disciplinary effect imposed by import competition.

Hakura (1998) offers one means of incorporating the open economy context into the estimation of mark-ups of price over marginal cost. The starting point of analysis is the suggestion that tariff and other trade restrictions shield domestic industry from international competition. Hence a reduction in trade barriers should decrease the market power of domestic producers, for example through increased import penetration and decreased tariff, decreasing the mark-ups of price over marginal cost. The suggestion is thus that trade liberalisation such as imports and tariff reductions will reduce the pricing power of industry (see for instance Helpman and Krugman, 1989).

In order to see how changes in import penetration have affected the price marginal cost mark-up, the specification that is interacted with the import penetration ratios (IPR) and the relationship tested by Hakura (1998) is given by,

$$PCM_{it} = \beta_0 + \beta_1 \ln\left(IPR_{it} - \overline{IPR_i}\right) + \beta_2 \ln(\frac{K}{PQ})_{it} + \beta_3 \ln(\frac{\dot{Q}}{PQ})_{it} \qquad (3.8)$$

where $PCM_{it}$ is a price-cost mark-up, $\ln IPR_{it}$ denotes the natural logarithm of the import penetration ratio for the $i$'th industry, and $\ln \overline{IPR_i}$ denotes the natural logarithm of the mean import penetration ratio for the $i$'th industry. Other variables included in the regression include the capital to output ratio, $\frac{K}{PQ}$, and the percent change in the industry sales, $\frac{\dot{Q}}{PQ}$. Since the gross return to capital is included in the price-cost mark-up, the mark-up is expected to be positively related with the $\frac{K}{PQ}$. Also, as noted by Esposito and Esposito (1971) high capital requirements reflect a cost disadvantage and serve as a barrier. Thus, high capital requirements, which prevent new entrants into the market, will be positively related to the level of industry profits rates. Increases in industry demand, as reflected in a high growth rate of industry sales, should also be positively related to industry profits.

$i$ and $t$ denotes industry and time period respectively, while $\beta_1$ captures the impact of deviations of import penetration from the sectoral mean value of import penetration on the mark-up. Where $\beta_1 < 0$, rising import penetration lowers the mark-up, where $\beta_1 > 0$, rising import penetration raises the mark-up. $\beta_2$ captures the sensitivity for $i$'th industry the capital to output ratio on variations of the mark-up, and $\beta_3$ captures the sensitivity for $i$'th industry sales on variations of the mark-up

The industry-level import penetration ratio (IPR) is defined as imports divided by the total value of domestic production plus imports in natural logarithms.

The industry-level mean value of import penetration ratio ($\overline{IPR}$) is defined as imports divided by the total value of domestic production plus imports and divided by the number of industry in the list in natural logarithms.

Moreover, a final extension of Equation (3.8) proves necessary due to the use of panel data in this paper. Estimation of the mark-up on an industry-by-industry basis requires a control only for an individual-industry variation of import penetration in order to capture trade effects on the mark-up. In a panel data context this is not sufficient, as it is also important to capture the heterogeneity of the industries in the whole sample. Thus, for this reason the following specification will be adjusted to investigate for the impact of import penetration ratios on variations of the mark-up for an individual $i$'th industry as well for the whole sample except industry $i$:

$$\mu_{it} - 1 = \theta_0 + \theta_1 \ln(IPR_{it} - \overline{IPR}_i) + \theta_2 \ln(IPR_{-it} - \overline{IPR}_{-i})$$
$$+\theta_3 \ln(\frac{K}{PQ})_{it} + \theta_4 \ln(\frac{\dot{Q}}{PQ})_{it} \qquad (3.9)$$

where $\ln IPR_{it}$ denotes the natural logarithm of the import penetration ratio for an individual $i$'th industry, $IPR_{-it}$ denotes the natural logarithm of the import penetration ratio for the whole sample except industry $i$, $\ln \overline{IPR_i}$ denotes the natural logarithm of the mean import penetration ratio for an individual $i$'th industry, and $\ln \overline{IPR_{-i}}$ denotes the natural logarithm of the mean import penetration ratio for the whole sample except industry $i$. Thus $\theta_1$ captures the sensitivity for an individual $i$'th industry import penetration ratio on variations of the mark-up, and $\theta_2$ captures the sensitivity for the whole sample except industry $i$ import penetration ratio on variations of the mark-up. Hence $\theta_3$ captures the sensitivity for an individual $i$'th industry the capital to output ratio on variations of the mark-up, and $\theta_4$ captures the sensitivity for an individual $i$'th industry sales on variations of the mark-up.

Meanwhile $\mu_{it} - 1$ denotes mark-up according to Equation (3.5) having already taken into account intermediate inputs. Interpretation of the results of Equation (3.9) is symmetrical with Equation (3.8), except that the impact of import penetration ratio on variations of the mark-up for an individual industry and the whole sample in natural logarithms is included. Equation (3.9) split sources of the sensitivity on variations of the mark-up in manufacturing industry into two components: that due to the impact of the deviation of import penetration ratio from the mean value of import penetration ratio on the variations of the mark-up for an individual $i$'th manufacturing industry; and that due to the impact of deviation of import penetration ratio from the mean value of import penetration ratio on the variations of the mark-up for the whole sample except industry $i$.

There are many reasons to expect the sensitivity of the mark-up to vary between industries, ranging from the degree of trade liberalisation, tariffs, market structure, trade composition, contestability, establishment size, and market size, amongst others. For example, the rationale sensitivity of the mark-up to vary for an individual industry as well as the whole sample rests on the type of industry and form of competition. Following Sutton (1991) and a subsequent discussion by Schmalensee (1992), two major types of industries (or type of competition) can be identified. Industries with typical small average establishment size were termed "fragmented" industries (industries with a small average establishment in which the number of firms typically grows in line with the size of the markets). In "segmented" industries (industries characterised by the existence of large establishments, covering a large proportion of employment and output), concentration remains relatively stable or converges towards a finite lower bound. This market structure taxonomy can also be related to more direct indicators of sunk costs, e.g. large advertising or R & D, product innovation and to qualitative information about the different industries (see Oliviera-Martins *et al.*, (1996) for more details on the set of market structure indicators used to group industries into market structure taxonomy).

The expectation is that the impact of international trade and tariffs on the variations of the mark-up in manufacturing industry tends to be greater in an individual-industry dominance of "segmented" industries than in "fragmented" industries. This seems to lend support to the hypothesis that counter-cyclical pattern of the mark-up is the result of increased foreign competition during economic booms. This is indeed likely to be more apparent for the industries characterised by an individual-industry dominance of large firms or establishments ("segmented" industries) with market power and concentrated industries. For example, data from Mexico show that with the liberalisation of the late 1980s, mark-ups fell dramatically, particularly in industries with greater market concentration and a high dominance of large firms ("segmented" industries). If imports are produced most cost effectively by "segmented" industries for example Multinational Company (MNCs) than the "fragmented" domestic industries, some domestic producer will be driven out of that range of goods. Thus it is possible that domestic production concentration increases and price of goods declines. In this case, greater concentration is consistent with greater productivity and lower prices and mark-up. Grether (1996) finds that a reduction in tariffs of 1% would lower mark-ups by up to 1.5% for large firms ("segmented" industries) in more concentrated industries. In addition, Pugel (1980), Melo and Urata (1986), Domowitz *et al.* (1988) and Katics and Petersen (1994) find that import competition reduces average cost mark-ups, particularly in domestically concentrated industries.

Furthermore, industrial organization literature highlights the importance of a firm's entry on industry mark-up (Bresnahan and Reiss, 1991). Entry of new firms is shown to have direct and powerful effects on curbing monopoly power of the incumbent firms in the market. These results suggest the important of entry regulations (barriers) such as increase tariffs in determining industry mark-up. Thus industries with market power and so greater mark-up might be better equipped to lobby for higher tariffs.

To test for the impact of tariffs on variations of the mark-up, Equation (3.8) can be rewritten with IPR replaced by tariffs as given by:

$$\mu_{it} - 1 = \Theta_0 + \Theta_1 \ln(Tariff_{it} - \overline{Tariff}_i) + \Theta_2 \ln(Tariff_{-it} - \overline{Tariff_{-i}})$$
$$+ \Theta_3 \ln(\frac{K}{PQ})_{it} + \Theta_4 \ln(\frac{\dot{Q}}{PQ})_{it} \qquad (3.10)$$

where $\ln Tariff_{it}$ denotes the natural logarithm of the tariff for an individual $i$'th industry, $\ln Tariff_{-it}$ denotes the natural logarithm of the tariff for the whole sample except industry $i$, $\ln \overline{Tariff_i}$ denotes the natural logarithm of the mean tariff for an individual $i$'th industry, and $\ln \overline{Tariff_{-i}}$ denotes the natural logarithm of the mean tariff for the whole sample except industry $i$. Equation (3.10) also splits of sources of the sensitivity on variations of the mark-up in manufacturing industry into two components: that due to the impact of deviation of tariffs from the mean value of tariffs on variations of the mark-up for an individual $i$'th manufacturing industry; and that due to the impact of deviation of tariffs from the mean value of tariffs on variations of the mark-up for the whole sample except industry $i$. Other variables also included in the regression include the capital to output ratio, $\frac{K}{PQ}$, and the percent change in the industry sales, $\frac{\dot{Q}}{PQ}$.

The industry-level mean value of $Tariff$ ($\overline{Tariff}$) is defined as the total value of $Tariff$ divided by the number of industry in the list in natural logarithms.

Thus $\Theta_1$ captures the sensitivity for an individual $i$'th industry tariff on variations of the mark-up, and $\Theta_2$ captures the sensitivity for the whole sample except $i$ industry tariffs on variations of the mark-up. Hence $\Theta_3$ captures the sensitivity for an individual $i$'th industry the capital to output ratio on variations of the mark-up, and $\Theta_4$ captures the sensitivity for an individual $i$'th industry sales on variations of the mark-up.

In the meantime $\mu_{it} - 1$ also denotes mark-up according to Equation (3.5) having already taken into account intermediate inputs.

Tariffs and other restrictions on trade have been widely used to shield domestic industries from international competition. Trade barriers give domestic suppliers greater market power and allow them to increase the mark-ups of price over marginal cost. Thus, profitability is artificially high and incentives to produce efficiently are lower than in the absence of tariffs. A vast body of literature (see, Pugel (1980), Melo and Urata (1986), Domowitz *et al.* (1988), Helpman and Krugman (1989), Katics and Petersen (1994), Grether (1996) and Blomstrom and Kokko (1996)) argues that this inefficiency can be remedied by liberalization of international trade. Hence, a lowering of trade barriers will lead to a reduction in market power and lower profit margins. Although this argument is theoretically well established, the empirical evidence to support it is rather limited. Some more recent notable studies on this issue are by Levinsohn (1993) and Harrison (1994).

## 3.2 The Econometric Methodology

To proceed, Equations (3.7), (3.9), and (3.10) will be estimated. The Pooled Mean Group (PMG) estimator provided by Pesaran, Shin and Smith (1999) provides the panel estimator. See also the discussion in Fedderke, Shin and Vaze (2000) and Fedderke (2003a).

### 3.2.1 Panel Estimator

Consider the unrestricted error correction ARDL (p, q) representation:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' X_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \Delta X_{i,t-j} + \vartheta_i + \varepsilon_{it} \tag{3.11}$$

where $i = 1,2,....,N, t = 1,2,...,T$, p, q denote the cross section units, time period, lags dependent and lags independent variable respectively. Here $y_{it}$ is a scalar dependent variable, $X_{it}(k x 1)$ a vector of (weakly exogenous) regressors for group *i*, and $\vartheta_i$ represents fixed effects. Allow the disturbances $\varepsilon_{it}$'s to be independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2$>0, and assume that $\phi_i$< 0 for all *i*. Then there exists a long-run relationship between $y_{it}$ and $X_{it}$:

$$y_{it} = \theta_i' X_{it} + \eta_{it},\ i = 1, 2, ...., \mathrm{N},\ t = 1, 2, ....., \mathrm{T}, \tag{3.12}$$

where $\theta_i = \frac{-\beta_i'}{\phi_i}$ is the *k* x 1 vector of the long-run coefficients, and $\eta_{it}$'s are stationary with possibly non-zero means (including fixed effects). This allows Equation (3.12) to be written as:

$$\Delta y_{it} = \phi_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \Delta X_{i,t-j} + \vartheta_i + \varepsilon_{it} \tag{3.13}$$

where $\eta_{i,t-1}$ is the error correction term given by Equation (3.12 ), and thus $\phi_i$ is the error correction coefficient measuring (ECM) the speed of adjustment towards the long-run equilibrium.

This general framework allows the formulation of the PMG estimator, which allows the intercepts, short-run coefficients and error variances to differ freely across groups, but the long-run coefficients to be homogeneous; i.e. $\theta_i = \theta \forall i$. Group specific short-run coefficients and the common long-run coefficients are computed by the pooled maximum likelihood estimation. Denoting these estimators by $\tilde{\phi}_i, \tilde{\beta}_i, \tilde{\lambda}_{ij}, \tilde{\delta}_{ij}$ and $\tilde{\theta}_i$. The PMG estimation will be obtained by $\hat{\phi}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\phi}_i}{N}, \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\beta}_i}{N}, \hat{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\lambda}_i}{N}$, $j = 1, \ldots p-1$, and $\hat{\delta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\delta}_{ij}}{N}, j = 0, \ldots, q-1, \hat{\theta}_{PMG} = \tilde{\theta}.$

PMG estimation provides an intermediate case between the dynamic fixed effects (DFE) estimator, which imposes the homogeneity assumption for all parameters except for the fixed effects, and the mean group (MG) estimator proposed by Pesaran and Smith (1995), which allows for heterogeneity of all parameters. PMG exploits the statistical power offered by the panel through long-run homogeneity, while still admitting short-run heterogeneity.

The crucial question is whether the assumption of long-run homogeneity is justified, given the threat of inefficiency and inconsistency noted by Pesaran and Smith (1995). A Hausman (1978) test (hereafter h-test) will be employed on the difference between MG and PMG estimates of long-run coefficients to test for long run heterogeneity. An alternative is offered by a Log-Likelihood Ratio test. However, the finite sample performances of such tests are generally unknown and thus unreliable. Note that as long as the homogeneity test is passed in the estimations, the report will focus only on the PMG estimation results.

Finally, it is worth pointing out that a crucial advantage of the estimation approach of this paper is that the dynamics of adjustment in the mark-up are explicitly modelled, while recognising the presence of a long run equilibrium relationship underlying the dynamics. Thus the justification for the use of the PMG estimator is that it is consistent both with the underlying theory of a homogeneous long-run mark-up of price over marginal cost relationship and the possibly heterogeneous dynamic time series nature of the data. As long as sector-homogeneity is assured, the PMG estimator offers efficiency gains over the MG estimator, while granting the possibility of dynamic heterogeneity across sectors unlike the DFE estimator. In the presence of long-run homogeneity, therefore, the use of the PMG estimator is the preference.

## 3.3 The Data, Method of Estimation and Results

### 3.3.1 The Data

The data employed for this paper focus on the five digit manufacturing sectors in Malaysia, over the 1978 through 1999 period.

The data employed is a panel data set for purposes of estimation, with observations from 1978 through 1999. The list of sectors included in the panel is that specified in Table 3.1.

The Malaysian manufacturing industries used in this study are defined according to the SIC (Standard Industry Classification). This paper utilised the data that has been collected and reported to the Department of Statistics (DOS), Malaysia from census of Manufacturing Industries.

$\Delta q_{it}$

The proportional rate of change in real turnover is calculated by taking the natural logarithms (ln) of the level of output.

$\Delta n_{it}$

The proportional rate of change in quantity of labour is calculated by taking the natural logarithms (ln) of the level of labour.

$\Delta k_{it}$

These values are calculated using a perpetual inventory method. The proportional rate of change in capital stock is calculated by taking natural logarithms (ln) of the level of capital stock.

$\Delta r_{it}$

These values are calculated using the user costs method. The proportional rate of change in rental price of capital stock is calculated by taking natural logarithms (ln) of the level of rental price of capital stock.

$\Delta w_{it}$

These values are calculated using the user costs method. The proportional rate of change in wage rate of labour is calculated by taking the natural logarithms (ln) of the level of wage rates.

$\left(\frac{wN}{PQ}\right)_{it}$

The labour share is calculated by multiplying labour cost shares and dividing by turnover.

$\left(\frac{\omega M}{PQ}\right)_{it}$

The intermediate material share is calculated as intermediate material purchased in divided by turnover.

$\left(\frac{rK}{PQ}\right)_{it}$

The rental price of capital share is calculated by multiplying rental price of capital cost shares divided by turnover.

$Open_{it}$ and $Tariff_{it}$

Openness and Tariffs for each industry is measured as total import and import duties data according to manufacturing industry sector from Department of Statistics, Malaysia. All values of imports and imports duties are converted into natural logarithms (ln).

Table 3.1
Five digit Malaysian Manufacturing Industries

| Sectors | Period (T) | Five digit SIC (N) | Total of Panel Observations (NT) | Number of establishments |
|---|---|---|---|---|
| Food, beverages and Tobacco | 22 | 33 | 726 | 38,897 |
| Textiles, Apparel and Leather | 22 | 22 | 484 | 33,666 |
| Wood Products | 22 | 70 | 1540 | 26,682 |
| Paper Products, Printing and Publishing | 22 | 45 | 990 | 11,879 |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | 22 | 31 | 682 | 24,585 |
| Non-Metallic Mineral Products | 22 | 24 | 528 | 11,120 |
| Metallic Mineral Products | 22 | 26 | 572 | 3,911 |
| Metal Products, Machinery and Equipment | 22 | 74 | 1628 | 49,137 |
| Other Manufacturing | 22 | 46 | 1012 | 5,222 |

*Note: An Establishment is defined as "An economic unit that engages, under a single ownership or control, that is, under single legal entity, in one, or predominantly one, kind of economic activity at a single physical location"-Department of Statistics, Malaysia.*

### 3.3.2 Panel Estimation Results for Malaysian Manufacturing Sector

#### 3.3.2.1 Roeger's Approach with Intermediate Input

The results in Table 3.2 report the Pooled Mean Group Estimation (PMGE) for the manufacturing sectors mark-up given by the specification in Equation (3.14) for an individual $i$'th industry:

$$NSRGO_{it} = \gamma_{0i} + \gamma_{1i}(ROEGER_{it} - \overline{ROEGER_i}) + \varepsilon_{it} \quad (3.14)$$

where:

$$ROEGER_{it} = \left\{\tilde{\alpha}_{it}\Delta(n_{it} + w_{it}) + \tilde{\beta}_{it}\,\Delta(m_{it} + p_{it}^{m}) - (\tilde{\alpha}_{it} + \tilde{\beta}_{it})\Delta(k_{it} + r_{it})\right\}$$

with $\tilde{\alpha}_{it}$ and $\tilde{\beta}_{it}$ denoting the share of labour and intermediate material of sector $i$, $\Delta(n_{it} + w_{it})$ the change in nominal labour cost for sector $i$, $\Delta(k_{it} + r_{it})$ the change in total capital stock for sector $i$, $\Delta(m_{it} + p_{it}^{m})$ the change in total intermediate cost for sector $i$, $ROEGER_{it}$ denotes the natural logarithm of ROEGER for an individual $i$'th industry, and $\overline{ROEGER_i}$ denotes the natural logarithm of the mean ROEGER for an individual $i$'th industry. $NSRGO_{it}$ denotes the Nominal Solow Residual in Gross Output for an individual $i$'th industry. Thus allow the disturbances $\varepsilon_{it}$'s to be independently distributed across $i$ and $t$ with zero means and variances $\sigma_i^2>0$. $\gamma_{1i}$ will measure $(\mu - 1)$ for an individual $i$'th industry, where $\mu = \frac{P}{MC}$ is the mark-up.

Taking the deviation in the regression between *ROEGER* from the mean *ROEGER* ensures that $\hat{\gamma}_{1i}$ does not capture unobserved differences by industry that is correlated with ROEGER variables.

An important data measurement issue concerns the construction of the $\Delta(k+r)_{it}$ variable. This paper will employ the rental price of capital that is incorporated according to a user costs method. Hall and Jorgensen (1967) employ the rental price of capital, defined as $r_t = P_{t-1}q_t + P_t d_t - (P_t - P_{t-1})$, where $r$ is the rental price of capital, $P$ is the price index for new capital stock, $q$ is the net rate of return on the capital stock and $d$ is the rate of depreciation of capital stock. Defining capital income to equal nominal value added less labour compensation, and given information about depreciation, holding gains and capital stock, the net rate of return of the capital stock is estimated residually as $q_t = \frac{capitalincome - (P_t d_t - (P_t - P_{t-1}))K_{t-1}}{P_{t-1}K_{t-1}}$, where $K$ is the real capital stock and $PK$ is the nominal capital stock.

The results in Table 3.2 indicate that a statistically significant variation in the mark-up is present for an individual *i*'th manufacturing industry when estimated an industry-by-industry basis over the sample period.

In this paper estimation for the Roeger methodology, the average Malaysian manufacturing sector mark-up in line with or close to the average manufacturing sector mark-up obtained in the original Roeger (1995) estimation for the U.S.A, Oliviera-Martins *et al.* (1996) for Australia, by Oliviera-Martins *et al.* (1999) for France, Germany, Japan, and the United Kingdom (47 % in Malaysia as opposed to a 45% for the U.S.A., 24% for Australia, 52% for France, 52% for Germany, 43% for Japan, 31% for the United Kingdom). However the average manufacturing sector mark-up in Malaysia manufacturing industry (47 %) far below the average manufacturing sector mark-up obtained by Fedderke, (2003b) for the South Africa (79%). Whilst the results tend to vary widely for different countries, the estimate by Oliviera-Martins *et al.* (1996, 1999) provides support for the results obtained in this paper. Thus the mark-up in Malaysian manufacturing sector appear to be higher than in comparable in the U.S.A., Australia, Japan, and the United Kingdom manufacturing sectors, despite the fact that manufacturing sectors, in producing tradable goods, might be expected to be subject to foreign competitive pressure. Some manufacturing sectors such as Metallic Mineral Product have achieved higher mark-up due to government policy for protecting or promoting specific classes of industry. These include such policies as infant-industry protection, support to exporting industries and concessionary packages offered such as Export Processing Zone (EPZ). EPZs are usually defended on three grounds. First, they provide a source of foreign exchange. Second, they provide employment. Third, they offer the possibility for technology spillovers, and training.

Consequently, the results presented in this paper are more in line and intuitively plausible with estimates of profit rates typically reported in the manufacturing sector such as the results reported by Hall (1990) for the U.S.A. manufacturing sector in which many of Hall's significant mark-up ratio are close to, or over, 100 per cent. Roeger (1995) finds that estimates of mark-up ratio for the U.S.A. manufacturing sectors range from 15 to 175 per cent. However, the mark-up in Malaysian manufacturing sectors in this paper are still considered plausible and in line with other countries such as the U.S.A. and Japan.

Table 3.2 also shows that the speed of adjustment towards the long-run equilibrium as indicated by $\phi - parameter$ is rapid and the $\phi - parameter$ confirms the presence of a long run equilibrium relationship. The Hausman test accepts the inference of a long run homogeneity mark-up for the *i*'th manufacturing sector. The optimal lag length was determined by Akaike Information Criterion , (AIC (1)).

Table 3.2
PMG estimator results for an individual $i$'th industry mark-up

| Industry | $\gamma_1 = \mu - 1$ | $\phi(ECM)$ | h-test |
|---|---|---|---|
| Food, Beverages and Tobacco | 0.45** (0.03) | -1.21* (0.07) | 0.04 (0.92) |
| Textiles, Apparel and Leather | 0.46** (0.02) | -1.17* (0.06) | 1.14 (0.84) |
| Wood Products | 0.47** (0.03) | -1.23* (0.07) | 0.12 (0.73) |
| Paper Product, Printing and Publishing | 0.49** (0.02) | -1.19** (0.04) | 0.07 (0.79) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | 0.47** (0.03) | -1.21* (0.07) | 0.05 (0.95) |
| Non-Metallic Mineral Products | 0.49** (0.02) | -1.19** (0.05) | 0.08 (0.78) |
| Metallic Mineral Product | 0.50** (0.02) | -1.18** (0.04) | 0.48 (0.49) |
| Metal Product, Machinery and Equipment | 0.44** (0.03) | -1.16* (0.06) | 0.02 (0.89) |
| Other Manufacturing | 0.49** (0.02) | -1.20** (0.05) | 0.30 (0.58) |

(*** denotes Significance at 1% level, ** denotes Significance at 5% level, * denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

### 3.3.2.2 Hakura's Approach with Intermediate Inputs

In Table 3.3 reports the PMGE estimation for the specification given by:

$$\mu_{it}-1=\theta_0+\theta_1\ln\left[IPR_{it}-\overline{IPR_i}\right]+\theta_2\ln\left[IPR_{-it}-\overline{IPR_{-i}}\right]$$
$$+\theta_3\ln(\frac{K}{PQ})_{it}+\theta_4\ln(\frac{\dot{Q}}{PQ})_{it}+\varepsilon_{it} \tag{3.15}$$

where IPR denotes the import penetration ratio. $\theta_1$ captures the sensitivity for an individual $i$'th industry import penetration ratio on variations of the mark-up, and $\theta_2$ captures the sensitivity for the whole sample except industry $i$ import penetration ratio on variations of the mark-up. Thus $\theta_3$ captures the sensitivity for an individual $i$'th industry the capital to output ratio on variations of the mark-up, and $\theta_4$ captures the sensitivity for an individual $i$'th industry sales on variations of the mark-up. $\mu_{it}-1$ denotes an individual $i$'th industry, where $\mu=\frac{P}{MC}$ is the mark-up. Thus allow the disturbances $\varepsilon_{it}$'s to be independently distributed across $i$ and $t$, with zero means and variances $\sigma_i^2>0$.

Taking the deviation in the regression between IPR from the mean IPR ensures that $\hat{\theta}_1$ and $\hat{\theta}_2$ do not capture unobserved differences by industry that are correlated with IPR variables.

Column 7 in Table 3.3 shows that the Hausman test accepts the inference of a long run homogeneity mark-up for the manufacturing sector. Furthermore, the $\phi-parameters$ in columns 6 confirm the presence of rapid adjustment towards long-run equilibrium for all variables. The optimal lag length was determined by Akaike Information Criterion, (AIC (1)).

Essentially, columns 2 and 3 in Table 3.3 show that increased import penetration ratio seems to have a significant negative impact on the variations of the mark-ups (since $\theta_1$ and $\theta_2$ < 0). This finding is consistent with Levinsohn (1993), Harrison (1994), Krishna and Mitra (1998), Konings and Vandenbussche (2005), and Koning *et al.* (2005) such an example.

Intuitively, an increase in import penetration ratio means that domestic firms are facing more competition because foreign firms have a bigger presence in the domestic market. Thus one can think of the increase in foreign competition in the domestic market as an increase in competitive pressure for the industry, which will lower the mark-up of price over marginal cost (for example see Baldwin (1988), Dixit (1989) and Baldwin and Krugman (1989)).

Furthermore, the implication of imports means that domestic firms will integrate into world market so has the effect of increasing price competition and hence lowering the size of the domestic mark-up of price over marginal cost. This finding is consistent with Levinsohn (1993), Harrison (1994) and Krishna and Mitra (1998) such an example.

Table 3.3

PMG estimator results for the import penetration ratios, $\frac{K}{PQ}$ and Growth of Industry sales

| Industry | $\theta_1$ | $\theta_2$ | $\theta_3$ | $\theta_4$ | $\phi(ECM)$ | h-test |
|---|---|---|---|---|---|---|
| Food, beverages and Tobacco | $-0.54^{**}$ (0.02) | $-0.10^{**}$ (0.04) | $0.08^{**}$ (0.04) | $0.53^{**}$ (0.02) | $-1.27^{*}$ (0.06) | 13.93 (2.43) |
| Textiles, Apparel and Leather | $-0.52^{**}$ (0.02) | $-0.05^{**}$ (0.04) | $0.37^{**}$ (0.05) | $0.51^{**}$ (0.02) | $-1.33^{*}$ (0.08) | 6.00 (0.20) |
| Wood Products | $-0.58^{**}$ (0.01) | $-0.16^{**}$ (0.03) | $0.15^{**}$ (0.03) | $0.57^{**}$ (0.01) | $-1.18^{**}$ (0.04) | 8.83 (0.07) |
| Paper Product, Printing and Publishing | $-0.57^{**}$ (0.02) | $-0.15^{**}$ (0.03) | $0.13^{**}$ (0.03) | $0.56^{**}$ (0.02) | $-1.20^{**}$ (0.05) | 4.15 (1.79) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | $-0.53^{**}$ (0.02) | $-0.07^{**}$ (0.04) | $0.05^{**}$ (0.04) | $0.52^{**}$ (0.02) | $-1.30^{*}$ (0.07) | 10.95 (2.65) |
| Non-Metallic Mineral Products | $-0.52^{**}$ (0.04) | $-0.05^{**}$ (0.04) | $0.03^{**}$ (0.04) | $0.51^{**}$ (0.02) | $-1.34^{*}$ (0.08) | 5.50 (0.24) |
| Metallic Mineral Product | $-0.52^{*}$ (0.02) | $-0.04^{**}$ (0.04) | $0.03^{**}$ (0.04) | $0.51^{**}$ (0.02) | $-1.35^{*}$ (0.08) | 7.80 (0.10) |
| Metal Product, Machinery and Equipment | $-0.61^{**}$ (0.01) | $-0.23^{**}$ (0.02) | $0.22^{**}$ (0.03) | $0.60^{**}$ (0.01) | $-1.15^{**}$ (0.03) | 9.55 (0.05) |
| Other Manufacturing | $-0.57^{**}$ (0.02) | $-0.14^{**}$ (0.03) | $0.13^{**}$ (0.03) | $0.56^{**}$ (0.02) | $-1.20^{**}$ (0.05) | 15.64 (1.61) |

($^{***}$ denotes Significance at 1% level, $^{**}$ denotes Significance at 5% level, $^{*}$ denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

In Table 3.4 reports the PMGE estimation for the specification given by:

$$\mu_{it} - 1 = \Theta_0 + \Theta_1 \ln\left[Tariff_{it} - \overline{Tariff_i}\right] + \Theta_2 \ln\left[Tariff_{-it} - \overline{Tariff_{-i}}\right]$$

$$+\Theta_3 \ln(\frac{K}{PQ})_{it} + \Theta_4 \ln(\frac{\dot{Q}}{PQ})_{it} + \varepsilon_{it} \qquad (3.16)$$

where $\Theta_1$ captures the sensitivity for an individual $i$'th industry tariff on variations of the mark-up, and $\Theta_2$ captures the sensitivity for the whole sample except industry $i$ tariffs on variations of the mark-up. Hence $\Theta_3$ captures the sensitivity for an individual $i$'th industry the capital to output ratio on variations of the mark-up, and $\Theta_4$ captures the sensitivity for an individual $i$'th industry sales on variations of the mark-up. $\mu_{it} - 1$ denotes an individual $i$'th industry, where $\mu = \frac{P}{MC}$ is the mark-up. Thus allow the disturbances $\varepsilon_{it}$'s to be independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2 > 0$.

Taking the deviation in the regression between *Tariff* from the mean *Tariff* ensures that $\hat{\Theta}_1$ and $\hat{\Theta}_2$ do not capture unobserved differences by industry that are correlated with *Tariff* variables.

Columns 1 and 2 in Table 3.4 indicates that increased tariffs seem to have a significant positive impact on the variations of the mark-up (since $\Theta_1$ and $\Theta_2 >$ 0). This finding is consistent with Grether (1996), Blomstrom and Kokko (1996) and Harrison (1994).

For example, in this paper finds that a 1% fall in tariffs for an individual $i$'th industry will lower mark-ups by 0.37% in Metallic Mineral Products, 0.46% in Chemical, Petroleum, Coal, Rubber and Plastics Products, 0.54% in Non-Metallic Mineral Products, 0.55% in Textiles, Apparel and Leather , 0.65% in Wood Products, 0.68% in Food, Beverages and Tobacco, 0.69% in Metal Product, Machinery and Equipment, 0.82% in Paper Product, Printing and Publishing, and 0.84% in Other Manufacturing.

This paper is also finds that a reduction in tariffs of 1% for the whole sample except $i$ manufacturing industry would lower mark-up by 0.26% in Non-Metallic Mineral Products, 0.28% in Textiles, Apparel, Leather, 0.34% in Food, Beverages, Tobacco, and Metallic Mineral Products, 0.37% in Other manufacturing, 0.39% in Paper Product, Printing, Publishing, 0.42% in Wood Products, and Chemical, Petroleum, Coal, Rubber, and Plastics Products, and 0.59% in Metal Product, Machinery and Equipment.

Tariffs on trade have been widely used to shield domestic industries from international competition. Trade barriers give domestic suppliers greater market power and allow them to increase the mark-ups of price over marginal costs. As a result, profitability is artificially high and incentives to produce efficiently are lower than in the absence of tariffs. A vast body of literature (see, for example, Helpman and Krugman, 1989) argues that this inefficiency can be remedied by liberalization of international trade. The finding in Column 1 and 2 in Table 3.4 shows that the sign of the coefficient on $\Theta_1$ and $\Theta_2$ consistent with the empirical evidence from Helpman and Krugman (1989). Intuitively, an increase in tariffs seems to have a significant positive impact on the variations of the mark-up.

Column 7 in Table 3.4 shows that the Hausman test accepts the inference of a long run homogeneity mark-up for the manufacturing sector. Furthermore, the $\phi - parameters$ in columns 6 confirm the presence of rapid adjustment towards long-run equilibrium for all variables. The optimal lag length was determined by Akaike Information Criterion, (AIC (1)).

Table 3.4

PMG estimator results for the tariffs, $\frac{K}{PQ}$, and Growth of Industry Sales

| Industry | $\Theta_1$ | $\Theta_2$ | $\Theta_3$ | $\Theta_3$ | $\phi(ECM)$ | h-test |
|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | $0.68^{*}$ (0.09) | $0.34^{*}$ (0.09) | $0.45^{*}$ (0.09) | $0.85^{*}$ (0.09) | $-1.63^{**}$ (0.04) | 3.22 (0.52) |
| Textiles, Apparel and Leather | $0.55^{*}$ (0.08) | $0.28^{*}$ (0.09) | $0.45^{*}$ (0.09) | $0.15^{*}$ (0.09) | $-1.58^{**}$ (0.05) | 1.66 (0.80) |
| Wood Products | $0.65^{*}$ (0.07) | $0.42^{*}$ (0.09) | $0.46^{*}$ (0.08) | $0.93^{*}$ (0.07) | $-1.57^{**}$ (0.03) | 6.63 (0.16) |
| Paper Product, Printing and Publishing | $0.82^{*}$ (0.09) | $0.39^{*}$ (0.09) | $0.48^{*}$ (0.09) | $0.85^{*}$ (0.09) | $-1.53^{**}$ (0.03) | 6.21 (0.18) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | $0.46^{*}$ (0.09) | $0.42^{*}$ (0.09) | $0.44^{*}$ (0.09) | $0.99^{*}$ (0.09) | $-1.62^{**}$ (0.04) | 2.97 (0.56) |
| Non-Metallic Mineral Products | $0.54^{*}$ (0.08) | $0.26^{*}$ (0.09) | $0.48^{*}$ (0.09) | $0.12^{*}$ (0.09) | $-1.59^{**}$ (0.04) | 1.88 (0.76) |
| Metallic Mineral Product | $0.37^{*}$ (0.09) | $0.34^{*}$ (0.09) | $0.49^{*}$ (0.09) | $0.03^{*}$ (0.09) | $-1.66^{**}$ (0.05) | 2.42 (0.66) |
| Metal Product, Machinery and Equipment | $0.69^{*}$ (0.08) | $0.59^{*}$ (0.09) | $0.49^{*}$ (0.08) | $0.04^{*}$ (0.08) | $-1.43^{**}$ (0.02) | 6.18 (0.19) |
| Other Manufacturing | $0.84^{*}$ (0.09) | $0.37^{*}$ (0.09) | $0.50^{*}$ (0.09) | $0.84^{*}$ (0.09) | $-1.53^{**}$ (0.03) | 6.70 (0.15) |

($^{***}$ denotes Significance at 1% level, $^{**}$ denotes Significance at 5% level, $^{*}$ denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

## 3.4 Conclusion

This paper investigates the impact of international trade and tariffs on the strength of the mark-up of price over marginal cost in manufacturing industries in Malaysia over the sample period of 1978 to 1999. This period is particularly interesting because it captures the effects of many actions in favour of international trade liberalisation on competition.

To estimate the mark-ups, this paper uses an extension of the approach put forward by Roeger (1995) where price margins are defined over gross output instead of value added. The main conclusions are summarised below.

The results are statistically robust, and the variations of the mark-ups estimated for Malaysian manufacturing industries in the 1978 to 1999 period are in the range of 44 per cent to 50 per cent for an individual $i$'th manufacturing industry. This indicates mark-ups are statistically significant and greater than one, implying the existence of market power in Malaysian manufacturing industries. These results are also plausible and more in line with other developed countries such as the U.S.A. and Japan.

This paper finds that increased import penetration ratios serve to decrease industry mark-ups in Malaysian manufacturing sectors. This implication is thus that integrating Malaysian manufacturing sectors into world markets has the effect of increasing price competition, and hence lowering the size of the domestic mark-up.

Furthermore, the overall effect of import penetration ratios on the mark-ups lead to an increase price competition, thus decreasing the size of the mark-ups in Malaysian manufacturing sectors. This has indeed been found in this paper, which is consistent with other findings such as Levinsohn (1993), Harrison (1994), Krishna and Mitra (1998), and Konings and Vandenbussche (2005), and Koning *et al.* (2005).

Finally, this paper finds that an increase in tariffs for manufacturing industries in Malaysia seems to have a significant positive impact on the mark-up. Increasing or decreasing tariffs increases or decreases the mark-ups for domestic manufacturing industries. This finding is also consistent with Grether (1996), and Harrison (1994).

# Chapter 4

## Business Cycle, Entry and Exit and the Mark-up: Evidence from Malaysian Manufacturing Industries from 1978 to 1999

### 4.0 Introduction

This paper investigates the behaviour of the mark-up of price over marginal cost under different business cycle situations. This involves examining the effect of the business cycle and of entry and exit on the strength of the mark-up in manufacturing industries in Malaysia over the sample period of 1978 to 1999. This period is particularly interesting because it captures at least two significant downturns in the Malaysian economy, namely the periods of downturn in 1984-1987 (due to lower demand in the developed countries) and in 1997-1998 (due to the Asian financial crisis). It also analyses how the interaction between firms' entry and exit, and the business cycle affects the variations in the degree and cyclicality of the mark-up.

A longstanding issue among macroeconomists is the question of why the measured productivity residual is pro-cyclical, i.e. higher in years of economic booms than in years of economic recessions. A representative neoclassical explanation is given by Real Business Cycle (RBC) theory, according to which economic booms are the result of productivity increases generated by technological shocks. In this context, productivity and output move in tandem and increases in total factor productivity (TFP) are attributable to technological shocks.

TFP is usually represented by the conventional Solow residual. However, Hall (1990) argued that, conceptually, increasing returns to scale, the mark-up ratio and demand externalities could all induce procyclicality of the Solow residual. He demonstrated that the technology factor is not the only source of the procyclicality of the Solow residual. Examining the U.S.A. industry data, Hall (1990) as well as Caballero and Lyons (1992) found that among the different factors potentially responsible for the procyclicality of the Solow residual are mark-up ratios, increasing returns to scale and demand externalities, all of which played a critical role.

Their results, however, have been questioned by Basu and Fernald (1995) and Burnside (1996), who argued that the Solow residuals calculated by Hall (1990) and Caballero and Lyons (1992) were biased because intermediate inputs were ignored and value added was used to measure output. Basu and Fernald (1995) and Burnside (1996) showed that once intermediate inputs were incorporated into the production function, it displayed constant returns to scale, whilst no demand externalities were found. Burnside (1996) and Burnside, Eichenbaum and Rebelo (1996) criticised the studies by Hall (1990) and Caballero and Lyons (1992) from a different angle: they showed that once the operating rate of capital stock, which Hall (1990) and Caballero and Lyons (1992) did not consider, was included, increasing returns to scale and demand externalities could no longer be found.

On top of that, much of the macroeconomic literature stresses the role of imperfect competition in the business cycle (see e.g. Hall (1986 and 1988), Rotemberg and Woodford (1991, 1992, 1995 and 1996a), and Gali (1994)). This literature builds upon the observation that, in many U.S.A. industries, price exceeds marginal cost and mark-ups are countercyclical. In addition to this empirical observation, an analysis of data at the business cycle frequency suggests that: firms' entry rates are procyclical; firms' exit rates are countercyclical; and mark-ups react negatively to increases in the number of firms.

The debate regarding the cyclicality of the Solow residual and imperfect competition in the business cycle and the empirical findings of these studies are also of considerable relevance to Malaysia, especially since Malaysia has achieved a relatively impressive growth rate of approximately 7% per annum since its independence in 1957 (Economic Report). In addition, in the middle of 1997, Malaysia was affected by the financial crisis that was triggered initially by the speculative attack on the Thai currency (Baht).

These empirical observations have motivated this paper to investigate behaviour of the mark-up over business cycle as well as the impact of the business cycle, and entry and exit on the strength of variations in the degree of the mark-up of price over marginal cost, for Malaysian manufacturing sector from 1978 to 1999. There are certainly many reasons to expect the mark-up to vary between industries substantially, ranging from entry conditions, type of market structure, trade composition, contestability, product differentiation, product quality, establishment size, and market size, amongst others. Thus, this paper will attempt to investigate behaviour and variations in the mark-up, as measured by the sensitivity of the mark-up toward the business cycle, and entry and exit, for sub-sectors of industries and for the sample as a whole, respectively.

In this paper as in the previous paper (Chapter 3), mark-ups are estimated for Malaysian manufacturing industries using a Nominal Solow Residual (NSR) Roeger (1995) type model. This paper also will employ the Dynamic Heterogeneous Panel Estimation (DHPE) technique proposed by Pesaran, Shin and Smith (1999), in the form of the Pooled Mean Group (PMG) and Mean Group (MG) estimator as a robustness check. The advantage of these techniques is that they incorporate the recognition of an explicit long run relationship, as well as short run dynamics. The objection to the use of a panel estimator is the reason motivating an industry-by –industry estimation approach. It is interesting to examine the extent to which the mark-up varies across the industries within a sector. However, it is also helpful to pool the data across all manufacturing industries to gain further insights into the reason for variations in the mark-up in the whole sample.

The plan of this paper is as follows. In Section 4.1, the literature review and theoretical background will be discussed. Section 4.2, the estimation methodology is outlined. In section 4.3, data are described and the regression results are presented and analysed. Section 4.4 concludes the paper by summarising the important findings.

## 4.1 Literature Review and Theoretical Background

### 4.1.1 Market Power

The estimation of the degree of market power in various U.S.A. industries has received increased attention over the last two decades from 1980s to 1990s. See for example Hall (1988), Domowitz, Hubbard, and Petersen (1988), and Roeger (1995) for studies that estimate the mark-up ratio in value added data. Similarly, for estimation of the mark-up ratio in gross output, see Morrison (1992), Norrbin (1993), Oliviera-Martins, *et al.* (1996), Basu and Fernald (1997), and Basu and Fernald (1999). Whilst these different studies use different methodological approaches and analyse different data sets, the empirical evidence emerging from these studies suggests consistently that the presence of mark-ups of prices over marginal costs is evident in many U.S.A. industries. Overall, estimates of the price over marginal cost ratio in value added data in the U.S.A. ranges between 1.2 and 1.4, whilst an estimate of the price-marginal cost ratio in gross output in the U.S.A. varies between 1.05 and 1.15. However no attention has been paid to the degree of market power in Malaysia particularly in the Malaysian manufacturing industry.

### 4.1.2 Market Power and the Business Cycle

Greenwald *et al.* (1984), Gottfries (1991), Klemperer (1995), and Chevalier and Scharfstein (1996) have studied and emphasized the role of capital-market imperfections in price fluctuations over the business cycle. When capital-market imperfections exist, the incentives for firms to make investments may be reduced because firms may not reap the profits associated with the investments. One form of investment is a low price that builds a firm's market share by attracting more customers in the future. During recession, firms may raise prices, forgoing any attempt to raise future market share, because the probability of default is high. Chevalier and Scharfstein (1996) find support for this hypothesis in data drawn from the supermarket industry.

Another strand of the literature has emphasized the role of collusion. Rotemberg and Saloner (1986), Rotemberg and Woodford (1991, 1992) and Bagwell and Staiger (1997) show that a firm participating in a collusive group may have more incentive to defect during a boom period, because the short-term gains from defection are relatively large. Thus, an optimal collusive mechanism may involve lower prices (or mark-ups over marginal cost) during booms than during recessions, in order to eliminate the incentive to defect. Bagwell and Staiger (1997) show that this pattern of countercyclical pricing (or mark-ups) becomes less likely as demand shocks become more positively correlated. The model in Bagwell and Staiger (1997) does not predict that the variance of price changes will be greater in recessions than in expansions. Their unique prediction is that a high transitory demand shock within a recessionary or expansionary regime is associated with a lower most-collusive price. This would generate a negative covariance between price changes and quantity changes within recessions and expansions.

Domowitz, Hubbard and Petersen (1987) examine the empirical evidence on cyclical responses of prices and price-cost margins. With a panel data set of industries at the four-digit SIC level spanning 1958-1981, they find that more concentrated industries have more procyclical margins. As they note, these estimates may be biased upward (downward) if marginal cost is greater (less) than measured average variable cost. Consistent with the Rotemberg and Saloner predictions, Domowitz *et al.* further find that industries with high price-cost margins have more countercyclical price movements. However, Domowitz *et al.* use industry-level changes in capacity utilization as a proxy for business cycle movements. Low capacity utilization at the industry level may simply be a result of high prices, rather than the result of a downward shift in demand. Bresnahan (1989) also points out the limitations of cross-industry comparisons of competition when assessing cyclical variations of margins and prices.

To avoid the problems of using accounting data for estimating the price-cost margin, Domowitz (1992) takes an approach that examines total factor productivity. He adjusts the Solow residual to allow firms to price above marginal cost and then permits the price-cost margin to vary with the level of aggregate demand as measured by capacity utilization in manufacturing. Domowitz's point estimates indicate that there is a negative correlation between the margin and aggregate demand movements; however, the standard errors are large enough so that the null hypothesis of cyclicality cannot be rejected.

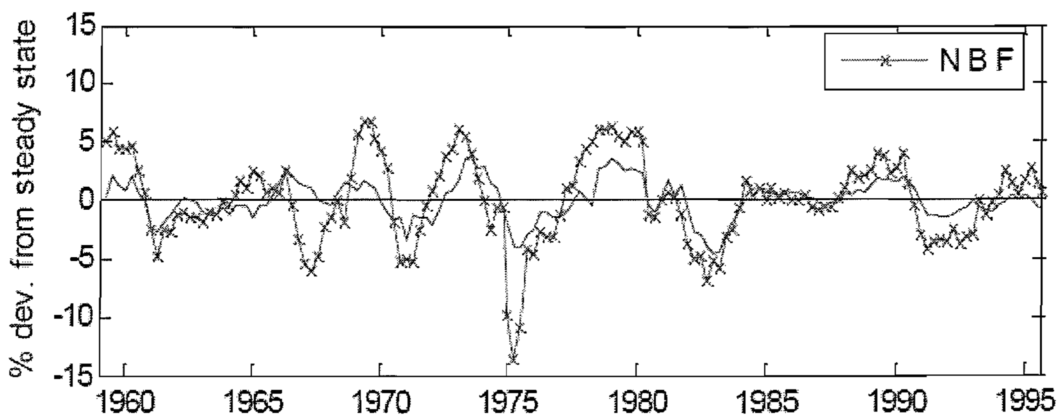
Bresnahan and Suslow (1989) study the aluminium industry and do not find any evidence of oligopoly market power. They develop an econometric model of short run supply, capacity constraints, and long-lived capital. Employing a switching regression model, they find evidence of two regimes in their reduced form quantity-produced and quantity-shipped equations. The implication is that in the high demand regime, prices are competitive (determined by the vertical portion of the supply curve) when production is constrained at capacity. Output is unconstrained in the second regime; output falls well short of capacity and prices are determined by linear average variable costs.

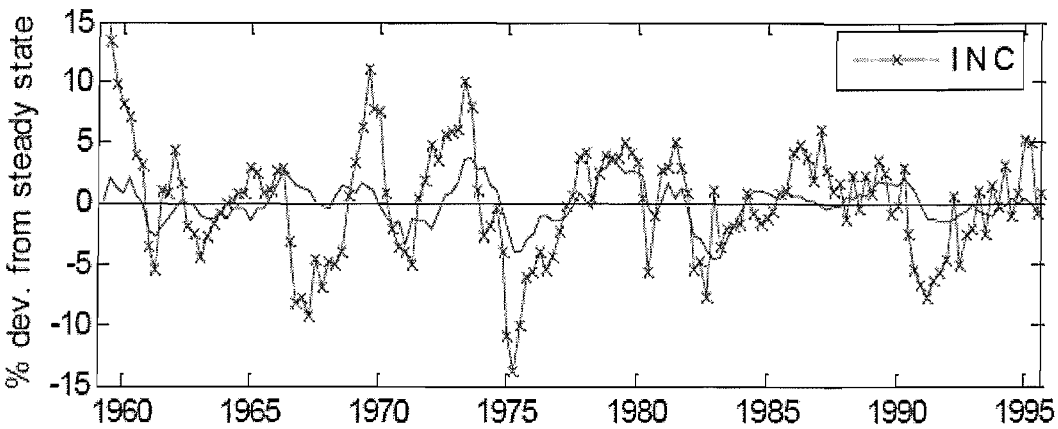
Wilson (1998) reports evidence from laboratory experiments on oligopoly pricing. The experiments are similar to the posted offer pricing experiments of Davis and Holt (1994) except that Wilson considers the effects of demand shifts rather than the effects of supply/capacity change. The results are broadly consistent with the model's prediction. When demand is high, prices are near the short run competitive level. When demand is low, prices remain above the short run competitive level and prices are more variable than when demand is high. When demand is low, prices fail to conform precisely to the equilibrium mixed strategy predictions but appear to follow a disequilibrium process similar to an Edgeworth cycle process.

### 4.1.3 Entry, Exit and the Business Cycle

Figure 4.1 reproduces the figures in Chatterjee *et al.* (1993) and Devereux, Head, and Lapham (1996). It shows cyclical fluctuations in real GDP, in the net business formation index, and in new business incorporations at the quarterly frequency between 1958 and 1995 in the U.S.A. As is evident from Figure 4.1, and as Chatterjee *et al.* (1993) and Devereux, Head, and Lapham (1996) emphasize, net business formation and the incorporation measures are all strongly procyclical. The contemporaneous correlation between the deviations from the Hodrick-Prescott (HP) trend of the net business formation index and from the HP trend of real GDP equals 0.73. The contemporaneous correlation between the deviations from the HP trend of new business incorporations and from the HP trend of real GDP equals 0.50. Similarly, Devereux, Head and Lapham (1996) report that the contemporaneous correlation between the deviations from the HP trend of the aggregate number of business failures and from the HP trend of real GDP is -0.42. A business failure is defined as the closing of a business with a loss to at least one creditor.

Figure 4.1: HP filtered GDP, Net Business Formation, and Incorporation






Devereux, Head and Lapham (1996) analyze the dynamic correlation among these three series (deviations from trend of net business formation, new business incorporation, and business failures) and the deviations from the HP trend of real GDP. These authors highlight the clear procyclicality of net business formations and of new business incorporation rates, and the clear countercyclicality of the number of business failures. They emphasise that the strongest correlation of net entry takes place either contemporaneously or slightly prior to an increase in aggregate output.

Direct measures of the number of operating firms in the U.S.A. economy exist for the years between 1988 and 2003, and this data also supports the procyclicality of the variations in the number of firms. For documentation of this data set see the Small Business Administration at http://www.sba.gov/advo/research/. The contemporaneous correlation between the deviations from the HP trend of the number of firms and the deviation from the HP trend of real GDP equals 0.50 and is significant at the 5% level. Chatterjee *et al.* (1993) provide some additional evidence on the procyclicality of the number of firms. They report that during the Great Depression the number of firms in all industries fell about 10%, whilst in the manufacturing sector the fall was in excess of 33%.

As suggested earlier, one of the empirical concerns with respect to these results is that whilst this evidence suggests that in the U.S.A. data the number of firms varies procyclically, the fluctuations are driven mainly by changes in the number of small firms. However, it is important to emphasise that variations in the number of firms are only one of the channels that generate actual changes in the number of competitors. Some evidence that addresses this claim can be found by analysing variations in the number of establishments and franchises as an additional channel affecting the number of competitors. Direct measures of the number of establishment in the U.S.A. economy exist at the yearly frequency between 1980 and 2001. Similar to the procyclicality of the number of firms, the contemporaneous correlation between deviations from the HP trend of the number of establishments and real GDP equals 0.44 and is significant at the 5% level. As noted earlier, Lafontaine and Blair (2005) demonstrate the quantitative significance of franchises in the U.S.A. economy. Again, similar to the procyclicality of the number of firms and establishments, the contemporaneous correlation between the deviation from the HP trend of the number of franchises and real GDP is positive and equals 0.32. Furthermore, at business cycle frequency, the number of franchises and establishments is significantly volatile. The ratio of the standard deviation of deviations from the HP trend of the number of franchises and the deviations from the HP trend of real GDP equals 2.8. Similarly, the ratio between standard deviation of the deviations from the HP trend of the number of establishments to deviations from the HP trend of real GDP equals 1.3. The significant fluctuations in the number of the franchises and establishments suggest that, indeed, these are two potentially important sources of fluctuation in the number of competitors at the business cycle frequency.

### 4.1.4 Variations in the Mark-up

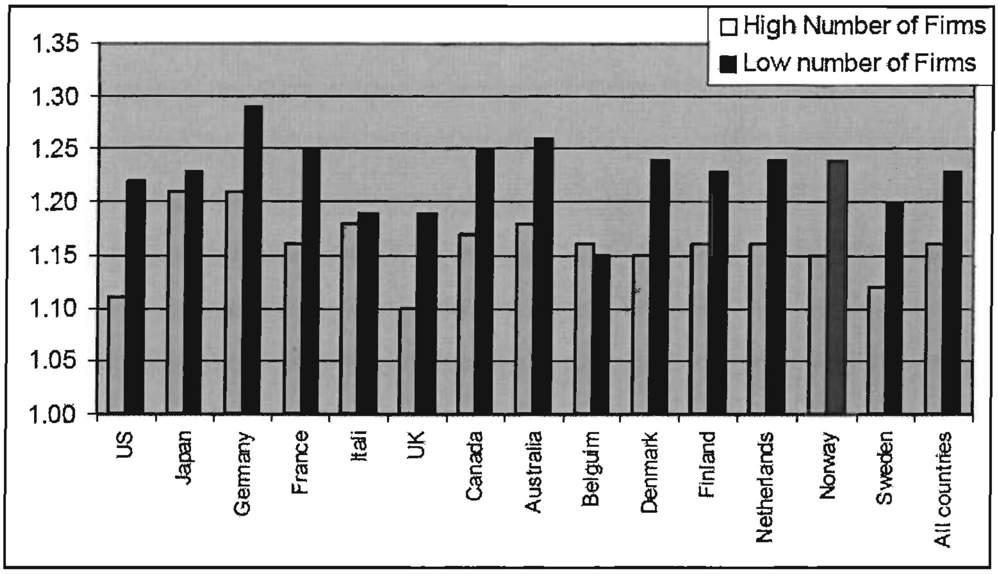
#### 4.1.4.1 Behaviour of the Mark-up

Given the unobserved nature of marginal cost, different studies use different methodological approaches to estimate the marginal cost and, in turn the cyclicality of the mark-up. Most of these studies conclude that in the U.S.A. economy mark-ups are countercyclical. For example, Bils (1987) uses two-digit industry level data to estimate countercyclical mark-ups. His results are consistent with Rotemberg and Woodford's (1991); they use mostly aggregate data and a modified Solow residual to identify technology shocks. Rotemberg and Woodford (1991) estimate the correlation between the mark-up and output time series and conclude that "....the constructed series displays strongly countercyclical mark-up variations." Murphy, Shleifer, and Vishny (1989) provide somewhat indirect evidence, showing that for many industries, output prices move countercyclically relative to input prices. This supports the existence of countercyclical mark-up variations. In a later paper, Rotemberg and Woodford (1999) use three different methods to estimate the cyclicality of the mark-up. The first method is based on wage variations: they argue that mark-ups are countercyclical. The second method involves cyclical variations in the use of intermediate inputs and in inventory accumulations. They report that, generally, this method also predicts countercyclical mark-ups. Third, they study the response of mark-ups to particular non-technological shocks. Rotemberg and Woodford (1999) use military purchases, variations in world oil prices, and monetary policy shocks. Using this approach, they argue that these experiments also support the presence of countercyclical mark-ups. Similarly, Chevalier, Kashyap, and Rossi (2003) examine the retail and wholesale prices of a large supermarket chain. They show that prices tend to fall during the seasonal demand peak for a product and that changes in the retail margin explain most of these price changes.

In an analysis that covers 14 OECD countries, Oliviera-Martins *et al.* (1996) report on the cyclical properties of mark-ups from 1970 to 1992. They classify industries by relative establishment sizes and Research & Development intensity. Following a two-by-two classification, they find mark-ups to be countercyclical in 53 out of the 56 cases they consider, and to a degree that is statistically significant in most. In addition, they conclude that entry rates are negatively and significantly correlated with mark-ups, and argue, "....this seems to lend support to the hypothesis that countercyclical pattern of mark-ups is the result of increased competition during economic booms." Figure 4.2 presents evidence reported by Oliviera-Martins *et al.* (1996) and shows the relationship between the number of firms and the mark-up in manufacturing industries in OECD countries. As can been seen in the Figure 4.2, in all of OECD countries except Belgium, the sectors with more firms have lower mark-ups. Morrison (1994) finds countercyclical mark-ups for the U.S.A. manufacturing sector whilst documenting procyclical mark-ups for the Canadian manufacturing sector. In a well-known work, Domowitz, Hubbard, and Petersen (1986) suggest that mark-ups are procyclical. However, Rotemberg and Woodford (1999) highlight some potential biases in the results, because they are based on measures of average variable costs, not on marginal costs.

Regarding the interaction between the number of operating firms and the price-marginal cost ratio, Bresnahan and Reiss (1991) find that competitive conduct changes quickly as the number of incumbents increase. They report that increases in the number of producers will increase the competitiveness in the market they analyse. Finally, Campbell and Hopenhayn (2005) provide empirical evidence to support the argument that "Face-to-Face" strategic interactions are an important component of competition. They emphasise that one implication of this evidence is that the number of competitors they face affects firms' pricing decisions. Campbell and Hopenhayn (2005) provide estimates for the "toughness of price competition" and show that mark-ups react negatively to an increase in the number of firms.

Figure 4.2: Mark-ups and Number of Firms in Manufacturing in the OECD (Oliviera-Martins *et al.* (1996))




### 4.1.4.2 Why Mark-up varies

The variations in the mark-up in manufacturing industries must be in part due to differences in entry conditions into each industry. Traditionally, entry conditions and the resulting market structures have been related to technological conditions, such as economies of scale and scope. The entry of new firms can be expected to bring prices down to average costs over the long run (Oliviera-Martins *et al.*, 1996). Another explanation of the variations in the mark-up is the existence of product differentiation. Research such as Falvey (1981), Shaked and Sutton (1983) and Falvey and Kierzkowski (1987) has focused on so-called "vertical" product differentiation where firms are able to influence the perceived quality of their products. In industries where firms engage in such product differentiation, product strategies may be able to influence entry conditions in the market; this influence could generate endogenous sunk costs, e.g. large advertising or R & D expenditures. These industries could not exist under a regime of perfect competition.

Along these lines, the rationale for consistent variations in the mark-up in manufacturing industry also rests on the type of industry and form of competition. Following Sutton (1991) and a subsequent discussion by Schmalensee (1992), two major types of industries (or type of competition) can be identified. Industries with typical small average establishment size were termed "fragmented" industries (industries with a small average establishment in which the number of firms typically grows in line with the size of the markets). In "segmented" industries (industries characterised by the existence of large establishments, covering a large proportion of employment and output), concentration remains relatively stable or converges towards a finite lower bound. This market structure taxonomy can also be related to more direct indicators of sunk costs and product innovation and to qualitative information about the different industries (see Oliviera-Martins *et al.*, 1996 for more details on the set of market structure indicators used to group industries into market structure taxonomy). The expectation is that the impact of the business cycle, and entry and exit, on the mark-up variations in manufacturing industry tends to be more volatile and sensitive in "fragmented" industries than in "segmented" industries. This seems to lend support to the hypothesis that counter-cyclical pattern of the mark-up is the result of increased competition during economic booms. This is indeed likely to be more apparent for the industries characterised by an industry dominance of small firms or establishments in which the number of firms typically grows in line with the size of the markets (Sutton (1991) and Schmalensee (1992)).

Furthermore, the variations in the mark-up in manufacturing industries must be also in part due to the way that each firm in manufacturing industry takes into account the effect of the pricing and production decisions of other firms on the demand for its goods. Thus the more firms in a sector, the more elastic is the demand that each producer faces; this leads in turn to a lower mark-up that the producer can charge. According to Bernard *et al.* (2003), producers that are more efficient tend to have cost advantages over their competitors in their industry and therefore set higher mark-ups. At the same time, in an industry where there are a number of efficient firms, mark-ups may be relatively low. Research such as Bagwell and Ramey (1995) found that the variety of goods offered for sale at a given establishment in an industry is an important dimension of producers' quality. If firms with larger variety have larger sales and more employees, then competition between a few firms in an industry to provide high variety can produce a positive relationship between market size and establishments' size. It appears that competition in an industry is tougher in larger markets. Furthermore Jeffrey *et al.* (2005) found that producers in on industry with larger markets are more competitive and have lower price-cost mark-up. This means that producers in more competitive markets must recover their fixed costs by selling more at a lower mark-up.

### 4.1.5 The productivity residuals and the mark-up

Under the assumption of constant returns to scale and constant mark-up, the primal Solow residual (SR, but often termed growth in TFP) can be expressed as follows (Hall, 1990):

$$TFP = SR = \Delta q_{it} - \alpha \Delta n_{it} - (1-\alpha)\Delta k_{it} = (\mu - 1)\alpha(\Delta n_{it} - \Delta k_{it}) + \Theta_{it} \qquad (4.1)$$

where the left hand side of Equation (4.1) has become known as the primal "Solow Residual" (SR). The mark-up of price over marginal cost is: $\mu = \frac{P}{MC}$, with $\Delta$ denoting the first difference or growth rate, lower case denotes the natural logarithms transform, $q$, $n$, and $k$ denote real value added, labour, and capital inputs respectively, $\alpha$ is the labour share in value added, and $\Theta = \frac{\dot{A}}{A}$ denotes exogeneous Hicks-neutral technological progress.

Under perfect competition $\mu = 1$, while imperfectly competitive markets allow $\mu > 1$. Estimation of Equation (4.1) faces the difficulty that the explanatory variables $(\Delta n - \Delta k)$ will themselves be correlated with the productivity shocks, which results in bias and inconsistency in the estimate of $\mu$. One solution is to use an instrument, which in turn raises the requirement that the instruments are correlated with the factor inputs, but not with technological change and hence the error term.

Roeger (1995) has suggested an alternative approach to avoid the endogeneity bias and instrumentation problems. By computing the dual of the Solow Residual (DSR), a relation of the price-based productivity measure to the mark-up can again be obtained as the expression below:

$$DSR_{it} = \alpha \Delta w_{it} + (1-\alpha)\Delta r_{it} - \Delta p_{it} = (\mu - 1)\alpha(\Delta w_{it} - \Delta r_{it}) + \Theta_{it} \tag{4.2}$$

with w, r and p denoting the natural logarithms of the wage rate of labour, rental price of capital and price of output respectively. Whilst Equation (4.2) is subject to the same endogeneity problems, and hence instrumentation problems as Equation (4.1), Roeger's insight was that subtraction of Equation (4.2) from Equation (4.1) would give the nominal Solow residual (NSR), given by:

$$\begin{aligned} NSR_{it} &= \Delta(p_{it} + q_{it}) - \alpha\Delta(n_{it} + w_{it}) - (1-\alpha)\Delta(k_{it} + r_{it}) \\ &= (\mu_{it} - 1)\alpha\left\{\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it})\right\} \end{aligned} \tag{4.3}$$

in which the productivity shocks have cancelled out, removing the endogeneity problem, leaving an equation with only observable variables. The NSR is a function of the mark-up, the labour share and the growth rate of the ratio of labour to capital costs.

Equation (4.3) is a rather well mannered expression for the estimation of the mark-up ratio. Adding an error term, the mark-up can be estimated by standard OLS techniques. Alternatively, the mark-up coefficient could even be calculated algebraically for each year and each sector and a simple average computed over a given period:

$$\mu_{it} - 1 = \frac{\Delta(p_{it} + q_{it}) - \alpha\Delta(n_{it} + w_{it}) - (1-\alpha)\Delta(k_{it} + r_{it})}{\alpha(\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it}))} \tag{4.4}$$

Oliveira-Martins *et al.*, (1999) demonstrate that where the assumption of constant returns to scale is dropped, Equation (4.3) is actually:

$$NSR_{it} = \left(\frac{\mu}{\lambda} - 1\right)\alpha\left\{\Delta(n_{it} + w_{it}) - \Delta(k_{it} + r_{it})\right\} \tag{4.5}$$

where $\lambda > 1$ denotes increasing returns to scale. From Equation (4.5) it can be seen that with increasing returns to scale, Roeger's method produces a downward bias in the estimation mark-up. For example, if the "true" mark-up coefficient is 1.33 and $\lambda$ is equal to 1.2, the mark-up ratio estimated by means of Equation (4.3) would be 1.10. Conversely, the presence of decreasing returns to scale induces an upward bias in the estimation of the mark-up. Thus any estimates of the mark-up that follow from Solow residuals should be interpreted as lower bound values of the true mark-ups if increasing returns to scale are present.

Equation (4.3) can be easily extended in order to incorporate intermediate inputs and express the mark-up ratio over gross output (GO) instead of value added (VA). This correction is important, insofar as the mark-up over value added induces a clear upward bias in the estimation. Indeed, Basu and Fernald (1997) show that the measurement of real value added assumes that the elasticity of output with respect to intermediate inputs equals its revenue share, which is only true if there is perfect competition. In the presence of market power, shifts in the intermediate inputs will be incorrectly attributed to shifts in value added and estimates of the mark-ups will be biased.

Taking into account intermediate inputs, Equation (4.3) becomes:

$$\begin{aligned} NSRGO_{it} &= \Delta(\tilde{p}_{it} + \tilde{q}_{it}) - \tilde{\alpha}\Delta(n_{it} + w_{it}) - \tilde{\beta}\Delta(m_{it} + p_{it}^{m}) - (1 - \tilde{\alpha} - \tilde{\beta})\Delta(k_{it} + r_{it}) \\ &= \mu_{it} - 1\left\{\tilde{\alpha}\Delta(n_{it} + w_{it}) + \tilde{\beta}\Delta(m_{it} + p_{it}^{m}) - (\tilde{\alpha} + \tilde{\beta})\Delta(k_{it} + r_{it})\right\} \qquad (4.6) \end{aligned}$$

where $\Delta$ denotes the first difference or growth rate, $\tilde{p}$ and $\tilde{q}$ correspond to gross output and its respective price, $m$ and $p^{m}$ correspond to intermediate inputs and their prices, $k$ and $r$ correspond to capital inputs and their price and $\tilde{\alpha}$ and $\tilde{\beta}$ to the share of labour and intermediate inputs in gross output value respectively. This extension for intermediate inputs illustrates an important advantage of Roeger's approach. Equation (4.6) only requires nominal variables, there is no need to gather price indexes for intermediate inputs, information that is not readily available. However, the treatment of capital costs still requires a separate computation for the growth rate of the rental price of capital, r.

### 4.1.6 Sectoral Business Cycles and Dynamic Mark-up

Empirical studies have indicated the possibility that the mark-up may be sensitive to the business cycle (See Bils, 1987; Domowitz *et al.*, 1988; Rotemberg and Woodford, 1991; Morrison, 1994, Haskel *et al.*, 1995; and Beccarello, 1996), although their reliance on the Hall methodology is likely to compromise their reliability (See the discussion in Ramey, 1991). Theory is ambiguous concerning the expectations that might form on mark-up behaviour over the business cycle. Both counter-and pro-cyclical mark-ups are feasible. The mark-up is likely to depend on the specific product market conditions in which each firm operates. Oligopolistic markets in which conjectural response behaviour is present would generate mark-ups that depend on market conditions. Where capacity utilisation constraints are present, mark-ups would be pro-cyclical (Chatterjee *et al.*, 1993).

Counter-cyclical mark-ups are also feasible. Where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up (Chatterjee *et al.*, 1993). Where firms develop customer bases during expansions, mark-ups may again prove counter-cyclical (Bil, 1987, and Phelps, 1994). Should firms defecting from cartels increase market share during upturns, the gain from increased market share may outweigh the long-term loss from cartel punishment (Rotemberg and Saloner, 1986; and Chevalier and Scharfstein, 1996). Since profit maximisation implies that the mark-up is an inverse function of demand elasticity, the mark-up will prove counter-cyclical as long as product variety is pro-cyclical (Weitzman, 1982).

In addition considerable attention has been paid to the fixity or variability of the mark-up and thus the profit rate. The debate over the variability of the mark-up has been primarily empirical in nature. The major area of contention has centred on the demand sensitivity of the mark-up (e.g. see Dolan, (1984), Eckstein *et al.*, (1972), Goldstein, (1986a, and Gordon (1975)). On the one hand, proponents of cyclically fluctuating mark-up consider both cost and demand determinants of the mark-up and focus on the income elasticity of demand to explain mark-ups that decline during the expansion phase of the business cycle and rise during the contraction. Where entry into markets is feasible, the expansion phase of the business cycle would be characterised by entry, increased competition, and downward pressure on the mark-up (Chatterjee *et al.*, 1993). On the other hand, there are the cost dominated theories of the mark-up, which predominantly argue that the mark-up is constant over the business cycle (e.g. see Blair (1972) and Eichner (1976)).

Thus, this paper will attempt to concentrate on the variability of the mark-up. A simple way to measure the variability of the mark-up over the business cycle is to postulate a linear relationship between price cost mark-ups and a variable which captures the cyclical fluctuations of demand (e.g. see Domowitz *et al.*, (1988), Haskel (1995) and Beccarello (1996)).

Assume the following relation between the *Lerner Index (B)* and the business cycle (see more detailed discussion in Appendix 4.2):

$$B_{it} = \overline{B} + \lambda \ln CYCL_{it} \qquad (4.7)$$

where $(CYCL)$ is an indicator of cyclical variation. For the measure of cyclical variation$(CYCL)$, the literature has employed different proxies for product demand at either the aggregate or the sectoral level. For example, aggregate unemployment and capacity utilisation (both in Haskel *et al.*, 1995), sectoral employment (Bils, 1987), and deviations of output from long term trend as given by the Hodrick-Prescott (HP) filter (Oliviera-Martins *et al.*, 1999).

Thus the deviation of industry output from its long-term trend will be used in this paper to proxy for the measure of cyclical variation $(CYCL)$. The trend of output of Malaysian manufacturing industry from 1978-1999 is obtained on a smoothing approach based on the Hedrick-Prescott filter. The weighting factor is set to 100.

Drawing from Equation (4.7) and maintaining the simplifying assumption of constant returns to scale, it can be shown that the new estimating equation with a cyclical mark-up is as follows (see also more detailed discussion in Appendix 4.2):

$$NSR_{it} = \overline{B}(OLIVIERA_{it}) + \lambda\left[OLIVIERA_{it}(\ln CYCL_{it}) - \Delta \ln CYCL_{it}\right] \quad (4.8)$$

where $OLIVIERA_{it} = \Delta\left(p_{it} + q_{it}\right) - \Delta\left(k_{it} + r_{it}\right)$ (4.9)

with $\Delta\left(p_{it} + q_{it}\right)$ denotes the change in nominal value added, $\Delta(k_{it} + r_{it})$ denotes the change in total capital stock and $B = \frac{P - MC}{P} = 1 - \frac{1}{\mu}$ is the *Lerner Index*, such that $\overline{\mu} = \frac{1}{1 - \overline{B}}$ gives the constant component of the mark-up, whilst $\lambda$ provides an estimate of the cyclical component of the mark-up. The $\lambda$ parameter can be negative or positive, implying a counter-cyclical or pro-cyclical variation of mark-ups.

Further augmenting Equation (4.8) to allow for cyclical variation of the mark-up for an individual *i*'th industry,

equation (4.8) can be rewritten as follows:

$$NSR_{it} = \overline{B}(OLIVIERA_{it} - \overline{OLIVIERA_i}) + \lambda\left[(MARKUPCHARACTER_{it} - \overline{MARKUPCHARACTER_i})\right] \quad (4.10)$$

where $OLIVIERA_{it} = \Delta\left(p_{it} + q_{it}\right) - \Delta\left(k_{it} + r_{it}\right)$ and

$MARKUPCHARACTER_{it} = OLIVIERA_{it}(\ln CYCL_{it}) - \Delta \ln CYCL_{it}$,

$MARKUPCHARACTER_{it}$ denotes the natural logarithm of cyclical variation of mark-up for an individual $i$'th industry, and $\overline{MARKUPCHARACTER_i}$ denotes the natural logarithm of the mean cyclical variation of mark-up for an individual $i$'th industry. $NSR_{it}$ is the Nominal Solow Residuals for an individual $i$'th industry. Thus $\lambda$ captures the counter-cyclical (negative signs) or pro-cyclical (positive signs) for an individual $i$'th industry variation of the mark-up.

The industry-level mean value of $MARKUPCHARACTER$ ($\overline{MARKUPCHARACTER}$) is defined as the total value of $MARKUPCHARACTER$ divided by the number of industry in the list in natural logarithms.

The industry-level mean value of $OLIVIERA$ ($\overline{OLIVIERA}$) is defined as the total value of $OLIVIERA$ divided by the number of industry in the list in natural logarithms.

Moreover, the impact of the business cycle on the strength of the mark-up of price over marginal cost can be tested as follows:

$$\mu_{it} - 1 = \Lambda_0 + \Lambda_1 \ln(CYCL_{it} - \overline{CYCL_i}) + \Lambda_2 \ln(CYCL_{-it} - \overline{CYCL_{-i}}) \qquad (4.11)$$

where $CYCL$ is defined as for Equation (4.7). In addition Equation (4.11) splits the sources of the variations of the mark-up in manufacturing industry into two components: that due to the impact of deviations of demand fluctuations from the mean value of demand fluctuations on variations of the mark-up for an individual $i$'th manufacturing industry; and that due to the impact of deviations of demand fluctuations from the mean value of demand fluctuations on variations of the mark-up for the whole sample except for manufacturing industry *i*. Thus $\Lambda_1$ captures the sensitivity for an individual $i$'th manufacturing industry demand fluctuation of the variations on the mark-up, and $\Lambda_2$ captures the sensitivity for the whole sample except for manufacturing industry $i$ demand fluctuations of the variations on the mark-up.

$\mu_{it} - 1$ denotes the mark-up according to Equation (4.4) having already taken into account intermediate inputs.

The industry-level mean value of $CYCL$ ($\overline{CYCL}$) is defined as the total value of $CYCL$ divided by the number of industry in the list in natural logarithms.

Furthermore, the impact of entry and exit on the mark-up can be investigated as given by:

$$\mu_{it} - 1 = \tau_0 + \tau_1 \ln(EntryExit_{it} - \overline{EntryExit_i}) + \tau_2 \ln(EntryExit_{-it} - \overline{EntryExit_{-i}}) \quad (4.12)$$

where $\ln EntryExit_{it}$ denotes the natural logarithm of entry and exit for an individual $i$'th industry, $\ln EntryExit_{-it}$ denotes the natural logarithm of entry and exit for the whole sample except for industry *i*, $\ln \overline{EntryExit_i}$ denotes the natural logarithm of the mean entry and exit for an individual $i$'th industry, and $\ln \overline{EntryExit_{-i}}$ denotes the natural logarithm of the mean entry and exit for whole sample except for industry *i*. In addition Equation (4.12) also splits sources of the sensitivity of variations of the mark-up in manufacturing industry into two components: that due to the impact of deviations of entry and exit from the mean value of entry and exit on variations of the mark-up for an individual $i$'th manufacturing industry; and that due to the impact of deviations of entry and exit from the mean value of entry and exit on variations of the mark-up for the whole sample except for manufacturing industry *i*.

Hence $\tau_1$ captures the sensitivity of the mark-up to entry and exit for an individual $i$'th manufacturing industry, and $\tau_2$ captures the sensitivity of the mark-up to entry and exit for the whole sample except for manufacturing industry *i*.

To measure entry and exit in the Malaysian manufacturing industry, the turnover rate will be employed. The turnover rate will be defined as entering firms plus exiting firms divided by total firms.

The industry-level mean value of $EntryExit$ ($\overline{EntryExit}$) is defined as the total value of $EntryExit$ divided by the number of industry in the list in natural logarithms.

$\mu_{it} - 1$ denotes the mark-up according to Equation (4.4) having already taken into account intermediate inputs.

## 4.2 The Econometric Methodology

To proceed, Equations (4.10), (4.11), and (4.12) will be estimated. The Pooled Mean Group (PMG) estimator has been employed as a panel estimator for estimation of Equations (4.10), (4.11), and (4.12) provided by Pesaran, Shin and Smith (1999). See also the discussion in Fedderke, Shin and Vaze (2000) and Fedderke (2003a).

### 4.2.1 Panel Estimator

Consider the unrestricted error correction ARDL (p,q) representation:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \beta_i' X_{i,t-1} + \sum_{j=1}^{p-1} \omega_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \Delta X_{i,t-j} + \Omega_i + \varepsilon_{it} \qquad (4.13)$$

where $i = 1, 2, ...., N, t = 1, 2, ..., T$, p, q denote the cross section units, time period, lags dependent and lags independent variable respectively. Here $y_{it}$ is a scalar dependent variable, $X_{it}(k\text{x}1)$ a vector of (weakly exogenous) regressors for group *i*, and $\Omega_i$ represents fixed effects. Allow the disturbances $\varepsilon_{it}$'s to be independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2 > 0$, and assume that $\phi_i < 0$ for all *i*. Then there exists a long-run relationship between $y_{it}$ and $X_{it}$:

$$y_{it} = \theta_i' X_{it} + \eta_{it}, \; i = 1, 2, ...., \text{N}, \; t = 1, 2, ....., \text{T}, \qquad (4.14)$$

where $\theta_i = \frac{-\beta_i'}{\phi_i}$ is the *k* x 1 vector of the long-run coefficients, and $\eta_{it}$'s are stationary with possibly non-zero means (including fixed effects). This allows Equation (4.14) to be written as:

$$\Delta y_{it} = \phi_i \eta_{i,t-1} + \sum_{j=1}^{p-1} \omega_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta'_{ij} \Delta X_{i,t-j} + \Omega_i + \varepsilon_{it} \tag{4.15}$$

where $\eta_{i,t-1}$ is the error correction term given by Equation (4.14), and thus $\phi_i$ is the error correction coefficient measurement (ECM) the speed of adjustment towards the long-run equilibrium.

This general framework allows the formulation of the PMG estimator, which allows the intercepts, short-run coefficients and error variances to differ freely across groups, but the long-run coefficients to be homogeneous; i.e. $\theta_i = \theta \forall i$. Group specific short-run coefficients and the common long-run coefficients are computed by the pooled maximum likelihood estimation. Denoting these estimators by $\tilde{\phi}_i, \tilde{\beta}_i, \tilde{\omega}_{ij}, \tilde{\delta}_{ij}$ and $\tilde{\theta}_i$. The PMG estimation will be obtained by $\hat{\phi}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\phi}_i}{N}, \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\beta}_i}{N}, \hat{\omega}_{jPMG} = \frac{\sum_{i=1}^{N} \tilde{\omega}_i}{N}$, $j = 1, \dots p-1$, and $\hat{\delta}_{PMG} = \frac{\sum_{i=1}^{N} \tilde{\delta}_{ij}}{N}, j = 0, \dots, q-1, \hat{\theta}_{PMG} = \tilde{\theta}.$

PMG estimation provides an intermediate case between the dynamic fixed effects (DFE) estimator, which imposes the homogeneity assumption for all parameters except for the fixed effects, and the mean group (MG) estimator proposed by Pesaran and Smith (1995), which allows for heterogeneity of all parameters. PMG exploits the statistical power offered by the panel through long-run homogeneity, while still admitting short-run heterogeneity.

The crucial question is whether the assumption of long-run homogeneity is justified, given the threat of inefficiency and inconsistency noted by Pesaran and Smith (1995). A Hausman (1978) test (hereafter h-test) will be employed on the difference between MG and PMG estimates of long-run coefficients to test for long run heterogeneity. An alternative is offered by Log-Likelihood Ratio test.

However, the finite sample performances of such tests are generally unknown and thus unreliable. Note that as long as the homogeneity Hausman test is passed in the estimations, the report will focus only on the PMG estimation results.

Finally, it is worth pointing out that a crucial advantage of the estimation approach of this paper is that the dynamics of adjustment in the mark-up are explicitly modelled, while recognising the presence of a long run equilibrium relationship underlying the dynamics. Thus the justification for the use of the PMG estimator is that it is consistent both with the underlying theory of a homogeneous long-run mark-up of price over marginal cost relationship and the possibly heterogeneous dynamic time series nature of the data. As long as sector-homogeneity is assured, the PMG estimator offers efficiency gains over the MG estimator, while granting the possibility of dynamic heterogeneity across sectors unlike the DFE estimator. In the presence of long-run homogeneity, therefore, the use of the PMG estimator is the preference.

## 4.3 The Data, Method of Estimation and Results

### 4.3.1 The Data

Refer to 3.3.1 page 130 to 131 for similar data descriptions.

*CYCL*

The deviation of industry output from its long-term trend will be used for the measure of cyclical variation. The trend of output of Malaysian manufacturing industry from 1978-1999 is obtained on a smoothing approach based on the Hedrick-Prescott filter. The weighting factor is set to 100.

*Entry and Exit*

To measure entry and exit in the Malaysian manufacturing industry, the turnover rate will be employed. The turnover rate will be defined as entering firms plus exiting firms divided by total firms.

Table 4.1 provides the list of sectors included in the panel observations.

Table 4.1
Five digit Malaysian Manufacturing Industries

| Sectors | Period (T) | Five digit SIC (N) | Total of Panel Observations (NT) |
|---|---|---|---|
| Food, beverages and Tobacco | 22 | 33 | 726 |
| Textiles, Apparel and Leather | 22 | 22 | 484 |
| Wood Products | 22 | 70 | 1540 |
| Paper Products, Printing and Publishing | 22 | 45 | 990 |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | 22 | 31 | 682 |
| Non-Metallic Mineral Products | 22 | 24 | 528 |
| Metallic Mineral Products | 22 | 26 | 572 |
| Metal Products, Machinery and Equipment | 22 | 74 | 1628 |
| Other Manufacturing | 22 | 46 | 1012 |

### 4.3.2 Panel Estimation Results for Malaysian Manufacturing Industry

#### 4.3.2.1 Oliveira-Martins approach for estimating the constant components and behaviour of the mark-up over business cycle for each individual *i*'th industry.

Table 4.2 reports the PMGE estimations for the constant components of the mark-up and behaviour of the mark-up over Business Cycles for each individual *i*'th industry (Equation 4.16) as in the specification given by:

$$NSRGO_{it} = \lambda_0 (OLIVIERA_{it} - \overline{OLIVIERA_i}) + \lambda_1 \left[ (MARKUPCHARACTER_{it} - \overline{MARKUPCHARACTER_i}) \right] + \varepsilon_{it} \quad (4.16)$$

where $OLIVIERA_{it} = \Delta(p_{it} + q_{it}) - \Delta(k_{it} + r_{it})$

$MARKUPCHARACTER_{it} = OLIVIERA_{it}(\ln CYCL_{it}) - \Delta \ln CYCL_{it}$,

$\ln CYCL$ is an indicator of cyclical variation in natural logarithms. In this paper, the deviation of industry output from its long-term trend will be used as the measure of cyclical variation ($CYCL$). The trend of output of Malaysian manufacturing industry from 1978-1999 is obtained on a smoothing approach based on the Hedrick-Prescott filter. The weighting factor was set to 100.

$MARKUPCHARACTER_{it}$ denotes the natural logarithm of the behaviour of the mark-up over the business cycle for an individual $i$'th industry, $\overline{MARKUPCHARACTER_i}$ denotes the natural logarithm of the mean behaviour of the mark-up over the business cycle for an individual $i$'th industry. $NSRGO_{it}$ is the Nominal Solow Residual in Gross Output for an individual $i$'th industry.

Thus allow the disturbances $\varepsilon_{it}$ 's to be independently distributed across $i$ and $t$, with zero means and variances $\sigma_i^2 > 0$. Furthermore $\lambda_1$ captures the counter-cyclical (negative signs) or pro-cyclical (positive signs) for an individual $i$'th industry variation of the mark-up.

Taking the deviation in the regression between $MARKUPCHARACTER$ from the mean $MARKUPCHARACTER$ ensures that $\hat{\lambda}_1$ does not capture unobserved differences by industry that is correlated with $MARKUPCHARACTER$ variables.

Taking the deviation in the regression between $OLIVIERA$ from the mean $OLIVIERA$ ensures also that $\hat{\lambda}_0$ does not capture unobserved differences by industry that is correlated with $OLIVIERA$ variables.

The *Lerner index* is given directly by $\lambda_0 = \frac{P - MC}{P} = 1 - \frac{1}{\mu}$, containing the constant component of the mark-up. In order to render the mark-up estimate consistent with the preceding results, this paper will report it in the form $(\mu - 1) = \frac{\lambda_0}{1 - \lambda_0}$ for Equation (4.16). The signs of $\lambda_1$ indicates the cyclical character of the mark-up directly. If the $\lambda_1$ parameter is negative (< 0) , then a counter-cyclical variation of the mark-ups is implied, however if $\lambda_1$ parameter is positive (> 0), this implies pro-cyclical variations of the mark-ups.

$OLIVIERA_{it}$ is defined as for Equation (4.9) having already taken into account intermediate inputs.

In Table 4.2 Column 3 indicates that on the cyclical methodology, the constant component of the mark-up varies between 43 per cent and 49 per cent for an individual $i$'th manufacturing industry.

Column 5 in Table 4.2 shows the cyclical character of the mark-ups. The cyclical character of the mark-up suggests a statistically significant counter-cyclical variation of the price – marginal cost ratio over the business cycle for an individual *i*'th manufacturing industry (since $\lambda_1 < 0$). This is consistent with a growing body of empirical literature such as Bils (1987) and Rotemberg and Woodford (1999) showing that during economic booms there tends to be increased competition due to an increase in the number of firms entering to the market, thereby creating downward pressure on price cost margins.

Furthermore, the introduction of the cyclical variable (i.e. *Lerner Index*) does not have much effect on the values and the statistical significance of the constant component of the mark-up ($\overline{\mu} = \frac{1}{1-\overline{B}}$) as shown in Column 2 and Column 3 for an individual *i*'th manufacturing industry of Table 4.2. This finding is also consistent with Oliviera-Martins *et al.*, (1999).

Column 7 in Table 4.2 shows that the Hausman test accepts the inference of a long run homogeneity mark-up for an individual *i*'th manufacturing industry. Furthermore, the $\phi - parameters$ in Columns 6 confirm the presence of rapid adjustment towards long-run equilibrium relationship between NSRGO, business cycles and cycle variations for an individual *i*'th manufacturing industry. The optimal lag length was determined by Akaike Information Criterion, (AIC (1)).

Table 4.2
PMG estimator results for the constant components and behaviour of the mark-up over business cycle for an individual $i$'th manufacturing industry

| Industry (1) | Roeger Approach $\mu-1$[1] (2) | Oliveira-martins Approach $\mu-1$ (3) | $\lambda_0$ (4) | $\lambda_1$ (5) | $\phi(ECM)$ (6) | h-test (7) |
|---|---|---|---|---|---|---|
| Food, Beverages and Tobacco | 0.45 | 0.43 | 0.30** (0.03) | -0.69** (0.04) | -0.76* (0.08) | 5.52 (0.23) |
| Textiles, Apparel and Leather | 0.46 | 0.45 | 0.31** (0.04) | -0.70** (0.04) | -0.79* (0.09) | 5.03 (0.08) |
| Wood Products | 0.47 | 0.47 | 0.32** (0.02) | -0.71** (0.02) | -0.82* (0.06) | 11.36 (1.04) |
| Paper Product, Printing and Publishing | 0.49 | 0.47 | 0.32** (0.02) | -0.75** (0.03) | -0.81* (0.08) | 8.67 (0.09) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | 0.47 | 0.45 | 0.31** (0.04) | -0.70** (0.04) | -0.79* (0.09) | 4.03 (0.30) |
| Non-Metallic Mineral Products | 0.49 | 0.47 | 0.32** (0.04) | -0.72** (0.04) | -0.81* (0.09) | 2.22 (0.60) |
| Metallic Mineral Product | 0.50 | 0.49 | 0.33** (0.02) | -0.75** (0.04) | -0.86* (0.09) | 2.35 (0.56) |
| Metal Product, Machinery and Equipment | 0.44 | 0.43 | 0.30** (0.04) | -0.72** (0.04) | -0.80* (0.06) | 13.40 (1.03) |
| Other Manufacturing | 0.49 | 0.49 | 0.33** (0.02) | -0.78** (0.03) | -0.84* (0.08) | 8.96 (0.07) |

(*** denotes Significance at 1% level, ** denotes Significance at 5% level, * denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

[1]From Table 3.2, page 136 in Chapter 3. All reported $\mu-1$ are significant.

#### 4.3.2.2 The impact of demand fluctuations on the mark-up for an individual *i*'th industry and for the whole sample except for industry *i*

Table 4.3 reports the PMGE estimation of the impact of demand fluctuations on the mark-up for an individual *i*'th industry and the whole sample except industry *i* using the specification given by:

$$\mu_{it} - 1 = \Lambda_0 + \Lambda_1 \ln(CYCL_{it} - \overline{CYCL_i}) + \Lambda_2 \ln(CYCL_{-it} - \overline{CYCL_{-i}}) + \varepsilon_{it} \qquad (4.18)$$

where $CYCL$ is defined as for Equation (4.9). $\Lambda_1$ captures the sensitivity for an individual $i$'th manufacturing industry demand fluctuation of the variations on the mark-up, and $\Lambda_2$ captures the sensitivity for the whole sample except for manufacturing industry $i$ demand fluctuations of the variations on the mark-up. $\mu_{it} - 1$ denotes an individual $i$'th industry, where $\mu = \frac{P}{MC}$ is the mark-up. Thus allow the disturbances $\varepsilon_{it}$'s to be independently distributed across $i$ and $t$, with zero means and variances $\sigma_i^2 > 0$.

Taking the deviation in the regression between $CYCL$ from the mean $CYCL$ ensures that $\hat{\Lambda}_1$ and $\hat{\Lambda}_1$ do not capture unobserved differences by industry that are correlated with $CYCL$ variables.

Column 5 in Table 4.3 shows that the Hausman test accepts the inference of a long run homogeneity mark-up for an individual *i*'th manufacturing industry and the whole sample except for manufacturing industry *i*. Furthermore, the $\phi - parameters$ in columns 4 confirm the presence of rapid adjustment towards long-run equilibrium for dependent and independent variable. The optimal lag length was determined by Akaike Information Criterion, (AIC (1)).

In Table 4.3, columns 2 and 3 shows that demand fluctuations for an individual *i*'th industry and the whole sample except industry *i* seems to have a significant negative impact on the mark-ups (since $\Lambda_1$ and $\Lambda_2 < 0$). This is also consistent with a growing body of empirical literature such as Bils (1987), and Rotemberg and Woodford (1999) showing that during economic booms there tends to be increased competition due to an increase in the number of firms entering to the industry, thereby creating downward pressure on price cost margins and lower the mark-up. In addition, this finding is consistent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up.

Table 4.3
PMG estimator results for the impact of demand fluctuations on the mark-up for an individual $i$'th industry and for the whole sample except for industry $i$

| Industry | $\Lambda_1$ | $\Lambda_2$ | $\phi(ECM)$ | h-test |
|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.71** (0.04) | -0.29** (0.03) | -0.76* (0.09) | 5.52 (0.23) |
| Textiles, Apparel and Leather | -0.72** (0.04) | -0.30** (0.04) | -0.74** (0.09) | 9.80 (0.09) |
| Wood Products | -0.75** (0.04) | -0.33** (0.04) | -0.75* (0.09) | 9.41 (0.07) |
| Paper Product, Printing and Publishing | -0.75** (0.04) | -0.32** (0.04) | -0.75* (0.08) | 9.53 (0.17) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | -0.68** (0.04) | -0.30** (0.03) | -0.98* (0.09) | 8.89 (0.09) |
| Non-Metallic Mineral Products | -0.67** (0.04) | -0.29** (0.03) | -0.99* (0.09) | 8.47 (0.09) |
| Metallic Mineral Product | -0.76** (0.03) | -0.40** (0.03) | -0.78* (0.09) | 7.27 (0.13) |
| Metal Product, Machinery and Equipment | -0.71** (0.04) | -0.41** (0.03) | -0.75* (0.08) | 7.29 (0.14) |
| Other Manufacturing | -0.67** (0.04) | -0.32** (0.03) | -0.75* (0.09) | 10.73 (0.10) |

(*** denotes Significance at 1% level, ** denotes Significance at 5% level, * denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

#### 4.3.2.3 The impact of turnover rate (entering firms plus exiting firms divided by total firms) on the mark-up for an individual *i*'th industry and for the whole sample except for industry *i*

Table 4.4 reports the PMGE estimation the impact of turnover rate on the mark-up for an individual *i*'th industry and the whole sample except for industry *i* as from the specification given by:

$$\mu_{it} - 1 = \tau_0 + \tau_1 \ln(EntryExit_{it} - \overline{EntryExit_i})$$
$$+\tau_2 \ln(EntryExit_{-it} - \overline{EntryExit_{-i}}) + \varepsilon_{it} \qquad (4.19)$$

$\tau_1$ captures the sensitivity of the mark-up to entry and exit for an individual $i$'th manufacturing industry, and $\tau_2$ captures the sensitivity of the mark-up to entry and exit for the whole sample except for industry *i* manufacturing industry. $\mu_{it} - 1$ denotes an individual $i$'th industry, where $\mu = \dfrac{P}{MC}$ is the mark-up. Thus allow the disturbances $\varepsilon_{it}$'s to be independently distributed across *i* and *t*, with zero means and variances $\sigma_i^2 > 0$.

Taking the deviation in the regression between $EntryExit$ from the mean $EntryExit$ ensures that $\hat{\tau}_1$ and $\hat{\tau}_1$ do not capture unobserved differences by industry that are correlated with $EntryExit$ variables.

Column 5 in Table 4.4 shows that the Hausman test accepts the inference of a long run homogeneity mark-up for an individual *i*'th manufacturing industry and the whole sample except for manufacturing industry *i*. Furthermore, the $\phi - parameters$ in columns 4 confirm the presence of rapid adjustment towards long-run equilibrium for dependent and independent variable. The optimal lag length was determined by Akaike Information Criterion, (AIC (1)).

In Table 4.4, columns 2 and 3 shows that turnover rate for an individual *i*'th industry and the whole sample except industry *i* seems to have a significant negative impact on the mark-ups (since $\tau_1$ and $\tau_2 < 0$). This is consistent with a growing body of empirical literature such as Bils (1987), and Rotemberg and Woodford (1999) showing that during economic booms there tends to be increased competition due to an increase in the number of firms entering to the industry, thereby creating downward pressure on price cost margins and lower the mark-up. Besides, this finding is also consistent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up.

Table 4.4
PMG estimator results for the impact of turnover rate on the mark-up for an individual *i*'th industry and for the whole sample except for industry *i*

| Industry | $\tau_1$ | $\tau_2$ | $\phi(ECM)$ | h-test |
|---|---|---|---|---|
| Food, Beverages and Tobacco | -0.75** (0.04) | -0.33** (0.04) | -0.75* (0.08) | 9.41 (0.07) |
| Textiles, Apparel and Leather | -0.75** (0.03) | -0.41** (0.03) | -0.82* (0.09) | 4.60 (0.26) |
| Wood Products | -0.71** (0.02) | -0.32** (0.02) | -1.82* (0.07) | 11.38 (0.10) |
| Paper Product, Printing and Publishing | -0.78** (0.03) | -0.34** (0.02) | -0.79* (0.08) | 13.12 (0.12) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | -0.73** (0.04) | -0.29** (0.03) | -0.77* (0.09) | 7.78 (0.10) |
| Non-Metallic Mineral Products | -0.69** (0.04) | -0.32** (0.04) | -0.81* (0.09) | 5.51 (0.20) |
| Metallic Mineral Product | -0.76** (0.04) | -0.34** (0.03) | -0.85* (0.09) | 6.47 (0.15) |
| Metal Product, Machinery and Equipment | -0.66** (0.02) | -0.37** (0.02) | -0.99** (0.05) | 13.81 (0.15) |
| Other Manufacturing | -0.80** (0.03) | -0.36** (0.02) | -0.80* (0.08) | 13.51 (0.13) |

(*** denotes Significance at 1% level, ** denotes Significance at 5% level, * denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

## 4.4 Conclusion

This paper investigates behaviour of the mark-up under different business cycle situations. This involves examining the impact of the business cycle, and turnover rate on the strength of the mark-up of price over marginal cost in manufacturing industries in Malaysia over the sample period of 1978 to 1999. This period is also particularly interesting due to it captures two significant downturns in the Malaysian economy mainly during the period of downturns in 1984-1987 due to lower demand in the developed countries and in 1997-1999 due to the Asian financial crisis.

This paper also employs an extension of the approach put forward by Roeger (1995) to estimate the mark-ups. The price margins are defined over gross output instead of value added. The main conclusions are summarised below.

Firstly, by estimating the character of the mark-up over business cycles for each individual *i*'th manufacturing industry, this paper shows that the cyclical character of the mark-up suggests a counter-cyclical variation of the price-marginal cost ratio over the business cycle. This is also consistent with a growing body of empirical literature such as Bils (1987), and Rotemberg and Woodford (1999) showing that during economic booms there tends to be increased competition due to an increase in the number of firms entering to the industry, thereby creating downward pressure on price cost margins. Hence this leads to a lower mark-up.

Secondly, the introduction of the cyclical variable (i.e. *Lerner Index*) does not have much effect on the values and the statistical significance of the constant component of the mark-up ($\overline{\mu} = \frac{1}{1-\overline{B}}$) for an individual *i*'th industry in Malaysian manufacturing industry. This finding is consistent with Oliviera-Martins *et al.* (1999).

Thirdly, testing the impact of demand fluctuations for an individual *i*'th industry and the whole sample except industry *i*, this paper reveals that demand fluctuations seems to have a significant negative impact on the mark-up. This finding is consistent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up and vice versa.

Finally, investigating the impact of turnover rate for an individual *i*'th industry and the whole sample except industry *i*, this paper as well uncovers that turnover rate seems to have a significant negative impact on the mark-up. This finding is also coherent with Chatterjee *et al.* (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up and vice versa.

# Chapter 5

## Summary and Conclusion

This thesis has analysed the relationship between primal and dual total factor productivity (TFP) growth approaches, international trade and the mark-up and business cycle, turnover rate and the mark-up. In Chapter 2, which is the first empirical study in this thesis, we investigate the theoretical relationship between the primal and dual TFP from the accounting measurement perspective and assess their accuracy in measuring unobserved TFP growth in the presence of MP and NCRTS in the context of Malaysia's manufacturing industry. In order to achieve this objective, this chapter relaxes both the assumption of constant returns to scale (CRTS) and perfect competition (PC) and shows that the wedge between the two TFP accounting measures depends on the growth rates of factor shares in total revenue. Thus, if factor shares in total revenue remain constant, then one will expect that the difference between the growth rates of primal and dual TFP will vanish, even in the presence of MP and/or NCRTS.

In addition, we also estimate average TFP growth, industry mark-up and scale coefficients according to the structural model of production and cost functions. As well, we compare the estimation of TFP growth to those of primal and dual TFP accounting measures. Furthermore, we discuss the relationship between generalised primal TFP and returns to scale, the relationship between generalised dual TFP and returns to scale, the relationship between generalised primal TFP and the mark-up and the relationship between generalised dual TFP and the mark-up and finally we apply the GMM (Generalised Method of Moments) method to estimate average TFP growth, mark-up and returns to scale at the aggregate level.

There are four main findings in the empirical study in Chapter 2. First, this chapter has proved theoretically and shown empirically, that even in the presence of MP and NCRTS in Malaysian manufacturing industry during the period of study from 1975 to 1999, primal and dual TFP accounting measures are proved to be equal mainly because the factor shares in value added in all industries are relatively constant. Differences between primal and dual TFP, however, still can be observed in a few cases. Similar findings also were found in the studies by Young (1995) and Hsieh (2002). This difference was considered as white noise by Young (1995) and could also be due to data inaccuracy as argued by Hsieh (2002). If the factor shares in value added are not constant, then the differences should depend on MP (Roeger, 1995) and/or NCRTS (as suggested by this paper) as well as the changes in factor shares and how investment is treated in the production model, as being either endogenous or exogenous (Hall, 1988). The finding from this chapter is in contrast with the result from Roeger (1995), which shows that MP alone could explain the differences between primal and dual TFP accounting measures in the U.S.A. manufacturing sector.

Second, this chapter demonstrates that the assumptions of CRTS and PC are essential for both primal and dual TFP in measuring TFP growth for Malaysian manufacturing industry. If these assumptions are violated, both accounting methods could underestimate TFP growth. In the case of Malaysian manufacturing industry, results from the GMM estimation that has been used to estimate TFP growth of Malaysia's industries from 1975 to 1999, found a strong result. The results from the GMM estimation supported the argument if the assumption of CRTS and PC are not violated; in that case the accounting measures will underestimate the TFP growth. Furthermore, the results for all industries in the sample reject the two assumptions of CRTS and PC, respectively and as a result, the estimated productivity growths in Malaysia's industries are relatively higher due to the impact on the magnitudes of the scale and mark-up. The finding is consistent with Aklilu A.Z. *et al* (2000).

Third, this chapter sheds light on the debate between Young (1992, 1995) and Hsieh (1999, 2002) who argued that the discrepancies at the aggregate level for primal and dual TFP growth are mainly driven by data issues, since factor shares in value added are relatively constant. Thus, Young and Hsieh rejected the possibility that this discrepancy is related to the assumptions used in the estimation. However, from Hsieh and Young papers, they found that even at the aggregate level, the two essential assumptions (CRTS and PC) should be supported to show that the primal and dual TFP growth be equal. Nevertheless, Hsieh and Young findings are different. For this reason, both Young (1992, 1995) and Hsieh (1999, 2002) might have underestimated the aggregate TFP growth of Singapore. The finding of this paper shows that if we can allow for NCRTS and MP estimating the TFP growth, the TFP growth is substantially higher than the accounting measures using either primal or dual methods. Thus, this paper strongly recommends that both assumptions should be taken into consideration in measuring TFP growth.

Fourth, by analysing empirically the relationship between returns to scale and their mark-up in Malaysian manufacturing industry from 1975 to 1999, this chapter shows that there is a strong (positive) correlation between the estimated returns to scale and mark-up for the industries in the sample during period of study. This is consistent with theoretical prediction of Basu and Fernald (1997) that returns to scale and mark-up should be strongly (positively) correlated.

The objective of the analysis in Chapter 3 is to investigate the impact of international trade on the strength of the mark-up of price over marginal cost. International trade can have an impact on the variations of the mark-up since foreign competition makes domestic product markets more competitive. Higher international trade intensity tends to increase the degree of competition that the domestic firm faces. Thus, this paper attempts to investigate the effect on the variations of the mark-up, as measured by sensitivity of the mark-up toward import penetration ratio and tariffs for the Malaysian Manufacturing industries from 1978 to 1999.

There are four major findings of this chapter; first, the variations in the mark-ups estimated for the Malaysian manufacturing industries in the 1978 to 1999 period are in the range of 44 per cent to 50 per cent for each individual *i*'th manufacturing industry. This indicates mark-ups for each individual manufacturing industry that are statistically significant and greater than one, implying the existence of market power in Malaysian manufacturing industries. These results are also plausible and more in line with other developed countries such as the U.S.A. and Japan particularly compared to an individual manufacturing industry.

Second, this chapter finds that increased import penetration ratios for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i* serve to decrease industry mark-ups. This implication is thus that integrating Malaysian manufacturing sectors into world markets has the effect of increasing price competition for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i*, and hence lowering the size of the domestic mark-up.

Third, the overall effect of import penetration ratios on the mark-ups is expected to be increased price competition, thus decreasing the size of the mark-ups in an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i*. This has indeed been found in this paper, which is consistent with other findings such as Levinsohn (1993), Harrison (1994), Krishna and Mitra (1998), and Konings and Vandenbussche (2005), and Koning *et al.* (2005).

Fourth, this chapter also finds that increased tariffs for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i* in Malaysia seem to have a significant positive impact on the mark-up. Increasing tariffs increases mark-ups for domestic manufacturing sectors. This finding is also consistent with Grether (1996), and Harrison (1994).

The empirical study in Chapter 4 investigates the behaviour of the mark-up of price over marginal cost under different business cycle situations. This also involves the effect of the business cycle and as well as entry and exit on the strength of the mark-up in manufacturing industries in Malaysia over the sample period of 1978 to 1999. This period is particularly interesting because it captures at least two significant downturns in the Malaysian economy - the periods of downturns in 1984-1987 (due to lower demand in the developed countries) and in 1997-1998 (due to the Asian financial crisis). It also analyses how the interaction between firms' entry and exit, and the business cycle affects the variations in the degree and cyclicality of the mark-up.

There are four major findings of Chapter 4. First, incorporating business cycles for an individual *i*'th manufacturing industry, this paper shows that the cyclical character of the mark-up suggests a statistically counter-cyclical variation of the price-marginal cost ratio over the business cycle for an individual *i*'th manufacturing industry. This is consistent with a growing body of empirical literature such as Bils (1987) and Rotemberg and Woodford (1999) showing that economic booms tend to increase competition due to an increase in the number of firms entering the industry, thereby creating downward pressure on price cost margins. Hence this leads to a lower mark-up.

Second, the introduction of the cyclical variable (i.e. *Lerner Index*) does not have much effect on the values and the statistical significance of the constant component of the mark-up ($\bar{\mu} = \frac{1}{1-\bar{B}}$) for an individual *i*'th manufacturing industry. This finding is consistent with Oliviera-Martins *et al.* (1999).

Third, incorporating demand fluctuations for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i*, this paper reveals that demand fluctuations seems to have a significant negative impact on the mark-up. This finding is consistent with Chatterjee et. al (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up.

Finally, incorporating turnover rate for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i*, this paper uncovers that turnover rate for an individual *i*'th manufacturing industry and the whole sample except manufacturing industries *i* seems to have a significant negative impact on the mark-up. This finding is also coherent with Chatterjee et. al (1993), which argues that where entry into markets is feasible, expansion of demand would lead to entry, increased competition, and downward pressure on the mark-up.

**Some Policy Implications**

The results of this study indicate that substantial changes will be required in Malaysian manufacturing industry. For instance, the relatively low contribution of growth in TFP in certain individual manufacturing industries requires technological deepening of those industries. However, changes in technology can only come about if there are people who can deepen the technological content of the industries.

Furthermore, the analysis of competitiveness in this study has focused on productivity issues and has several implications for development strategies and policy. TFP improvements are associated with technological improvements. Based on the indicators shown in this study, there are certain constraints on competitiveness of the Malaysian manufacturing sector. Clearly, labour-intensive industries are no longer viable as compared with the earlier years immediately after the 1984 recession. There is a need to move forward in local higher value added technology to keep up with world markets and technology-oriented industrialisation. These have been correctly identified by policy makers; however this policy has faced several labour constraints, in terms of the skilled labour as well as the science and technology manpower required. At the policy level, these problems have also been recognised and hence an increasing budget has been allocated toward education and training. Nevertheless, there is some conflict between the call to train and move toward science and technical courses and the concurrent liberal policy toward foreign unskilled labour. Although this policy was instituted in response to the tightness of the labour market, it may have outlived its usefulness and a delay in removing the dependency on unskilled foreign labour may only serve to retard the restructuring that is necessary and vital for increasing the competitiveness of the industries.

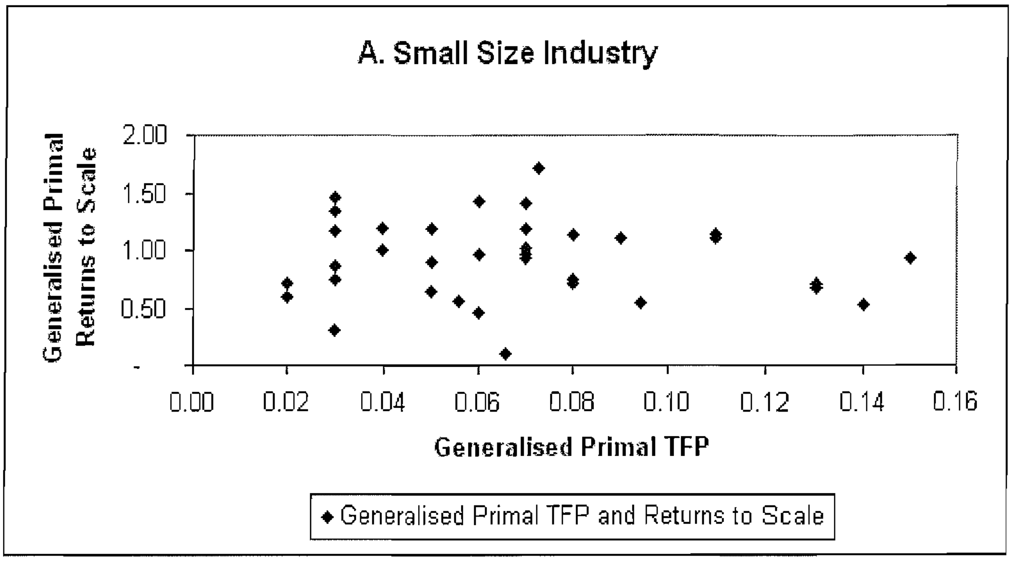
Besides the issue of foreign labour, the competitiveness of Malaysian industries also depends acutely on the speed with which Malaysia can produce the essential manpower required for the technological deepening of the industries. Whilst private supply of manpower has been liberalised to counter this challenge, there is a need for regulating private supply to ensure the proper running of private supply program. Further, it is important to remember that the quest to fulfil manpower requirements should not be made at the expense of quality, not when Malaysia needs to compete with quality products – quality products can only be produced by quality workers. A committed and well-trained workforce is crucial, and a system of compensation that rewards productivity is also necessary to motivate workers. Bench-marking and business re-engineering are other approaches that could be taken by firms to enhance productivity and competitiveness.

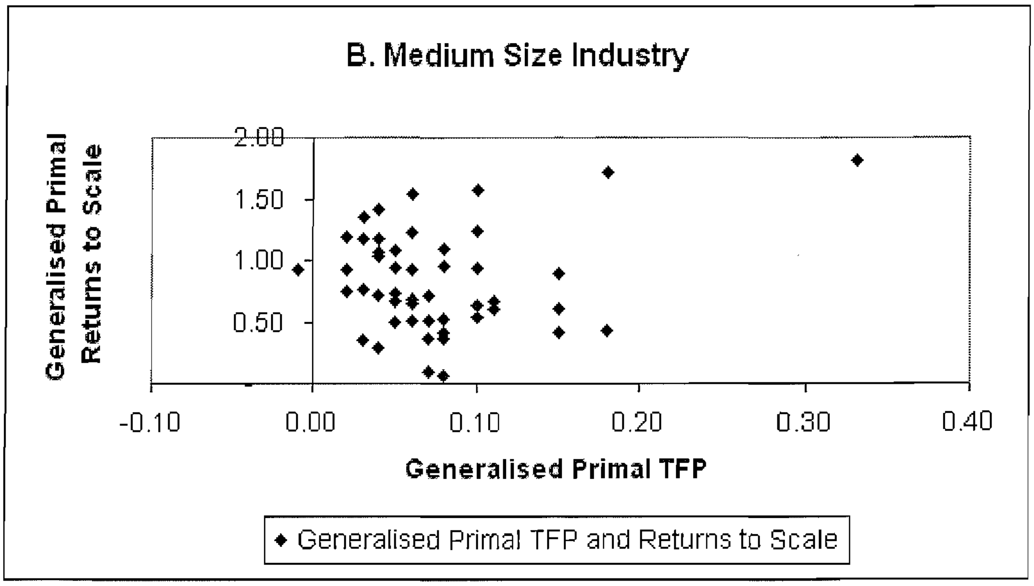
In addition, improvement in human capital will also enhance the absorption of foreign technology. In Malaysia, the dependency on foreign technology arises from the lack of indigenous technology. Thus, technological development basically comes from FDI, via staff training programs, local purchase of inputs and also technology transfer agreements. This is important as long as Foreign Direct Investment (FDI) continues to play an important role in the economy and as long as indigenous technological development is not established. There are both benefits and losses due to the continued dependence on FDI. Consequently, it is important to try to increase the benefits, the most important of which is the extent of technology transferred. Ultimately, to be truly competitive will require a complete shift from being recipients of foreign technology to being technology innovators in Malaysia's own right.

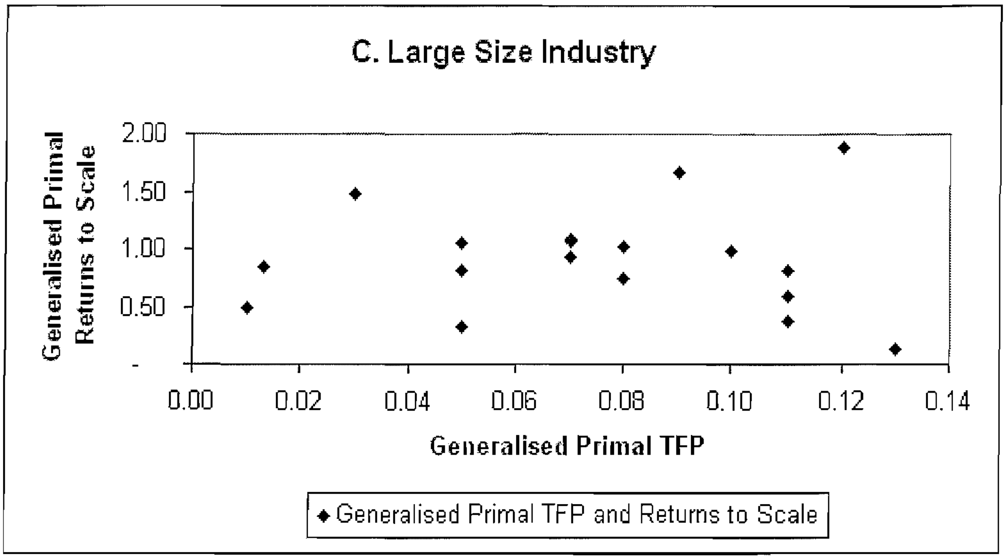
Finally, the indigenous development of technology has been hindered by the shortage of skilled and technical manpower, the low level of R & D activities, especially private sector R & D, and the lack of financial resources of Malaysian manufacturers, which are mainly SMI (Small Medium Industry). The government, in its effort to nurture private participation in research and technology development, has offered a variety of fiscal incentives, such as double-deduction for in-house R & D projects, tax holidays for firms which are established to perform commercial R & D or produce new technology-based products, as well as allowances on capital expenditure for a corporate group to set up a R & D affiliate. Besides fiscal incentives, a matching grant scheme in the form of the Industrial Technology Assistance Fund (ITAF) was launched in 1989 to support product development and design schemes as well as quality and productivity schemes, particularly for the SMIs. However, several problems have been encountered in the utilisation of these schemes, and it appears that a feedback mechanism on implementation problems is important for the successful implementations of these schemes. Thus, there is yet another important role for trade associations besides the provision of training, and that is to channel the problems in implementation of ITAF and possible solutions to the relevant authorities.

# APPENDIXES

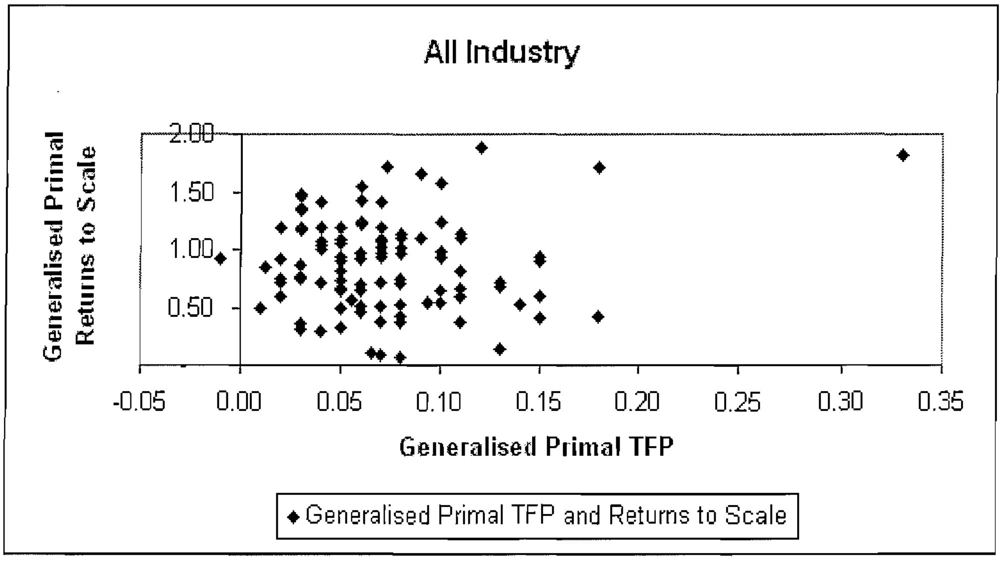
**Appendix 2.1**:Generalised Primal TFP and Returns to Scale in Malaysian manufacturing by 5-digit industry and size of the industry



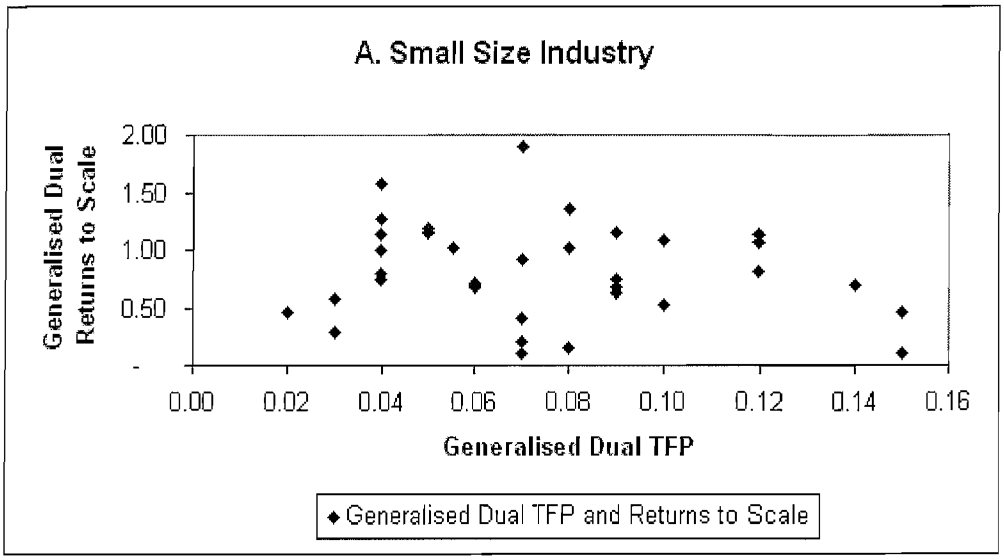


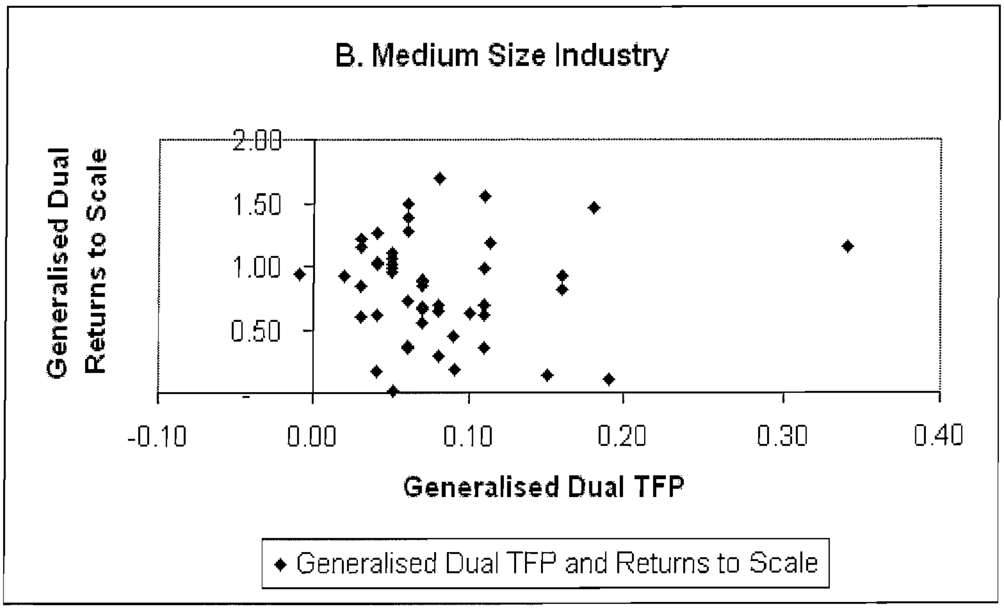
C. Large Size Industry
Generalised Primal Returns to Scale
2.00
1.50
1.00
0.50
-
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Generalised Primal TFP
Generalised Primal TFP and Returns to Scale

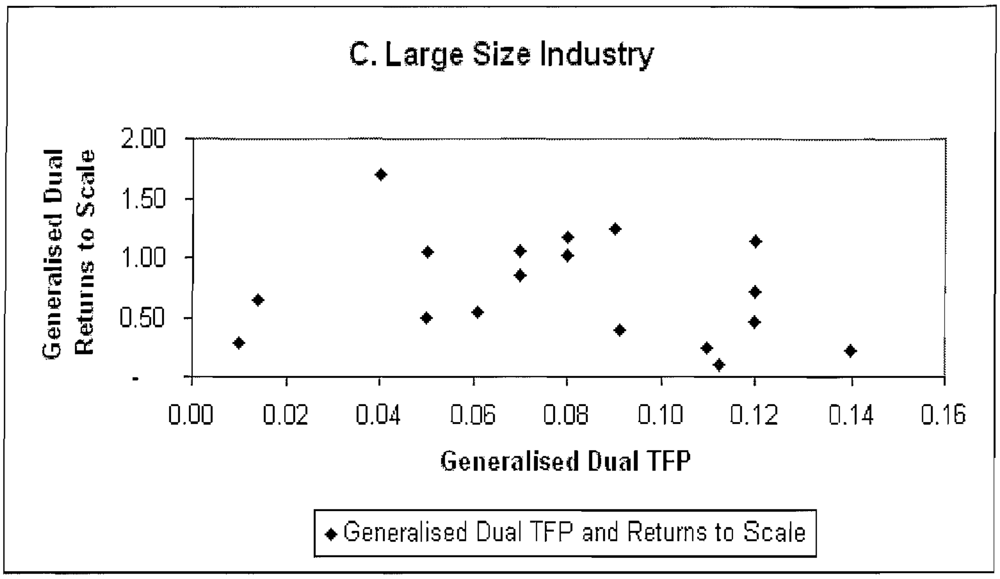



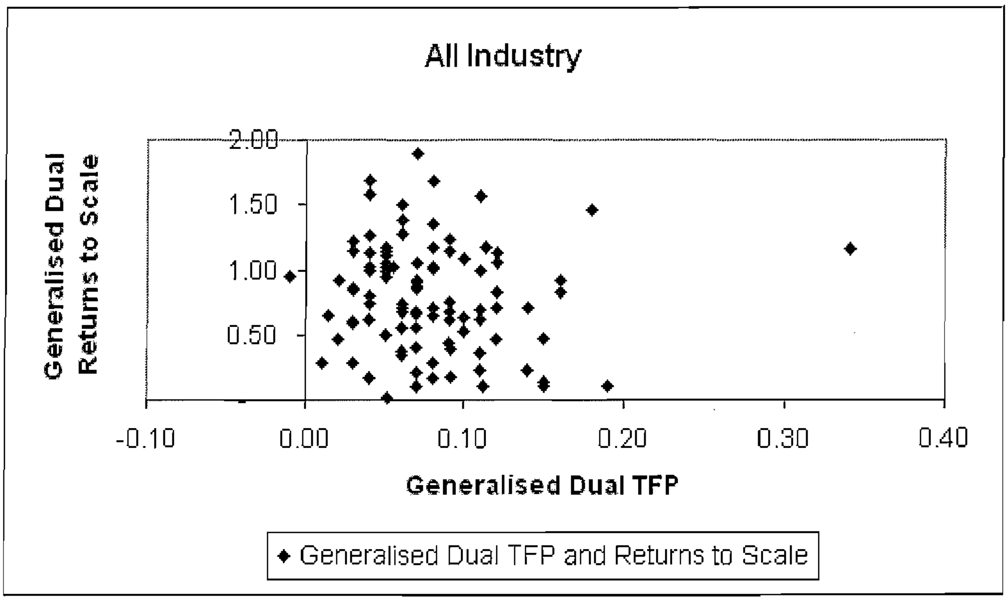
All Industry
Generalised Primal Returns to Scale
2.00
1.50
1.00
0.50
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Generalised Primal TFP
Generalised Primal TFP and Returns to Scale

**Appendix 2.2**:Generalised Dual TFP and Returns to Scale in Malaysian manufacturing by 5-digit industry and size of the industry

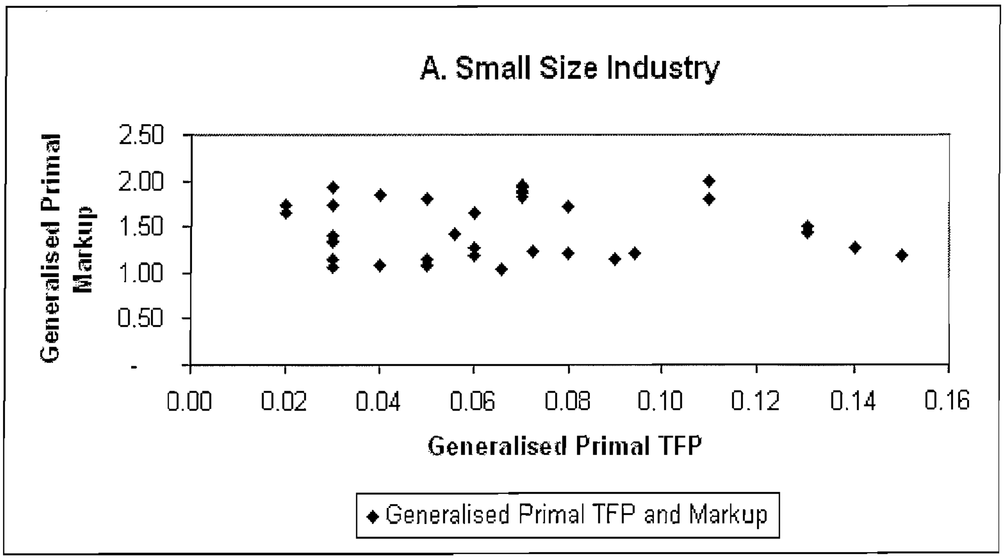


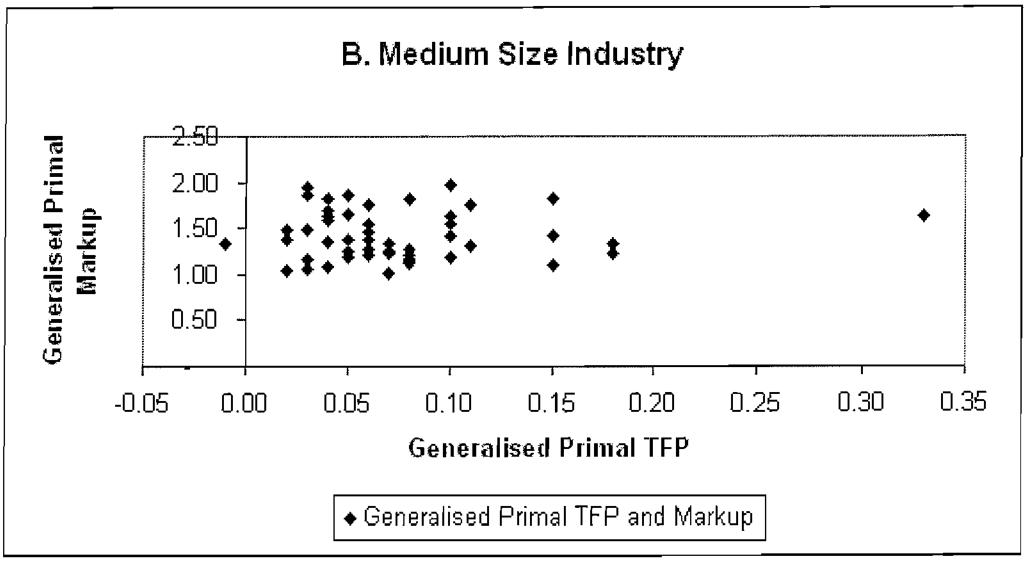



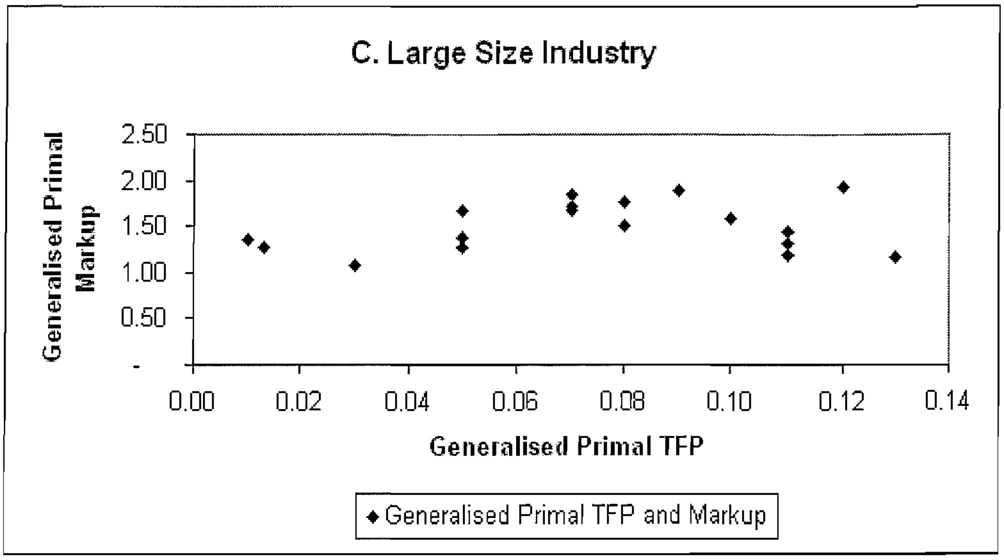

C. Large Size Industry
Generalised Dual Returns to Scale
2.00
1.50
1.00
0.50
-
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Generalised Dual TFP
Generalised Dual TFP and Returns to Scale

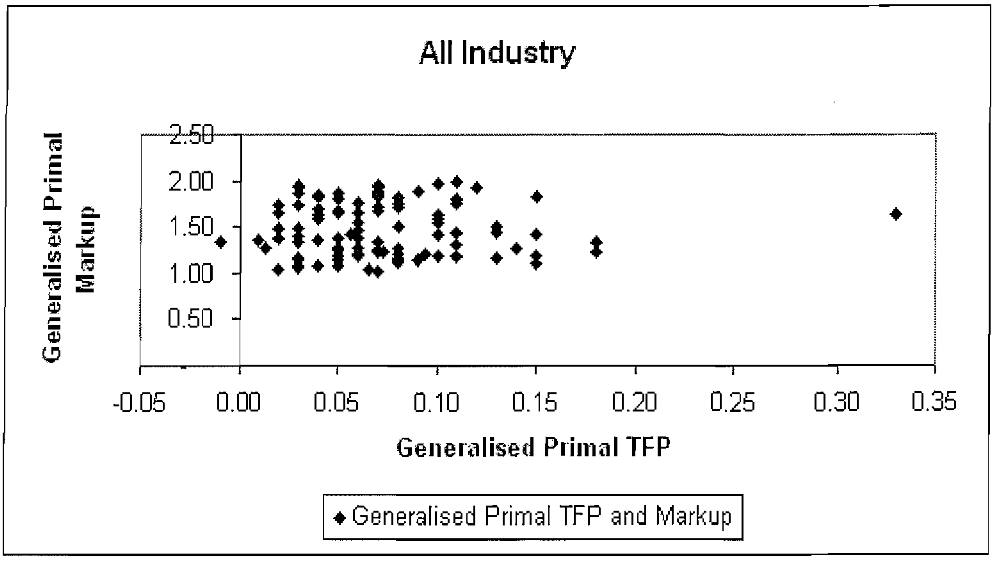

All Industry
Generalised Dual Returns to Scale
2.00
1.50
1.00
0.50
-0.10
0.00
0.10
0.20
0.30
0.40
Generalised Dual TFP
Generalised Dual TFP and Returns to Scale

**Appendix 2.3**:Generalised Primal TFP and Mark-up in Malaysian Manufacturing at 5-digit industry and size of the industry

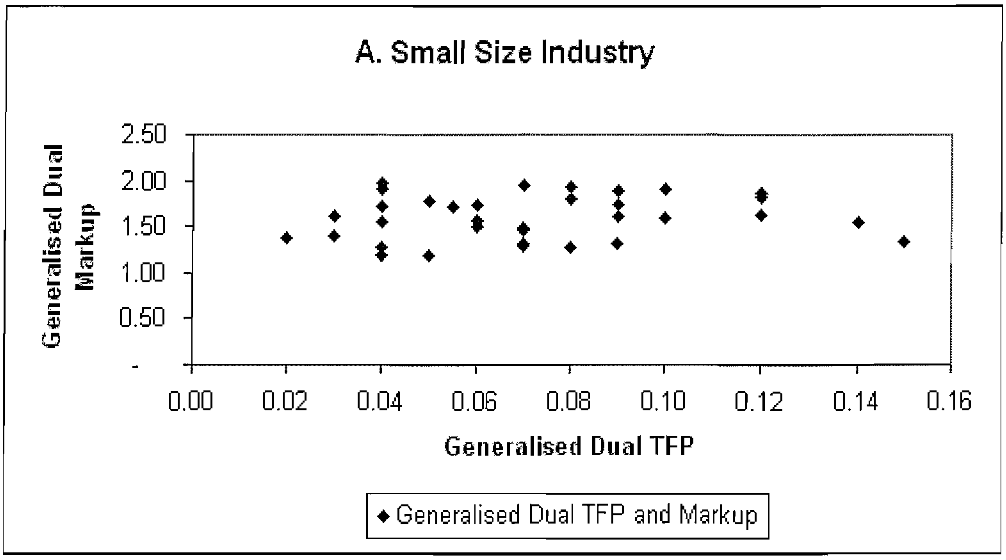


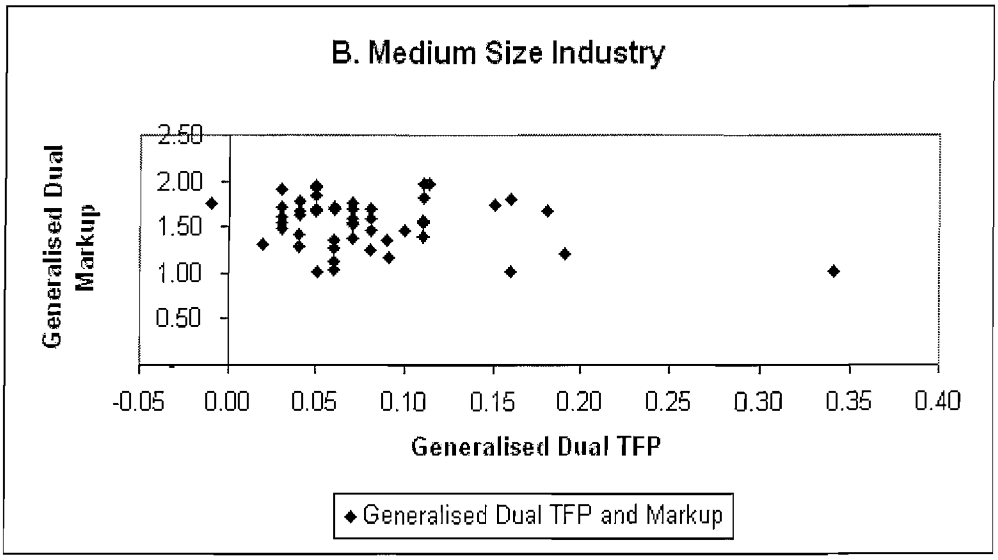



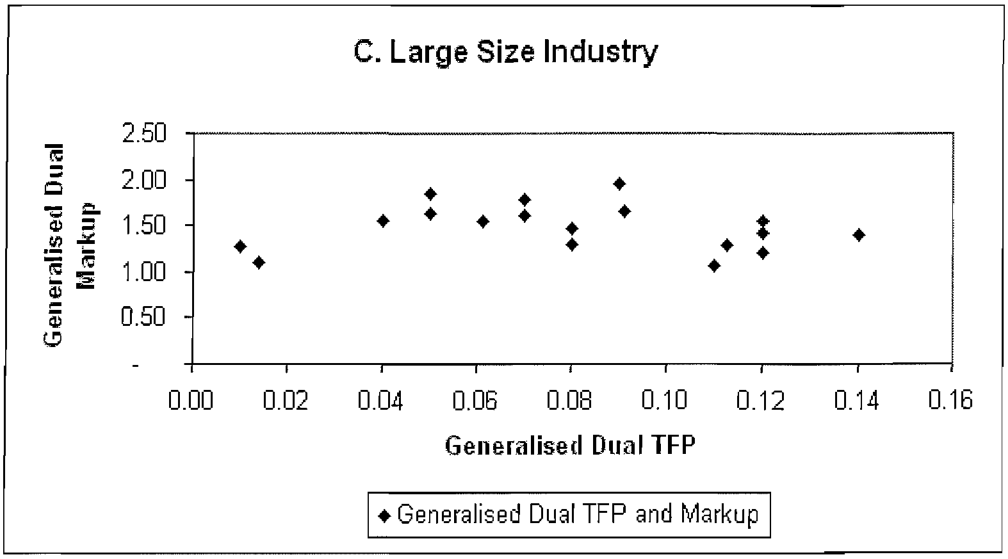

C. Large Size Industry
Generalised Primal Markup
2.50
2.00
1.50
1.00
0.50
-
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
Generalised Primal TFP
Generalised Primal TFP and Markup

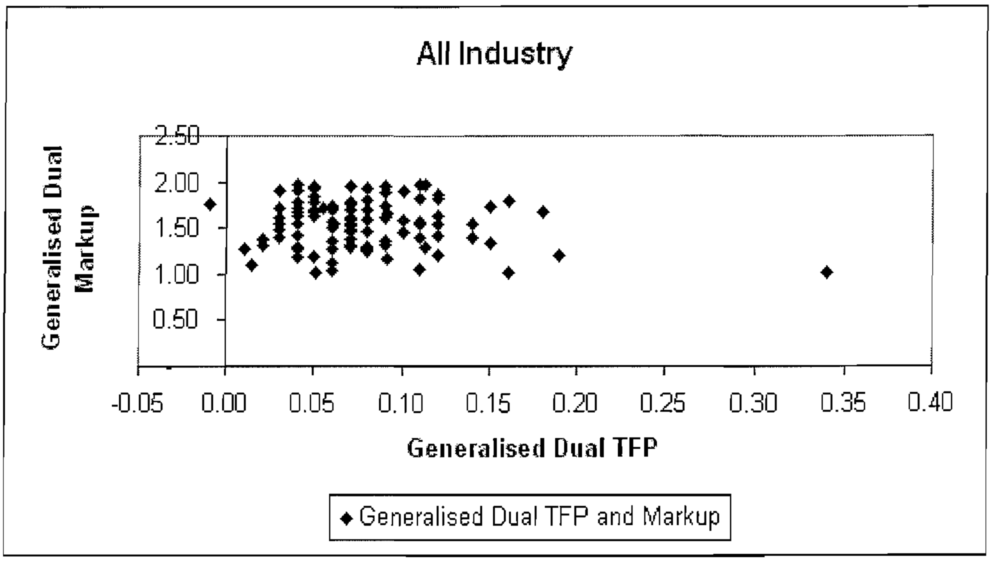

All Industry
Generalised Primal Markup
2.50
2.00
1.50
1.00
0.50
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Generalised Primal TFP
Generalised Primal TFP and Markup

**Appendix 2.4**:Generalised Dual TFP and Mark-up in Malaysian Manufacturing at 5-digit industry and size of the industry




C. Large Size Industry
Generalised Dual Markup
2.50
2.00
1.50
1.00
0.50
-
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Generalised Dual TFP
Generalised Dual TFP and Markup


All Industry
Generalised Dual Markup
2.50
2.00
1.50
1.00
0.50
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
Generalised Dual TFP
Generalised Dual TFP and Markup

## Appendix 2.5

**Moving from the Traditional to Generalised Neoclassical Approach**
**Primal Analysis**

Returning to equation (1) in which it was assumed that each sector, indexed by *i*, to has at time *t*, the following production function,

$$Q_{it} = \Theta_{it} F_i(K_{it}, N_{it}) \qquad (1)$$

Taking logarithms and then differentiating Equation (1) with respect to time will give,

$$\frac{\frac{\partial Q_{it}(K_{it}, N_{it}, t)}{\partial t}}{Q_{it}} = \frac{K_{it}\partial F_i}{F_{it}\partial K_i} \cdot \frac{\frac{\partial K_{it}}{\partial t}}{K_{it}} + \frac{N_{it}\partial F_i}{F_{it}\partial N_i} \cdot \frac{\frac{\partial N_{it}}{\partial t}}{N_{it}} + \frac{\frac{\partial \Theta_{it}}{\partial t}}{\Theta it} \qquad (2)$$

Let $\hat{X}_t = \frac{\frac{\partial X}{\partial t}}{X}$, and let $\frac{X}{F}\frac{\partial F}{\partial X} = \frac{X}{Y}\frac{\partial Y}{\partial X} = \Phi_X$, the elasticity of output with respect to input X.

To simplify matters, equation (2) can be rewritten as

$$\hat{Q}_{it} = \Phi_{iK}\hat{K}_{it} + \Phi_{iN}\hat{N}_{it} + \hat{\Theta}_{it} = \hat{\Theta}_{it} + \Phi_{iK}\hat{K}_{it} + \Phi_{iN}\hat{N}_{it} \qquad (3)$$

where $\Phi_{iN}$ and $\Phi_{iK}$ are the elasticity of output with respect to labour and capital inputs.

Now, assume that each industry *i*, faces a production function $F_i$ that is homogeneous of degree $Z_i$. $Z_i$ is assumed to have three conditions; equal to 1, it indicates that the firm faces constant returns to scale, when $Z_i$ is less than 1, decreasing returns to scale and $Z_i$ is more than 1, demonstrating increasing returns to scale.

So, using Euler's Theorem for homogeneous function one obtains

$$\Phi_{iN} + \Phi_{iK} = Z_i \tag{4}$$

$\Phi_N + \Phi_K = \left(\frac{\partial F}{\partial N}\right)\left(\frac{N}{F}\right) + \left(\frac{\partial F}{\partial K}\right)\left(\frac{K}{F}\right) = Z$, by Euler equation for homogenous function.

By substituting equation (4) into (3), one can rewrite equation (3) as

$$\hat{Q}_{it} - \hat{K}_{it} = \hat{\Theta}_{it} + \Phi_{iN}\left(\hat{N}_{it} - \hat{K}_{it}\right) + \left(Z_i - 1\right)\hat{K}_{it} \tag{5}$$

As a result, simplifying equation (5) with the convention, one obtains

$$\hat{q}_{it} = \hat{\Theta}_{it} + \Phi_{iN}\hat{\pi}_{it} + \left(Z_i - 1\right)\hat{K}_{it} \tag{6}$$

Now, introducing a price mark up of firm *i* over marginal cost of firm *i* one achieves

$$\omega_i = \frac{P_{it}}{m_{it}} \tag{7}$$

and $\Omega_{iK} = \frac{r_i K_i}{P_i Q_i}$ the share of capital in total revenue

therefore

$$\Phi_{iN} = \omega_i \left(1 - \Omega_{iK}\right) \tag{8}$$

Hence the elasticity of output with respect to labour can be also written as the price mark up of firm *i* over marginal cost multiplied by 1 minus the share of capital in total revenue.

**Proof**

Let the firm facing given w and r, minimise the following;

min C= wN + rK

s.t. $Q = \Theta F\left(N, K\right)$

so, Lagrangian function $= wN + rK - \lambda\left(\Theta F\left(N, K\right) - Q\right)$

First Order Condition (FOC),

$$w = \lambda\Theta\left(\frac{\partial F}{\partial N}\right)$$

By Envelope Theorem,

$$m = \frac{\partial C}{\partial Q} = \lambda$$

This is the marginal cost of the production function.

Thus,

$$\frac{w}{m\Theta}=\frac{\partial F}{\partial N}\rightarrow\Phi_N=\left(\frac{P}{m}\cdot\frac{wN}{PQ}\right)=\frac{wN}{mQ}=w\left(1-\Omega_K\right)$$

This is the elasticity of output with respect to labour.

Similarly, $\Phi_K=w\left(1-\Omega_N\right)\Rightarrow$ the elasticity of output with respect to capital.

Substituting equation (8) into (6), gives

$$\hat{q}_{it}=\hat{\Theta}_{it}+\omega_i\left(1-\Omega_{iK}\right)\hat{\pi}_{it}+\left(Z_i-1\right)\hat{K}_{it} \tag{9}$$

As a result, in the presence of MP $(\omega\neq 1)$ and NCRTS ($Z\neq 1$), the relationship between the growth rate of traditional primal TFP and $\hat{\Theta}_{it}$, the growth rate of generalised primal TFP, is

$$\widehat{TFP}_{it}\,primal=\hat{q}_{it}-\left(1-\Omega_{iK}\right)\hat{\pi}_{it} \tag{10}$$

Substitute Equation (9) into Equation (10), and rearrange it, gives

$$\widehat{TFP}_{it}\,primal=\hat{\Theta}_{it}+\left(\omega_i-1\right)\left(1-\Omega_{iK}\right)\hat{\pi}_{it}+\left(Z_i-1\right)\hat{K}_{it} \tag{11}$$

## Appendix 2.6

**Moving from the Traditional to Generalised Neoclassical Approach**
**Dual Analysis**

Initially starting with the Homogeneity of the Cost Function.

$C\left(w,r,F\left(N,K\right)\right)=wN+rK$ is a general cost function, and $Q=\Theta F(N,K)$,

if F is homogeneous of degree Z in (N,K),

as a result

i. C is homogeneous of degree $\frac{1}{Z}$ in F

ii. C is homogeneous of degree $\frac{1}{Z}$ in Q

iii. let $m=\frac{\partial C}{\partial Q}$, then $m=\frac{1}{Z}\frac{C}{Q}$.

**Proof**

i. C is homogeneous of degree $\frac{1}{Z}$ in F

Increase both N and K by $\lambda^{\frac{1}{Z}}$ times, $\lambda>0$;

$$C\left(w,r,\lambda F\left(N,K\right)\right)=C\left(w,r,F\left(\lambda^{\frac{1}{Z}}N,\lambda^{\frac{1}{Z}}K\right)\right)$$

by homogeneity of $F\left(N,K\right)$,

Since C is homogeneous of degree 1 in (N,K), the right-hand side of the above equation can be written as;

$$\lambda^{\frac{1}{Z}} C\left(w, r, F(N, K)\right)$$

Thus,

$$C\left(w, r, \lambda F(N, K)\right) = \lambda^{\frac{1}{Z}} C\left(w, r, F(N, K)\right)$$

which implies that $C\left(w, r, \lambda F(N, K)\right)$ is homogenous of degree $\frac{1}{Z}$ in $F(N, K)$

**Proof**

ii. C is homogeneous of degree $\frac{1}{Z}$ in Q

Notices that Q is homogeneous of degree 1 in F, so, C is homogeneous of degree $\frac{1}{Z}$ in F $\Rightarrow$ C is homogeneous of degree $\frac{1}{Z}$ in Q.

**Proof**

iii. let $m = \frac{\partial C}{\partial Q}$, then $m = \frac{1}{Z}\frac{C}{Q}$.

By Euler equation of homogeneous function, C is homogeneous of degree $\frac{1}{Z}$ in Q, so

$$\frac{\partial C}{\partial Q} Q = \frac{1}{Z} C \Rightarrow m = \frac{1}{Z}\frac{C}{Q}$$

Based on the above properties, it can be rewritten as general cost function,

$$C\left(w_{it}, r_{it}, F_i\left(N_{it}, K_{it}\right)\right) = w_{it} N_{it} + r_{it} K_{it} \qquad (1)$$

C is homogeneous of degree 1 in $N_{it}$ and $K_{it}$. As shown in the above properties, since $F_i\left(N_{it},K_{it}\right)$ is homogeneous of degree $Z_i$, C is homogeneous of degree $\frac{1}{Z}$ in $F_i\left(N_{it},K_{it}\right)$. Homogeneity of $C_i$ enables one to simplify the function further, therefore by simplifying the Equation (1), obtaining input prices equation;

$$C\left(w_{it},r_{it},F_i\left(N_{it},K_{it}\right)\right)=\left(F_i\left(N_{it},K_{it}\right)\right)^{\frac{1}{Z_i}}G_i\left(w_{it},r_{it}\right)$$

$$=\left(\frac{Q_{it}}{\Theta_{it}}\right)^{\frac{1}{Z_i}}G_i\left(w_{it},r_{it}\right) \qquad (2)$$

where $G\left(w,r\right)=C\left(w,r,1\right)$ is the unit cost function, which depends only on input prices.

Thus, based on Equation (2) where input prices remain unchanged and when the industry produces more or if it becomes less efficient, then the total cost will be greater.

To find the marginal cost function, $m_{it}$, differentiate equation (2) with respect to $Q_{it}$

$$m_{it}=\frac{\partial C_{it}}{\partial Q_{it}}=\frac{1}{Z_i}\frac{Q_{it}^{\frac{1}{Z_i}-1}}{\Theta_{it}^{\frac{1}{Z_i}}}G_i\left(w_{it},r_{it}\right) \qquad (3)$$

Simplify Equation (3) with logarithms,

$$\ln m_{it}=-\ln Z_i+\left(\frac{1}{Z_i}-1\right)\ln Q_{it}-\frac{1}{Z_i}\Theta_{it}+\ln G_i\left(w_{it},r_{it}\right) \qquad (4)$$

Differentiate Equation (4) with respect to time;

$$\begin{aligned}
\hat{m} &= \left(\frac{1}{Z_i}-1\right)\hat{Q}_{it} - \frac{1}{Z_i}\hat{\Theta}_{it} + \frac{w_{it}}{G_{it}}\frac{\partial G_i}{\partial w_{it}}\hat{w}_{it} + \frac{r_{it}}{G_{it}}\frac{\partial G_i}{\partial r_{it}}\hat{r}_{it} \\
&= \left(\frac{1}{Z_i}-1\right)\hat{Q}_{it} - \frac{1}{Z_i}\hat{\Theta}_{it} + \frac{w_{it}N_{it}}{C_{it}}\hat{w}_{it} + \frac{r_{it}K_{it}}{C_{it}}\hat{r}_{it} \\
&= \left(\frac{1}{Z_i}-1\right)\hat{Q}_{it} - \frac{1}{Z_i}\hat{\Theta}_{it} + \frac{w_{it}N_{it}}{C_{it}}\hat{w}_{it} + \hat{r}_{it} - \frac{r_{it}K_{it}}{C_{it}}\hat{r}_{it}
\end{aligned}$$

$$\hat{m}_{it} - \hat{r}_{it} = \left(\frac{1}{Z_i}-1\right)\hat{Q}_{it} - \frac{1}{Z_i}\hat{\Theta}_{it} + \frac{w_{it}N_{it}}{C_{it}}\left(\hat{w}_{it} - \hat{r}_{it}\right) \tag{5}$$

From Equation (2) to (5), and re-express Equation (5) with the convention that

$$x = \frac{X}{r}$$

can be rewritten and derive;

$$\left(\frac{\hat{m}_{it}}{r_{it}}\right) = \left(\frac{1}{Z_i}-1\right)\hat{Q}_{it} - \frac{1}{Z_i}\hat{\Theta}_{it} + \frac{w_{it}N_{it}}{C_{it}}\left(\frac{\hat{w}_{it}}{r_{it}}\right) \tag{6}$$

where $\frac{w}{G}\frac{\partial G}{\partial w} = \frac{wN}{G}\left(\frac{\Theta}{Q}\right)^{\frac{1}{Z}} = \frac{wN}{C}, \frac{r}{G}\frac{\partial G}{\partial r} = \frac{rK}{G}\left(\frac{\Theta}{Q}\right)^{\frac{1}{Z}} = \frac{rK}{C}$ and $\frac{wN}{C} + \frac{rK}{C} = 1$ are obtained from the definition of G(w,r).

Intuitively, this shows that the growth rate of marginal cost per rental price depends on the growth rate of output, productivity and wage per rental price.

Now, let $C_i X = \frac{w_i X_i}{C_i}$, the payment share of input X in the total cost of industry *i*.

Assuming also, that the mark up coefficient, $\omega_i$, is constant over time, so that the growth rate of output price is equal to the growth rate of marginal cost:

$$\hat{P}_{it} = \hat{m}_{it}$$

Multiply both sides of Equation (6) by $-Z_i$ and rearrange it, obtaining

$$\widehat{\left(\frac{r_{it}}{P_{it}}\right)} = \hat{\Theta}_{it} + Z_i C_{it} N_{it} \widehat{\left(\frac{r_{it}}{w_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{P_{it} Q_{it}}{r_{it}}\right)} \tag{7}$$

Actually $Z_i C_{it} N_{it} = \omega_i (1 - \Omega_{iK})$ the elasticity of output with respect to labour.

Thus the elasticity of output with respect to labour can be also written as the price mark up of firm i over marginal cost multiplied by 1 minus the share of capital in total revenue.

$$m = \frac{\partial C}{\partial Q}, \text{ then } m = \frac{1}{Z}\frac{C}{Q} \text{ (from proposition above)}$$

Thus $C = ZmQ$

So

$$CN = \frac{wN}{C} = \frac{wN}{ZmQ} = \frac{1}{Z}\frac{wN}{mQ} = \left(\frac{1}{Z}\right)\Phi_N = \left(\frac{1}{Z}\right)\omega(1 - \Omega_K)$$

Therefore;

$$ZCN = \omega(1 - \Omega_K)$$

Equation (7) can be further simplified to

$$\widehat{\left(\frac{r_{it}}{P_{it}}\right)} = \hat{\Theta}_{it} + \omega_i \left(1 - \Omega_{iK}\right) \widehat{\left(\frac{r_{it}}{w_{it}}\right)} + \left(Z_i - 1\right) \widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \quad (8)$$

where $\Omega_{iK}$ = the payment share of capital in total revenue of industry *i*.

or $\Omega_{iK} = \dfrac{r_i K_i}{P_i Q_i}$

Intuitively Equation (8) shows that the growth of real rental price depends on unobserved productivity growth, the growth rate of rental price per wage and the growth rate of total revenue per rental price.

So, in the presence of MP $(\omega_i \neq 1)$ and NCRTS ($Z \neq 1$), the relationship between the growth rate of traditional dual TFP and the growth rate of generalised dual TFP is,

$$\widehat{TFP_{it}dual} = \left(1 - \Omega_{iK}\right) \widehat{\left(\frac{r_{it}}{w_{it}}\right)} - \widehat{\left(\frac{P_{it}}{r_{it}}\right)}, \text{ by Hall (1988) definition} \quad (9)$$

$$\widehat{TFP_{it}dual} = \hat{\Theta}_{it} + \left(\omega_i - 1\right)\left(1 - \Omega_{iK}\right) \widehat{\left(\frac{r_{it}}{w_{it}}\right)} + \left(Z_i - 1\right) \widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \quad (10)$$

## Appendix 2.7

**The Difference**

The difference can be derived by subtracting Equation (27) form Equation (25):

$$= \widehat{TFP}_{it} primal - \widehat{TFP}_{it} dual$$

$$= \hat{\Theta}_{it} + (\omega_i - 1)(1 - \Omega_{iK})\hat{\pi}_{it} + (Z_i - 1)\hat{K}_{it} - \left( \hat{\Theta}_{it} + (\omega_i - 1)(1 - \Omega_{iK})\widehat{\left(\frac{r_{it}}{w_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \right)$$

$$= (\omega_i - 1)(1 - \Omega_{iK})\left( \hat{\pi}_{it} - \widehat{\left(\frac{r_{it}}{w_{it}}\right)} \right) + (Z_i - 1)\left( \hat{K}_{it} - \widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} \right)$$

$$= (\omega_i - 1)(1 - \Omega_{iK})\widehat{\left(\frac{w_{it}N_{it}}{r_{it}K_{it}}\right)} + (Z_i - 1)\widehat{\left(\frac{r_{it}K_{it}}{P_{it}Q_{it}}\right)}$$

where

$$\hat{\pi}_{it} - \widehat{\left(\frac{r_{it}}{w_{it}}\right)} = \widehat{\left(\frac{w_{it}N_{it}}{r_{it}K_{it}}\right)}$$

and

$$\hat{K}_{it} - \widehat{\left(\frac{P_{it}Q_{it}}{r_{it}}\right)} = \widehat{\left(\frac{r_{it}K_{it}}{P_{it}Q_{it}}\right)}$$

## Appendix 2.8

**Input Elasticity, Revenue Share and Cost Share**

Let

$\Phi_X = \frac{\partial F}{\partial X}\frac{X}{F}$, the elasticity of output with respect to input $X_i$

$\Omega_X = \frac{wX}{PY}$, the payment share of input $X$ in total revenue

$C_X = \frac{wX}{C}$, the payment share of input $X$ in total cost

**Proposition**

Let $Q = \Theta F(N,K)$ be the production function of a firm, and $F$ be homogeneous of degree $Z$ in $N$ and $K$. Let $\omega$ be the price over marginal cost mark-up. Let firm minimize cost. Then

1. $\Phi_X = \omega\Omega_X, X = N,K$
2. $C_X = \frac{1}{Z}\Phi_X = \frac{1}{Z}\omega\Omega_X, X = N,K$
3. $C_N + C_K = 1$
4. $\Phi_N + \Phi_K = Z$
5. $\Omega_N + \Omega_K = Z$

**Proof**

1. Firm facing given $w$ and $r$, minimize the following:

$\min C = wN + rK$

s.t. $Q = \Theta F(N,K)$

So, Lagrangian function $= wN + rK - \lambda\left(\Theta F\left(N,K\right) - Q\right)$

First Order Condition,

$$w = \lambda\Theta\frac{\partial F}{\partial N}$$

By Envelope Theorem,

$$m = \frac{\partial C}{\partial Q} = \lambda$$

This is the marginal cost of the production function.

Thus,

$$\frac{w}{m\Theta} = \frac{\partial F}{\partial N} \to \Phi_N = \left(\frac{P}{m}\cdot\frac{wN}{PQ}\right) = \frac{wN}{mQ} = \omega\left(1-\Omega_K\right)$$

Similarly,

$$\Phi_K = \omega\left(1-\Omega_N\right)$$

2. By homogeneity of $F\left(N,K\right)$

$$m = \frac{\partial C}{\partial Q}, \text{then } m = \frac{1}{Z}\frac{C}{Q} \Rightarrow C = ZmQ$$

Thus

$$C_N = \frac{wN}{C} = \frac{wN}{ZmQ} = \frac{1}{Z}\frac{wN}{mQ} = \left(\frac{1}{Z}\right)\Phi_N = \left(\frac{1}{Z}\right)\omega\left(1-\Omega_K\right)$$

similarly,

$$C_K = \left(\frac{1}{Z}\right)\Phi_K = \left(\frac{1}{Z}\right)\omega\left(1-\Omega_N\right)$$

3. $C_N + C_K = \frac{wN}{C} + \frac{rK}{C} = 1,$ by definition of $C$.

4. $\Phi_N + \Phi_K = \frac{\partial F}{\partial N}\cdot\frac{N}{F} + \frac{\partial F}{\partial K}\cdot\frac{K}{F} = Z,$ by Euler Equation for

homogeneous function.

5. $\Omega_N + \Omega_K = C_N \dfrac{Z}{w} + C_K \dfrac{Z}{w}$, by 2

$\Rightarrow \Omega_N + \Omega_K = \left(C_N + C_K\right) \dfrac{Z}{w} = \dfrac{Z}{w}$, by 3

**Appendix 2.9**
Data at a Glance in Malaysian Manufacturing at 5-digit industry with Small Size Industries

| | AVERAGE ANNUAL GROWTH RATE (%) OF | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Industry (1) | Output Capital Ratio (2) | Real Rental Price Ratio (3) | Labor Capital Ratio (4) | Wage Rental Ratio (5) | Capital (6) | Revenue Rental Ratio (7) | Output (8) | Average Labor Share(Gross Output) (9) | Average Labor Share(Value Added) (10) |
| 31121 | -0.14 | -0.02 | -0.02 | 0.01 | 0.24 | 0.06 | 0.10 | 0.75 | 0.33 |
| 31139 | 0.00 | -0.15 | -0.01 | -0.01 | 0.15 | -0.03 | 0.15 | 0.60 | 0.18 |
| 31151 | -0.05 | -0.24 | 0.00 | -0.01 | 0.03 | -0.29 | 0.00 | 1.45 | 0.13 |
| 31153 | 0.01 | -0.18 | 0.00 | 0.00 | 0.15 | -0.04 | 0.16 | 1.43 | 0.57 |
| 31162 | -0.06 | -0.80 | 0.00 | -0.05 | 0.10 | -0.78 | 0.04 | 1.21 | 0.13 |
| 31164 | -0.03 | -0.02 | -0.01 | 0.00 | 0.05 | -0.03 | 0.01 | 0.51 | 0.11 |
| 31169 | -0.02 | -0.56 | -0.02 | -0.04 | 0.65 | -0.33 | 0.21 | 1.51 | 0.39 |
| 31172 | -0.06 | -0.11 | -0.01 | -0.01 | 0.22 | 0.03 | 0.17 | 0.33 | 0.11 |
| 31211 | 0.02 | -0.05 | 0.00 | 0.00 | 0.05 | 0.00 | 0.07 | 0.36 | 0.18 |
| 31212 | -0.23 | -0.24 | -0.02 | -0.01 | 0.34 | -0.15 | 0.13 | 0.66 | 0.14 |
| 31215 | -0.25 | -0.59 | -0.02 | -0.04 | 0.49 | -0.38 | 0.24 | 0.57 | 0.15 |
| 31219 | -0.14 | -0.13 | -0.13 | 0.00 | 0.53 | 0.25 | 0.41 | 1.24 | 0.44 |
| 31220 | -0.04 | -0.02 | 0.00 | 0.00 | 0.14 | 0.07 | 0.11 | 1.49 | 0.45 |
| 32113/4 | -0.10 | -0.60 | -0.07 | -0.08 | 0.53 | -0.50 | 0.14 | 0.19 | 0.06 |
| 32119 | 0.03 | -0.42 | -0.01 | -0.04 | 0.21 | -0.20 | 0.25 | 0.38 | 0.16 |
| 32120 | 0.03 | -0.18 | -0.01 | -0.02 | 0.07 | -0.10 | 0.10 | 0.28 | 0.11 |
| 32330 | -0.03 | -0.13 | -0.02 | 0.00 | 0.20 | 0.01 | 0.19 | 0.27 | 0.09 |
| 32400 | 0.00 | -0.31 | -0.02 | -0.05 | 0.17 | -0.16 | 0.15 | 0.31 | 0.12 |
| 33114/19 | -0.03 | -0.17 | -0.01 | -0.02 | 0.22 | 0.00 | 0.19 | 0.49 | 0.19 |
| 33120 | -0.01 | -0.27 | -0.01 | -0.04 | 0.09 | -0.21 | 0.08 | 0.29 | 0.09 |
| 33200 | -0.19 | -0.02 | -0.05 | -0.13 | 0.78 | -0.27 | 0.60 | 0.34 | 0.12 |
| 35400 | -0.03 | -0.13 | -0.01 | 0.00 | 0.27 | 0.09 | 0.26 | 1.92 | 0.78 |
| 36922 | -0.01 | -0.24 | -0.02 | -0.02 | 0.24 | -0.03 | 0.25 | 0.50 | 0.22 |
| 36992 | -0.16 | 0.66 | -0.05 | 0.15 | 0.48 | 0.97 | 0.29 | 0.33 | 0.14 |
| 36999 | -0.32 | -0.28 | -0.11 | -0.03 | 0.59 | -0.03 | 0.29 | 0.67 | 0.25 |
| 37102 | 0.01 | -0.07 | -0.02 | 0.00 | 0.13 | 0.05 | 0.14 | 0.43 | 0.17 |
| 38111 | 0.10 | -0.37 | 0.01 | -0.04 | 0.18 | -0.12 | 0.27 | 0.34 | 0.13 |
| 38130 | -0.06 | -0.10 | -0.02 | 0.00 | 0.21 | 0.03 | 0.15 | 0.72 | 0.24 |
| 38210/20 | -0.06 | -0.31 | -0.02 | -0.03 | 0.24 | -0.15 | 0.20 | 0.72 | 0.25 |
| 38230 | -0.14 | -0.20 | -0.06 | -0.03 | 0.41 | 0.04 | 0.32 | 0.46 | 0.17 |
| 38240 | -0.02 | -0.24 | -0.02 | -0.02 | 0.18 | -0.10 | 0.16 | 0.69 | 0.22 |
| 38299 | -0.04 | -0.05 | 0.00 | 0.00 | 0.19 | 0.08 | 0.16 | 0.55 | 0.22 |
| 38431 | -0.09 | -0.31 | -0.11 | -0.03 | 0.97 | -0.94 | 0.40 | 0.75 | 0.22 |
| 39091 | -0.06 | -0.21 | -0.01 | -0.02 | 0.16 | -0.12 | 0.11 | 0.31 | 0.10 |
| 39099 | 0.00 | -0.07 | -0.01 | 0.00 | 0.12 | 0.03 | 0.13 | 0.41 | 0.17 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

**Appendix 2.10**

Data at a Glance in Malaysian Manufacturing at 5-digit industry with Medium Size Industry

| Industry (1) | Output Capital Ratio (2) | Real Rental Price Ratio (3) | Labor Capital Ratio (4) | Wage Rental Ratio (5) | Capital (6) | Revenue Rental Ratio (7) | Output (8) | Average Labor Share(Gross Output) (9) | Average Labor Share(Value Added) (10) |
|---|---|---|---|---|---|---|---|---|---|
| | AVERAGE ANNUAL GROWTH RATE (%) OF | | | | | | | | |
| 31110 | -0.03 | -0.02 | 0.01 | 0.00 | 0.21 | 0.14 | 0.20 | 0.88 | 0.29 |
| 31140 | 0.00 | -0.02 | -0.01 | 0.00 | 0.12 | 0.08 | 0.13 | 0.67 | 0.13 |
| 31152 | 0.04 | -0.06 | 0.00 | 0.00 | 0.14 | 0.10 | 0.20 | 4.71 | 0.58 |
| 31159 | -0.05 | -0.17 | 0.00 | 0.00 | 0.24 | 0.00 | 0.20 | 5.12 | 0.68 |
| 31163 | -0.05 | -0.21 | 0.00 | 0.00 | 0.11 | -0.17 | 0.06 | 3.96 | 0.70 |
| 31171 | -0.07 | -0.08 | -0.01 | 0.00 | 0.18 | 0.01 | 0.12 | 0.44 | 0.14 |
| 31190 | -0.02 | -0.05 | -0.01 | 0.00 | 0.15 | 0.06 | 0.14 | 1.01 | 0.24 |
| 31310/30/40 | 0.03 | 0.31 | -0.01 | 0.04 | 0.13 | 0.44 | 0.18 | 1.50 | 0.63 |
| 31400 | -0.05 | 0.01 | 0.00 | 0.00 | 0.12 | 0.05 | 0.07 | 1.68 | 0.67 |
| 32130 | -0.03 | 0.00 | -0.02 | 0.01 | 0.19 | 0.14 | 0.17 | 0.50 | 0.16 |
| 32150 | -0.07 | -0.82 | -0.02 | -0.09 | 0.23 | -0.67 | 0.19 | 0.36 | 0.16 |
| 32201 | -0.01 | -0.04 | -0.01 | 0.00 | 0.16 | 0.09 | 0.15 | 0.31 | 0.10 |
| 32310 | -0.05 | 0.24 | -0.01 | 0.03 | 0.16 | 0.33 | 0.11 | 0.67 | 0.17 |
| 33111 | -0.02 | -0.01 | -0.01 | 0.00 | 0.09 | 0.03 | 0.06 | 0.55 | 0.16 |
| 33113 | -0.01 | -0.06 | -0.01 | 0.00 | 0.15 | 0.06 | 0.14 | 0.47 | 0.15 |
| 34120 | -0.06 | 0.03 | -0.01 | 0.01 | 0.21 | 0.16 | 0.17 | 0.81 | 0.26 |
| 34190 | -0.02 | -0.20 | -0.01 | -0.01 | 0.20 | -0.05 | 0.18 | 0.71 | 0.24 |
| 34200 | -0.04 | 0.00 | -0.02 | 0.01 | 0.14 | 0.08 | 0.11 | 0.57 | 0.28 |
| 35120 | -0.21 | -0.07 | -0.01 | 0.00 | 0.30 | -0.01 | 0.09 | 3.33 | 0.84 |
| 35130 | -0.03 | -0.12 | -0.01 | 0.00 | 0.30 | 0.12 | 0.29 | 2.89 | 0.65 |
| 35210 | -0.03 | 0.01 | -0.01 | 0.00 | 0.15 | 0.10 | 0.13 | 1.88 | 0.61 |
| 35220 | -0.06 | -0.03 | -0.02 | 0.01 | 0.18 | 0.07 | 0.13 | 0.68 | 0.29 |
| 35231 | -0.02 | 0.00 | -0.01 | 0.00 | 0.12 | 0.08 | 0.11 | 1.87 | 0.77 |
| 35239 | -0.09 | -0.07 | -0.01 | 0.00 | 0.18 | 0.00 | 0.11 | 1.30 | 0.52 |
| 35290 | -0.03 | -0.05 | -0.01 | 0.00 | 0.19 | 0.08 | 0.17 | 0.95 | 0.31 |
| 35510 | 0.00 | -0.04 | 0.00 | 0.00 | 0.13 | 0.07 | 0.13 | 0.98 | 0.42 |
| 35591 | -0.02 | -0.07 | 0.00 | 0.00 | 0.07 | -0.05 | 0.07 | 2.43 | 0.36 |
| 35592 | -0.67 | -0.37 | -0.03 | -0.01 | 0.74 | -0.32 | 0.06 | 1.84 | 0.24 |
| 35600 | -0.01 | -0.01 | -0.01 | 0.01 | 0.19 | 0.14 | 0.20 | 0.51 | 0.18 |
| 36100 | 0.05 | -0.05 | 0.00 | 0.00 | 0.10 | 0.08 | 0.15 | 0.28 | 0.15 |
| 36200 | 0.01 | -0.04 | -0.01 | 0.00 | 0.19 | 0.13 | 0.23 | 1.04 | 0.45 |
| 36910 | -0.03 | -0.03 | -0.02 | 0.00 | 0.18 | 0.09 | 0.15 | 0.37 | 0.20 |
| 36991 | 0.00 | -0.05 | -0.01 | 0.00 | 0.16 | 0.08 | 0.17 | 0.94 | 0.34 |
| 37109 | -0.05 | -0.09 | -0.01 | 0.00 | 0.18 | 0.02 | 0.14 | 2.35 | 0.49 |
| 38120 | -0.04 | -0.12 | -0.02 | -0.01 | 0.20 | 0.01 | 0.16 | 0.47 | 0.16 |
| 38191 | -0.05 | 0.01 | -0.01 | 0.01 | 0.14 | 0.07 | 0.11 | 0.98 | 0.27 |
| 38192 | 0.00 | -0.03 | 0.00 | 0.00 | 0.14 | 0.08 | 0.16 | 1.15 | 0.28 |
| 38193 | -0.06 | -0.01 | -0.02 | 0.01 | 0.23 | 0.13 | 0.17 | 0.68 | 0.22 |
| 38199 | -0.01 | -0.06 | -0.01 | 0.00 | 0.29 | 0.20 | 0.29 | 0.81 | 0.25 |
| 38291 | 0.02 | -0.27 | 0.00 | -0.01 | 0.22 | -0.05 | 0.25 | 1.56 | 0.45 |
| 38310 | 0.05 | -0.85 | -0.01 | -0.07 | 0.36 | -0.46 | 0.42 | 0.68 | 0.21 |
| 38330 | 0.00 | -0.37 | -0.02 | -0.02 | 0.38 | -0.02 | 0.39 | 1.27 | 0.34 |

Appendix 2.10 (Continued)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38392 | -0.16 | -0.88 | -0.04 | -0.12 | 0.44 | -0.63 | 0.28 | 0.90 | 0.33 |
| 38393 | 0.23 | 0.45 | 0.00 | 0.09 | 0.21 | 0.87 | 0.43 | 0.61 | 0.21 |
| 38399 | -0.16 | -0.73 | -0.06 | -0.07 | 0.50 | -0.42 | 0.36 | 0.57 | 0.18 |
| 38410 | -0.61 | -0.87 | -0.19 | -0.04 | 0.97 | -0.54 | 0.37 | 0.75 | 0.31 |
| 38439 | 0.04 | -0.06 | -0.01 | 0.00 | 0.26 | 0.21 | 0.32 | 0.73 | 0.26 |
| 38441 | 0.11 | -0.52 | -0.01 | -0.03 | 0.36 | -0.07 | 0.47 | 1.53 | 0.37 |
| 38449 | -0.09 | -0.37 | 0.00 | -0.05 | 0.36 | -0.12 | 0.28 | 0.72 | 0.21 |
| 39030 | 0.72 | -0.20 | -0.01 | -0.15 | 0.45 | -0.05 | 0.18 | 0.36 | 0.14 |
| 39092 | -0.08 | -0.06 | -0.02 | 0.00 | 0.20 | 0.03 | 0.12 | 0.55 | 0.18 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

**Appendix 2.11**

Data at a Glance in Malaysian Manufacturing at 5-digit industry with Large Size Industry

AVERAGE ANNUAL GROWTH RATE (%) OF

| Industry (1) | Output Capital Ratio (2) | Real Rental Price Ratio (3) | Labor Capital Ratio (4) | Wage Rental Ratio (5) | Capital (6) | Revenue Rental Ratio (7) | Output (8) | Average Labor Share(Gross Output) (9) | Average Labor Share(Value Added) (10) |
|---|---|---|---|---|---|---|---|---|---|
| 31129 | -0.04 | -0.04 | 0.00 | 0.00 | 0.12 | 0.02 | 0.08 | 3.71 | 0.77 |
| 31131 | -0.04 | -0.38 | -0.01 | -0.04 | 0.04 | -0.60 | 0.08 | 0.55 | 0.13 |
| 31180 | -0.01 | -0.09 | 0.00 | 0.00 | 0.07 | -0.05 | 0.06 | 3.00 | 0.58 |
| 32111 | 0.04 | -0.21 | -0.01 | -0.01 | 0.07 | -0.13 | 0.10 | 0.77 | 0.22 |
| 32112 | -0.01 | -0.29 | -0.01 | -0.01 | 0.17 | -0.16 | 0.16 | 0.90 | 0.25 |
| 32115 | 0.01 | -0.57 | -0.01 | -0.04 | 0.30 | -0.29 | 0.34 | 0.86 | 0.28 |
| 33112 | -0.01 | -0.05 | -0.01 | 0.00 | 0.17 | 0.09 | 0.17 | 0.48 | 0.16 |
| 34110 | -0.04 | -0.08 | -0.35 | 0.03 | 0.17 | 0.13 | 0.26 | 0.81 | 0.26 |
| 35300 | -0.23 | -0.19 | 0.00 | 0.00 | 0.37 | -0.07 | 0.15 | 3.57 | 0.24 |
| 35593 | 0.02 | -0.07 | -0.01 | 0.00 | 0.04 | -0.03 | 0.05 | 0.30 | 0.12 |
| 35599 | -0.02 | -0.04 | -0.01 | 0.00 | 0.22 | 0.14 | 0.21 | 0.46 | 0.19 |
| 36921 | -0.07 | 0.01 | -0.01 | 0.00 | 0.19 | 0.11 | 0.13 | 2.84 | 0.33 |
| 37101 | -0.17 | 0.54 | -0.02 | 0.02 | 0.35 | 0.69 | 0.19 | 2.66 | 0.45 |
| 37209 | 0.01 | -0.10 | -0.01 | 0.00 | 0.27 | 0.66 | 0.77 | 2.58 | 0.37 |
| 38321 | 0.18 | 0.07 | 0.00 | 0.00 | 0.97 | -0.11 | 0.65 | 1.27 | 0.22 |
| 38391 | -0.15 | -0.26 | -0.03 | -0.02 | 0.43 | -0.01 | 0.29 | 1.38 | 0.34 |
| 38432 | -0.08 | -0.15 | -0.03 | 0.00 | 0.30 | 0.05 | 0.24 | 2.49 | 0.58 |
| 38510 | -0.01 | -0.06 | -0.01 | 0.00 | 0.16 | 0.07 | 0.15 | 0.50 | 0.23 |

Notes: Unless otherwise stated, all values represents the average annual growth rates from 1975 to 1999 in percentage terms

**Appendix 2.12**
Average Growth Labour Share in Value Added with Small Size Industry, 1975-1999

| | 1975-1979 | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1999 | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31121 | -0.04 | 0.00 | -0.09 | 0.08 | 0.06 | -0.25 | 0.16 | 0.00 | 0.12 | -0.62 | -0.01 |
| 31139 | 0.03 | 0.03 | -0.04 | 0.02 | 0.01 | -0.11 | 0.09 | 0.01 | 0.05 | 0.65 | 0.01 |
| 31151 | -0.08 | 0.05 | 0.04 | 0.02 | 0.04 | -0.59 | 0.29 | 0.01 | 0.15 | -0.12 | 0.01 |
| 31153 | -0.07 | 0.01 | 0.02 | -0.02 | 0.07 | -0.42 | 0.15 | 0.00 | 0.11 | -0.77 | -0.01 |
| 31162 | 0.02 | -0.18 | 0.04 | 0.03 | 0.21 | -0.41 | 0.43 | 0.01 | 0.20 | -0.57 | 0.00 |
| 31164 | 0.06 | -0.01 | -0.12 | 0.06 | 0.04 | -0.57 | 0.26 | 0.00 | 0.19 | -0.79 | 0.00 |
| 31169 | 0.16 | -0.11 | 0.16 | -0.11 | -0.14 | -0.43 | 0.62 | 0.00 | 0.27 | -0.75 | 0.01 |
| 31172 | -0.01 | 0.02 | 0.03 | 0.04 | 0.07 | -0.14 | 0.08 | 0.03 | 0.05 | 0.82 | 0.03 |
| 31211 | 0.01 | 0.08 | 0.01 | 0.01 | 0.03 | -0.29 | 0.37 | 0.03 | 0.17 | 0.65 | 0.03 |
| 31212 | 0.08 | 0.02 | -0.05 | 0.03 | 0.03 | -0.51 | 0.93 | 0.02 | 0.28 | 0.62 | 0.03 |
| 31215 | -0.14 | -0.04 | 0.00 | 0.08 | 0.16 | -0.59 | 0.21 | 0.00 | 0.18 | 0.67 | -0.01 |
| 31219 | -0.16 | -0.03 | 0.08 | 0.05 | 0.12 | -0.78 | 0.48 | 0.00 | 0.26 | -1.55 | 0.00 |
| 31220 | -0.04 | 0.08 | 0.02 | 0.03 | 0.03 | -0.24 | 0.39 | 0.02 | 0.11 | -0.87 | 0.03 |
| 32113/4 | -0.05 | 0.05 | -0.07 | 0.08 | 0.10 | -0.24 | 0.54 | 0.02 | 0.21 | -0.27 | 0.02 |
| 32119 | -0.08 | -0.01 | 0.08 | 0.13 | -0.03 | -0.58 | 0.31 | 0.02 | 0.20 | -0.77 | 0.03 |
| 32120 | -0.02 | 0.02 | 0.02 | 0.02 | 0.00 | -0.17 | 0.14 | 0.01 | 0.08 | -1.37 | 0.01 |
| 32330 | 0.05 | 0.07 | -0.01 | -0.02 | -0.04 | -0.24 | 0.30 | 0.02 | 0.15 | -0.06 | 0.02 |
| 32400 | 0.01 | 0.00 | -0.03 | 0.12 | 0.00 | -0.30 | 0.29 | 0.02 | 0.18 | 0.65 | 0.03 |
| 33114/19 | -0.07 | 0.03 | 0.11 | 0.01 | -0.04 | -0.40 | 0.34 | 0.01 | 0.14 | -0.61 | 0.02 |
| 33120 | -0.10 | 0.09 | -0.07 | 0.04 | 0.16 | -0.77 | 0.41 | 0.01 | 0.28 | -0.61 | 0.01 |
| 33200 | -0.04 | 0.09 | 0.02 | 0.08 | 0.03 | -0.27 | 0.21 | 0.03 | 0.13 | -0.45 | 0.04 |
| 35400 | 0.05 | -0.02 | -0.03 | 0.00 | 0.02 | -0.28 | 0.19 | 0.00 | 0.14 | -0.71 | 0.00 |
| 36922 | 0.36 | -0.21 | 0.03 | -0.12 | 0.01 | -0.53 | 1.01 | 0.02 | 0.35 | -0.18 | 0.02 |
| 36992 | -0.15 | 0.04 | 0.08 | -0.03 | 0.36 | -0.65 | 0.82 | 0.03 | 0.29 | 0.68 | 0.03 |
| 36999 | -0.06 | 0.02 | 0.05 | 0.11 | 0.02 | -0.29 | 0.66 | 0.03 | 0.22 | -1.50 | 0.04 |
| 37102 | -0.06 | 0.01 | 0.05 | 0.05 | 0.11 | -0.27 | 0.22 | 0.02 | 0.14 | -0.56 | 0.03 |
| 38111 | 0.11 | -0.08 | 0.01 | 0.04 | 0.07 | -0.41 | 0.42 | 0.03 | 0.21 | -1.03 | 0.03 |
| 38130 | -0.01 | -0.04 | 0.12 | 0.02 | 0.09 | -0.54 | 0.46 | 0.03 | 0.23 | -0.56 | 0.04 |
| 38210/20 | 0.04 | 0.01 | 0.08 | 0.05 | -0.12 | -0.65 | 0.56 | 0.02 | 0.25 | -1.34 | 0.03 |
| 38230 | 0.01 | -0.04 | -0.02 | 0.13 | 0.10 | -0.26 | 0.22 | 0.03 | 0.12 | 0.45 | 0.03 |
| 38240 | 0.03 | -0.04 | 0.06 | 0.24 | -0.29 | -0.52 | 0.63 | 0.03 | 0.29 | 0.12 | 0.04 |
| 38299 | -0.02 | 0.06 | -0.06 | 0.02 | 0.08 | -0.45 | 0.18 | 0.01 | 0.16 | 0.62 | 0.01 |
| 38431 | 0.05 | 0.05 | -0.13 | -0.01 | 0.19 | -0.65 | 0.35 | 0.01 | 0.16 | -0.54 | 0.01 |
| 39091 | 0.09 | -0.12 | 0.05 | 0.01 | 0.10 | -0.49 | 0.41 | 0.02 | 0.21 | -0.58 | 0.02 |
| 39099 | -0.01 | 0.08 | -0.02 | -0.12 | 0.09 | -0.55 | 0.28 | 0.00 | 0.18 | -0.88 | 0.00 |

**Appendix 2.13**

Average Growth Labour Share In Value Added with Medium Size Industry, 1975-1999

| | 1975-1979 | 1981-1985 | 1986-1990 | 1991-1995 | 1996-1999 | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31110 | -0.05 | 0.03 | -0.02 | 0.10 | -0.11 | -0.33 | 0.39 | 0.00 | 0.17 | 1.16 | 0.00 |
| 31140 | -0.01 | 0.02 | 0.03 | 0.07 | -0.07 | -0.19 | 0.18 | 0.02 | 0.11 | -0.20 | 0.02 |
| 31152 | 0.09 | -0.15 | -0.05 | 0.08 | 0.00 | -0.35 | 0.43 | 0.00 | 0.22 | -0.37 | 0.00 |
| 31159 | -0.17 | 0.10 | 0.10 | -0.03 | -0.01 | -0.62 | 0.70 | 0.00 | 0.32 | -0.76 | 0.00 |
| 31163 | -0.01 | 0.00 | -0.01 | -0.10 | 0.25 | -0.36 | 0.55 | 0.01 | 0.24 | 0.22 | 0.00 |
| 31171 | -0.02 | 0.04 | 0.02 | 0.08 | 0.02 | -0.18 | 0.15 | 0.03 | 0.08 | -0.53 | 0.03 |
| 31190 | -0.01 | 0.00 | 0.02 | 0.02 | 0.21 | -0.43 | 0.73 | 0.03 | 0.21 | -1.43 | 0.03 |
| 31310/30/40 | -0.02 | 0.03 | 0.13 | -0.07 | 0.06 | -0.29 | 0.36 | 0.02 | 0.14 | -0.94 | 0.03 |
| 31400 | 0.08 | 0.10 | -0.08 | -0.06 | 0.19 | -0.56 | 0.48 | 0.03 | 0.27 | -0.12 | 0.04 |
| 32130 | -0.01 | -0.02 | 0.03 | 0.06 | 0.02 | -0.09 | 0.13 | 0.02 | 0.05 | 1.09 | 0.02 |
| 32150 | -0.10 | -0.02 | 0.03 | 0.07 | 0.14 | -0.39 | 0.73 | 0.01 | 0.29 | -1.20 | 0.01 |
| 32201 | 0.00 | 0.04 | 0.05 | 0.03 | 0.04 | -0.03 | 0.09 | 0.03 | 0.03 | -1.47 | 0.04 |
| 32310 | -0.19 | 0.10 | -0.05 | 0.22 | -0.07 | -0.82 | 0.88 | 0.01 | 0.38 | -1.45 | 0.01 |
| 33111 | 0.06 | -0.05 | 0.07 | 0.03 | 0.02 | -0.24 | 0.36 | 0.02 | 0.14 | -0.36 | 0.03 |
| 33113 | 0.04 | 0.04 | 0.04 | 0.05 | -0.05 | -0.29 | 0.23 | 0.03 | 0.13 | 0.27 | 0.04 |
| 34120 | 0.06 | -0.01 | 0.02 | 0.05 | 0.01 | -0.29 | 0.35 | 0.03 | 0.12 | -0.15 | 0.03 |
| 34190 | -0.04 | 0.07 | 0.02 | 0.06 | 0.06 | -0.43 | 0.32 | 0.03 | 0.17 | 0.16 | 0.04 |
| 34200 | 0.01 | 0.03 | 0.05 | 0.05 | 0.00 | -0.18 | 0.24 | 0.03 | 0.09 | 0.25 | 0.04 |
| 35120 | 0.05 | 0.00 | 0.03 | 0.14 | -0.12 | -0.45 | 0.51 | 0.03 | 0.25 | -0.76 | 0.04 |
| 35130 | 0.00 | -0.09 | 0.03 | 0.16 | 0.03 | -0.29 | 0.36 | 0.03 | 0.17 | -0.28 | 0.03 |
| 35210 | 0.06 | 0.07 | -0.02 | 0.02 | 0.00 | -0.19 | 0.25 | 0.03 | 0.11 | -1.84 | 0.03 |
| 35220 | -0.04 | 0.04 | 0.02 | 0.02 | 0.00 | -0.34 | 0.19 | 0.01 | 0.11 | 1.08 | 0.01 |
| 35231 | 0.13 | 0.05 | 0.03 | -0.04 | -0.09 | -0.42 | 0.59 | 0.03 | 0.23 | 0.09 | 0.03 |
| 35239 | 0.09 | 0.07 | -0.03 | 0.10 | -0.22 | -0.59 | 0.99 | 0.02 | 0.31 | 1.57 | 0.03 |
| 35290 | 0.02 | -0.05 | -0.01 | 0.04 | 0.19 | -0.21 | 0.37 | 0.02 | 0.12 | 0.76 | 0.02 |
| 35510 | -0.05 | 0.09 | 0.07 | -0.03 | 0.07 | -0.41 | 0.36 | 0.03 | 0.16 | -1.38 | 0.03 |
| 35591 | 0.09 | -0.06 | 0.06 | 0.07 | -0.13 | -0.41 | 0.59 | 0.02 | 0.27 | 0.12 | 0.02 |
| 35592 | 0.13 | -0.09 | -0.09 | 0.01 | 0.23 | -0.56 | 0.51 | 0.02 | 0.29 | 0.49 | 0.02 |
| 35600 | 0.02 | -0.02 | 0.04 | 0.07 | 0.02 | -0.12 | 0.13 | 0.03 | 0.07 | 0.06 | 0.03 |
| 36100 | 0.10 | -0.06 | -0.01 | 0.09 | 0.06 | -0.52 | 0.68 | 0.03 | 0.22 | -1.52 | 0.04 |
| 36200 | 0.15 | -0.22 | 0.03 | 0.09 | 0.16 | -0.89 | 0.60 | 0.03 | 0.30 | -0.54 | 0.03 |
| 36910 | -0.01 | 0.07 | 0.03 | 0.04 | 0.01 | -0.21 | 0.13 | 0.03 | 0.07 | -1.09 | 0.03 |
| 36991 | 0.03 | -0.02 | 0.06 | 0.03 | -0.02 | -0.48 | 0.32 | 0.02 | 0.18 | 0.32 | 0.02 |
| 37109 | -0.03 | -0.13 | 0.04 | 0.08 | 0.10 | -0.54 | 0.29 | 0.00 | 0.18 | 0.30 | 0.00 |
| 38120 | -0.01 | 0.11 | 0.01 | 0.03 | 0.00 | -0.18 | 0.31 | 0.03 | 0.13 | -1.37 | 0.04 |
| 38191 | -0.03 | 0.04 | 0.01 | 0.14 | -0.02 | -0.18 | 0.32 | 0.03 | 0.11 | -0.23 | 0.04 |
| 38192 | 0.00 | -0.07 | 0.07 | 0.07 | 0.13 | -0.41 | 0.39 | 0.03 | 0.19 | -0.61 | 0.04 |
| 38193 | -0.02 | 0.01 | -0.02 | 0.00 | 0.11 | -0.29 | 0.28 | 0.01 | 0.11 | -0.99 | 0.01 |
| 38199 | -0.01 | 0.12 | 0.03 | -0.05 | 0.08 | -0.21 | 0.30 | 0.03 | 0.15 | -0.35 | 0.03 |
| 38291 | 0.04 | -0.07 | 0.13 | 0.05 | -0.01 | -0.62 | 0.39 | 0.03 | 0.22 | 0.67 | 0.04 |
| 38310 | 0.01 | 0.00 | -0.11 | 0.13 | 0.06 | -0.47 | 0.36 | 0.01 | 0.22 | -0.69 | 0.01 |
| 38330 | 0.03 | -0.11 | 0.12 | 0.01 | 0.11 | -0.51 | 0.49 | 0.02 | 0.29 | -0.60 | 0.02 |
| 38392 | 0.07 | 0.00 | 0.07 | -0.03 | 0.02 | -0.32 | 0.31 | 0.02 | 0.18 | 0.64 | 0.03 |
| 38393 | 0.20 | 0.00 | -0.08 | -0.08 | 0.08 | -0.44 | 0.51 | 0.02 | 0.19 | 0.63 | 0.02 |

**Appendix 2.13 (Continued)**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38399 | -0.08 | 0.08 | -0.04 | 0.09 | 0.05 | -0.34 | 0.74 | 0.02 | 0.23 | 1.59 | 0.02 |
| 38410 | 0.45 | -0.20 | -0.14 | 0.00 | -0.12 | -0.61 | 1.21 | 0.01 | 0.43 | -1.14 | 0.01 |
| 38439 | 0.00 | 0.07 | 0.02 | 0.01 | 0.01 | -0.27 | 0.22 | 0.02 | 0.11 | 1.11 | 0.03 |
| 38441 | -0.05 | -0.06 | 0.10 | 0.07 | -0.03 | -0.48 | 0.43 | 0.01 | 0.25 | -0.38 | 0.01 |
| 38449 | 0.05 | 0.00 | -0.14 | 0.02 | 0.14 | -0.62 | 0.32 | 0.00 | 0.21 | -0.65 | 0.00 |
| 39030 | -0.06 | -0.12 | 0.11 | 0.12 | 0.12 | -0.47 | 0.58 | 0.02 | 0.25 | -1.54 | 0.03 |
| 39092 | -0.11 | 0.02 | 0.05 | 0.05 | 0.04 | -0.28 | 0.56 | 0.01 | 0.20 | -0.84 | 0.01 |

**Appendix 2.14**

Average Growth Labour Share In Value Added with Large Size Industry, 1975-1999

| | **1975-1979** | **1981-1985** | **1986-1990** | **1991-1995** | **1996-1999** | Min | Max | Mean | S.D. | t-statistics | Average Growth |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31129 | -0.01 | 0.06 | -0.01 | 0.09 | -0.03 | -0.29 | 0.24 | 0.02 | 0.16 | 0.28 | 0.03 |
| 31131 | 0.16 | -0.25 | 0.20 | -0.06 | 0.01 | -0.81 | 0.81 | 0.01 | 0.44 | 0.18 | 0.01 |
| 31180 | 0.11 | -0.03 | 0.00 | 0.00 | 0.08 | -0.51 | 0.49 | 0.03 | 0.23 | -0.22 | 0.03 |
| 32111 | -0.13 | 0.02 | 0.11 | 0.13 | -0.19 | -0.53 | 0.39 | 0.00 | 0.23 | -1.51 | 0.01 |
| 32112 | -0.19 | 0.03 | -0.06 | 0.08 | 0.24 | -0.98 | 0.61 | 0.00 | 0.28 | -0.83 | -0.01 |
| 32115 | 0.05 | -0.11 | -0.05 | 0.04 | 0.10 | -0.36 | 0.33 | 0.00 | 0.19 | -0.20 | 0.00 |
| 33112 | 0.11 | -0.07 | 0.02 | 0.05 | 0.09 | -0.24 | 0.51 | 0.03 | 0.15 | 1.34 | 0.04 |
| 34110 | 0.03 | 0.09 | 0.09 | -0.06 | -0.17 | -0.37 | 0.35 | 0.01 | 0.20 | 0.27 | 0.02 |
| 35300 | 0.04 | -0.02 | -0.02 | 0.05 | -0.09 | -0.60 | 0.52 | 0.00 | 0.29 | 0.42 | 0.00 |
| 35593 | 0.00 | 0.11 | 0.01 | -0.02 | 0.05 | -0.26 | 0.34 | 0.03 | 0.15 | -0.66 | 0.03 |
| 35599 | 0.01 | -0.04 | 0.03 | 0.05 | 0.08 | -0.66 | 0.69 | 0.02 | 0.27 | -0.35 | 0.03 |
| 36921 | 0.06 | -0.06 | 0.09 | 0.10 | -0.25 | -0.59 | 0.54 | 0.01 | 0.26 | -0.41 | 0.02 |
| 37101 | 0.04 | -0.04 | 0.13 | -0.01 | -0.06 | -0.46 | 0.60 | 0.02 | 0.22 | -1.56 | 0.03 |
| 37209 | 0.07 | -0.19 | -0.01 | 0.13 | 0.10 | -0.74 | 0.42 | 0.01 | 0.28 | -1.49 | 0.01 |
| 38321 | -0.01 | 0.04 | -0.04 | 0.07 | 0.14 | -0.23 | 0.26 | 0.03 | 0.15 | -0.92 | 0.03 |
| 38391 | -0.16 | 0.03 | 0.04 | 0.03 | 0.07 | -0.71 | 0.34 | 0.00 | 0.23 | 1.86 | -0.01 |
| 38432 | 0.12 | 0.08 | 0.06 | -0.06 | -0.13 | -0.44 | 0.56 | 0.03 | 0.23 | -0.82 | 0.04 |
| 38510 | 0.06 | -0.02 | -0.05 | 0.04 | 0.07 | -0.38 | 0.47 | 0.02 | 0.20 | 0.37 | 0.02 |

**Appendix 2.15**

Decomposition of TFP growth in Malaysia Manufacturing Industry with Small Size Industry:1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| 31121 | -0.03 | -0.03 | 0.04 | 0.05 | 0.05 | 0.05 | 0.03 | 0.04 |
| 31139 | 0.01 | 0.01 | 0.06 | 0.07 | 0.07 | 0.07 | 0.04 | 0.05 |
| 31151 | -0.05 | -0.05 | 0.07 | 0.08 | 0.03 | 0.03 | 0.01 | 0.02 |
| 31153 | 0.01 | 0.01 | 0.16 | 0.17 | 0.15 | 0.15 | 0.11 | 0.12 |
| 31162 | -0.06 | -0.06 | 0.03 | 0.03 | 0.02 | 0.02 | 0.01 | 0.00 |
| 31164 | -0.03 | -0.03 | 0.02 | 0.03 | 0.02 | 0.03 | 0.00 | 0.01 |
| 31169 | -0.02 | -0.03 | 0.09 | 0.10 | 0.06 | 0.06 | 0.03 | 0.04 |
| 31172 | -0.05 | -0.05 | 0.06 | 0.07 | 0.07 | 0.07 | 0.04 | 0.05 |
| 31211 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.04 | 0.00 | 0.00 |
| 31212 | -0.02 | -0.02 | 0.08 | 0.09 | 0.06 | 0.07 | 0.01 | 0.01 |
| 31215 | -0.02 | -0.02 | 0.11 | 0.11 | 0.09 | 0.10 | 0.06 | 0.08 |
| 31219 | -0.01 | -0.01 | 0.04 | 0.05 | 0.04 | 0.04 | 0.02 | 0.03 |
| 31220 | -0.03 | -0.02 | 0.04 | 0.05 | 0.06 | 0.07 | 0.01 | 0.01 |
| 32113/4 | -0.03 | -0.03 | 0.03 | 0.04 | 0.08 | 0.09 | 0.00 | 0.00 |
| 32119 | -0.04 | -0.04 | 0.05 | 0.06 | 0.14 | 0.15 | 0.04 | 0.10 |
| 32120 | -0.01 | -0.02 | 0.07 | 0.08 | 0.07 | 0.09 | 0.04 | 0.05 |
| 32330 | -0.01 | -0.01 | 0.11 | 0.12 | 0.11 | 0.12 | 0.07 | 0.08 |
| 32400 | -0.02 | -0.02 | 0.08 | 0.08 | 0.07 | 0.08 | 0.03 | 0.04 |
| 33114/19 | -0.01 | -0.01 | 0.05 | 0.06 | 0.03 | 0.04 | 0.02 | 0.02 |
| 33120 | -0.01 | -0.02 | 0.04 | 0.05 | 0.03 | 0.04 | 0.02 | 0.04 |
| 33200 | -0.01 | -0.01 | 0.08 | 0.08 | 0.07 | 0.07 | 0.04 | 0.06 |
| 35400 | -0.03 | -0.03 | 0.04 | 0.04 | 0.13 | 0.14 | 0.00 | 0.00 |
| 36922 | -0.01 | -0.01 | 0.09 | 0.09 | 0.09 | 0.10 | 0.04 | 0.04 |
| 36992 | -0.01 | -0.01 | 0.08 | 0.08 | 0.04 | 0.05 | 0.00 | 0.00 |
| 36999 | -0.02 | -0.03 | 0.13 | 0.12 | 0.11 | 0.12 | 0.03 | 0.03 |
| 37102 | -0.05 | -0.06 | 0.06 | 0.06 | 0.03 | 0.04 | 0.00 | 0.00 |
| 38111 | -0.03 | -0.03 | 0.06 | 0.06 | 0.05 | 0.06 | 0.02 | 0.02 |
| 38130 | -0.04 | -0.04 | 0.01 | 0.03 | 0.08 | 0.09 | 0.01 | 0.02 |
| 38210/20 | -0.04 | -0.03 | 0.05 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 |
| 38230 | -0.08 | -0.07 | 0.10 | 0.09 | 0.13 | 0.12 | 0.06 | 0.06 |
| 38240 | 0.00 | 0.00 | 0.06 | 0.06 | 0.08 | 0.09 | 0.01 | 0.01 |
| 38299 | -0.03 | -0.04 | 0.03 | 0.03 | 0.05 | 0.06 | 0.00 | 0.00 |
| 38431 | -0.05 | -0.05 | 0.06 | 0.07 | 0.07 | 0.08 | 0.02 | 0.01 |
| 39091 | -0.04 | -0.04 | 0.06 | 0.08 | 0.06 | 0.06 | 0.00 | 0.01 |
| 39099 | 0.01 | 0.01 | 0.07 | 0.06 | 0.07 | 0.08 | 0.00 | 0.00 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

**Appendix 2.16**

Decomposition of TFP growth in Malaysia Manufacturing Industry with Medium Size Industry: 1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| 31110 | -0.03 | -0.02 | 0.02 | 0.03 | 0.08 | 0.09 | 0.03 | 0.04 |
| 31140 | -0.01 | -0.02 | 0.04 | 0.05 | 0.10 | 0.11 | 0.01 | 0.01 |
| 31152 | -0.04 | -0.06 | 0.07 | 0.08 | 0.11 | 0.11 | 0.10 | 0.10 |
| 31159 | -0.05 | -0.05 | 0.05 | 0.06 | 0.10 | 0.10 | 0.07 | 0.08 |
| 31163 | -0.05 | -0.04 | 0.06 | 0.08 | 0.04 | 0.04 | 0.03 | 0.03 |
| 31171 | -0.06 | -0.07 | 0.02 | 0.05 | 0.03 | 0.04 | 0.01 | 0.01 |
| 31190 | -0.01 | -0.02 | 0.03 | 0.06 | 0.06 | 0.07 | 0.06 | 0.06 |
| 31310/30/40 | 0.04 | 0.05 | 0.12 | 0.13 | 0.10 | 0.11 | 0.03 | 0.04 |
| 31400 | -0.05 | -0.04 | 0.01 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 |
| 32130 | -0.01 | -0.01 | 0.04 | 0.05 | 0.08 | 0.07 | 0.03 | 0.04 |
| 32150 | -0.04 | -0.04 | 0.09 | 0.11 | 0.11 | 0.11 | 0.05 | 0.05 |
| 32201 | 0.00 | 0.00 | 0.04 | 0.06 | 0.04 | 0.05 | 0.00 | 0.00 |
| 32310 | -0.04 | -0.04 | 0.06 | 0.08 | 0.07 | 0.08 | 0.06 | 0.05 |
| 33111 | -0.01 | -0.01 | 0.03 | 0.03 | 0.05 | 0.05 | 0.00 | 0.00 |
| 33113 | 0.00 | 0.00 | 0.02 | 0.05 | 0.05 | 0.05 | 0.00 | 0.01 |
| 34120 | -0.05 | -0.04 | 0.04 | 0.04 | 0.10 | 0.11 | 0.06 | 0.06 |
| 34190 | -0.01 | -0.02 | 0.04 | 0.05 | 0.04 | 0.04 | 0.00 | 0.00 |
| 34200 | -0.02 | -0.01 | 0.01 | 0.03 | 0.02 | 0.03 | 0.00 | 0.00 |
| 35120 | -0.06 | -0.07 | 0.03 | 0.05 | 0.07 | 0.06 | 0.00 | 0.00 |
| 35130 | -0.02 | -0.01 | 0.06 | 0.06 | 0.15 | 0.16 | 0.03 | 0.04 |
| 35210 | -0.03 | -0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.01 | 0.01 |
| 35220 | -0.04 | -0.03 | 0.05 | 0.06 | 0.04 | 0.05 | 0.01 | 0.02 |
| 35231 | -0.02 | -0.01 | 0.02 | 0.04 | 0.08 | 0.08 | 0.00 | 0.01 |
| 35239 | -0.07 | -0.07 | 0.05 | 0.07 | 0.02 | 0.03 | 0.00 | 0.00 |
| 35290 | -0.02 | -0.04 | 0.05 | 0.07 | 0.06 | 0.07 | 0.00 | 0.00 |
| 35510 | -0.03 | -0.04 | 0.02 | 0.03 | 0.05 | 0.06 | 0.00 | 0.00 |
| 35591 | -0.01 | -0.02 | 0.07 | 0.08 | 0.06 | 0.06 | 0.00 | 0.00 |
| 35592 | -0.03 | -0.02 | 0.03 | 0.05 | 0.03 | 0.03 | 0.02 | 0.02 |
| 35600 | -0.01 | -0.02 | 0.04 | 0.05 | 0.05 | 0.05 | 0.00 | 0.00 |
| 36100 | -0.04 | -0.05 | 0.04 | 0.05 | 0.07 | 0.07 | 0.00 | 0.01 |
| 36200 | -0.02 | -0.03 | 0.06 | 0.07 | 0.04 | 0.05 | 0.01 | 0.00 |
| 36910 | -0.01 | -0.02 | 0.04 | 0.04 | 0.04 | 0.03 | 0.00 | 0.00 |
| 36991 | 0.01 | -0.02 | 0.06 | 0.06 | 0.03 | 0.04 | 0.00 | 0.01 |
| 37109 | -0.05 | -0.06 | 0.04 | 0.05 | 0.08 | 0.09 | 0.00 | 0.00 |
| 38120 | -0.02 | -0.01 | 0.05 | 0.04 | 0.06 | 0.07 | 0.00 | 0.00 |
| 38191 | -0.04 | -0.03 | 0.03 | 0.04 | 0.03 | 0.04 | 0.00 | 0.00 |
| 38192 | -0.03 | -0.03 | 0.03 | 0.05 | 0.04 | 0.05 | 0.01 | 0.01 |
| 38193 | -0.04 | -0.03 | 0.04 | 0.04 | 0.07 | 0.07 | 0.02 | 0.02 |
| 38199 | 0.00 | 0.00 | 0.05 | 0.05 | 0.06 | 0.06 | 0.01 | 0.02 |
| 38291 | 0.02 | 0.02 | 0.11 | 0.11 | 0.15 | 0.16 | 0.03 | 0.03 |
| 38310 | 0.06 | 0.06 | 0.12 | 0.13 | 0.08 | 0.08 | 0.03 | 0.03 |
| 38330 | 0.02 | 0.02 | 0.10 | 0.11 | 0.06 | 0.06 | 0.00 | 0.00 |
| 38392 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | -0.01 | 0.00 | 0.00 |

Appendix 2.16 (Continued)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38393 | -0.02 | -0.02 | 0.11 | 0.10 | 0.10 | 0.11 | 0.02 | 0.03 |
| 38399 | -0.01 | -0.01 | 0.09 | 0.11 | 0.06 | 0.06 | 0.01 | 0.02 |
| 38410 | -0.04 | -0.04 | 0.07 | 0.08 | 0.18 | 0.19 | 0.03 | 0.03 |
| 38439 | 0.05 | 0.05 | 0.13 | 0.13 | 0.15 | 0.15 | 0.04 | 0.05 |
| 38441 | 0.01 | 0.01 | 0.10 | 0.11 | 0.18 | 0.18 | 0.03 | 0.03 |
| 38449 | -0.09 | -0.08 | 0.06 | 0.07 | 0.08 | 0.08 | 0.01 | 0.01 |
| 39030 | -0.03 | -0.03 | 0.08 | 0.08 | 0.33 | 0.34 | 0.02 | 0.02 |
| 39092 | -0.06 | -0.06 | 0.02 | 0.03 | 0.05 | 0.06 | 0.01 | 0.01 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

**Appendix 2.17**

Decomposition of TFP growth in Malaysia Manufacturing Industry with Large Size Industry:1975-1999

| Industry (1) | Traditional Primal TFP[a] (2) | Traditional Dual TFP[a] (3) | Adjusted Primal TFP (Hall)[b] (4) | Adjusted Dual TFP(Roeger)[b] (5) | Generalised Primal TFP[c] (6) | Generalised Dual TFP[c] (7) | Adjusted Primal & Dual TFP(Hall & Roger)[b] (8) | Generalised Primal & Dual TFP[c] (9) |
|---|---|---|---|---|---|---|---|---|
| 31129 | -0.04 | -0.04 | 0.03 | 0.04 | 0.03 | 0.04 | 0.01 | 0.02 |
| 31131 | -0.03 | -0.03 | 0.03 | 0.04 | 0.01 | 0.01 | 0.00 | 0.01 |
| 31180 | -0.01 | -0.01 | 0.05 | 0.06 | 0.05 | 0.05 | 0.03 | 0.04 |
| 32111 | 0.04 | 0.04 | 0.03 | 0.03 | 0.08 | 0.08 | 0.01 | 0.02 |
| 32112 | 0.00 | 0.00 | 0.06 | 0.07 | 0.08 | 0.09 | 0.00 | 0.00 |
| 32115 | 0.02 | 0.03 | 0.08 | 0.09 | 0.07 | 0.08 | 0.03 | 0.03 |
| 33112 | 0.00 | 0.00 | 0.06 | 0.06 | 0.07 | 0.07 | 0.00 | 0.00 |
| 34110 | -0.01 | -0.01 | 0.09 | 0.10 | 0.11 | 0.12 | 0.02 | 0.03 |
| 35300 | -0.02 | -0.02 | 0.02 | 0.03 | 0.11 | 0.11 | 0.04 | 0.05 |
| 35593 | 0.03 | 0.03 | 0.03 | 0.04 | 0.09 | 0.09 | 0.00 | 0.00 |
| 35599 | 0.00 | 0.00 | 0.04 | 0.05 | 0.11 | 0.12 | 0.00 | 0.00 |
| 36921 | -0.06 | -0.06 | 0.02 | 0.03 | 0.05 | 0.05 | 0.01 | 0.01 |
| 37101 | -0.02 | -0.01 | 0.08 | 0.09 | 0.13 | 0.14 | 0.02 | 0.02 |
| 37209 | -0.01 | -0.01 | 0.10 | 0.11 | 0.12 | 0.12 | 0.07 | 0.08 |
| 38321 | 0.03 | 0.03 | 0.09 | 0.09 | 0.10 | 0.11 | 0.07 | 0.08 |
| 38391 | -0.01 | -0.01 | 0.04 | 0.05 | 0.05 | 0.06 | 0.01 | 0.02 |
| 38432 | -0.01 | -0.01 | 0.07 | 0.07 | 0.01 | 0.01 | 0.01 | 0.02 |
| 38510 | 0.00 | 0.00 | 0.05 | 0.06 | 0.07 | 0.07 | 0.01 | 0.01 |

Note: [a] Traditional TFP assumes constant returns to scale and perfect competition

[b] Adjusted TFP assumes constant returns to scale and market power

[c] Generalised TFP assumes non constant returns to scale and market power

**Appendix 2.18**

Returns to scale and Mark-ups for Malaysian Manufacturing Industry with Small Size Industry

| Industry (1) | Generalised Primal Markup[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Markup[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup(Hall)[b] (6) | Adjusted Dual Markup (Roeger)[b] (7) | Adjusted Primal & Dual Markup (Roeger)[b] (8) | Generalised Primal & Dual Markup[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| 31121 | 1.08 | 1.19 | 1.18 | 1.18 | 1.08 | 1.72 | 1.04 | 1.09 | 1.22 |
| 31139 | 1.23 | 1.72 | 1.29 | 1.90 | 1.27 | 1.37 | 1.86 | 1.39 | 1.61 |
| 31151 | 1.14 | 0.30 | 1.40 | 0.28 | 1.14 | 1.00 | 1.27 | 1.14 | 0.27 |
| 31153 | 1.18 | 0.93 | 1.34 | 0.46 | 1.11 | 1.67 | 1.87 | 1.21 | 0.36 |
| 31162 | 1.66 | 0.59 | 1.37 | 0.46 | 1.36 | 1.83 | 1.83 | 1.20 | 0.25 |
| 31164 | 1.75 | 0.72 | 1.61 | 0.58 | 1.95 | 1.91 | 1.09 | 1.83 | 0.63 |
| 31169 | 1.19 | 1.42 | 1.71 | 1.02 | 1.99 | 1.70 | 1.81 | 1.17 | 1.31 |
| 31172 | 1.03 | 0.11 | 1.96 | 0.92 | 1.86 | 1.01 | 1.81 | 1.68 | 0.83 |
| 31211 | 1.33 | 0.74 | 1.54 | 0.80 | 1.51 | 1.74 | 1.01 | 1.03 | 0.98 |
| 31212 | 1.42 | 0.56 | 1.31 | 0.21 | 1.87 | 1.95 | 1.89 | 1.91 | 0.91 |
| 31215 | 1.21 | 0.54 | 1.59 | 0.52 | 1.11 | 1.91 | 1.87 | 1.74 | 0.89 |
| 31219 | 1.85 | 1.00 | 1.27 | 1.00 | 1.85 | 1.47 | 1.85 | 1.85 | 1.00 |
| 31220 | 1.66 | 0.97 | 1.45 | 0.41 | 1.69 | 1.84 | 1.89 | 1.88 | 0.99 |
| 32113/4 | 1.71 | 0.71 | 1.32 | 0.62 | 1.13 | 1.15 | 1.02 | 1.21 | 0.33 |
| 32119 | 1.26 | 0.53 | 1.34 | 0.10 | 1.43 | 1.97 | 1.55 | 1.30 | 0.32 |
| 32120 | 1.95 | 1.01 | 1.62 | 0.67 | 1.95 | 1.84 | 1.76 | 1.75 | 0.98 |
| 32330 | 1.98 | 1.11 | 1.81 | 1.06 | 1.87 | 1.89 | 1.89 | 1.91 | 1.04 |
| 32400 | 1.93 | 1.18 | 1.93 | 1.02 | 1.78 | 1.92 | 1.87 | 1.77 | 0.88 |
| 33114/19 | 1.74 | 1.17 | 1.91 | 1.13 | 1.63 | 1.82 | 1.77 | 1.82 | 1.06 |
| 33120 | 1.39 | 0.87 | 1.71 | 0.74 | 1.50 | 1.91 | 1.91 | 1.51 | 0.49 |
| 33200 | 1.86 | 0.94 | 1.48 | 0.11 | 1.05 | 1.06 | 1.60 | 1.56 | 0.02 |
| 35400 | 1.45 | 0.72 | 1.55 | 0.70 | 1.63 | 1.72 | 1.81 | 1.35 | 0.44 |
| 36922 | 1.14 | 1.11 | 1.90 | 1.09 | 1.01 | 1.99 | 1.90 | 1.85 | 1.09 |
| 36992 | 1.07 | 1.19 | 1.78 | 1.15 | 1.87 | 1.05 | 1.88 | 1.66 | 1.16 |
| 36999 | 1.80 | 1.14 | 1.86 | 1.13 | 1.70 | 1.91 | 1.73 | 1.70 | 1.19 |
| 37102 | 1.94 | 1.45 | 1.19 | 1.27 | 1.57 | 1.05 | 1.86 | 1.38 | 1.66 |
| 38111 | 1.80 | 0.89 | 1.57 | 0.68 | 1.79 | 1.77 | 1.76 | 1.67 | 0.72 |
| 38130 | 1.21 | 0.74 | 1.75 | 0.75 | 1.41 | 1.87 | 1.89 | 1.23 | 0.23 |
| 38210/20 | 1.05 | 1.34 | 1.98 | 1.58 | 1.70 | 1.35 | 1.85 | 1.00 | 1.17 |
| 38230 | 1.51 | 0.68 | 1.63 | 0.82 | 1.85 | 1.76 | 1.75 | 1.37 | 0.50 |
| 38240 | 1.72 | 1.13 | 1.89 | 1.15 | 1.61 | 1.02 | 1.00 | 1.86 | 1.25 |

Appendix 2.18 (Continued)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38299 | 1.13 | 0.64 | 1.51 | 0.71 | 1.30 | 1.60 | 1.71 | 1.29 | 0.37 |
| 38431 | 1.82 | 1.40 | 1.27 | 1.35 | 1.85 | 1.95 | 1.93 | 1.22 | 1.29 |
| 39091 | 1.28 | 0.46 | 1.73 | 0.70 | 1.75 | 1.94 | 1.05 | 1.75 | 0.66 |
| 39099 | 1.88 | 0.97 | 1.81 | 0.16 | 1.91 | 1.90 | 1.92 | 1.86 | 0.90 |

Note: [a] Generalised Markup and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Markup and Returns to Scale assume existing market power and constant returns to scale

**Appendix 2.19**

Returns to scale and markups for Malaysian Manufacturing Industry with Medium Size Industry

| Industry (1) | Generalised Primal Mark-up[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Mark-up[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup(Hall)[b] (6) | Adjusted Dual Markup (Roeger)[b] (7) | Adjusted Primal & Dual Markup(Roeger)[b] (8) | Generalised Primal & Dual Mark-up[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| 31110 | 1.15 | 0.42 | 1.36 | 0.44 | 1.19 | 1.53 | 1.44 | 1.18 | 0.25 |
| 31140 | 1.98 | 0.94 | 1.82 | 0.99 | 1.02 | 1.87 | 1.96 | 1.90 | 0.92 |
| 31152 | 1.32 | 0.60 | 1.58 | 0.61 | 1.71 | 1.86 | 1.03 | 1.88 | 0.83 |
| 31159 | 1.43 | 0.64 | 1.47 | 0.63 | 1.77 | 1.86 | 1.76 | 1.47 | 0.62 |
| 31163 | 1.08 | 0.29 | 1.29 | 0.17 | 1.95 | 1.35 | 1.93 | 1.57 | 0.64 |
| 31171 | 1.49 | 0.76 | 1.64 | 0.61 | 1.78 | 1.89 | 1.87 | 1.64 | 0.71 |
| 31190 | 1.28 | 0.69 | 1.75 | 0.90 | 1.53 | 1.83 | 1.75 | 1.52 | 0.73 |
| 3131030/40 | 1.19 | 1.24 | 1.55 | 1.56 | 1.08 | 1.02 | 1.05 | 1.52 | 1.52 |
| 31400 | 1.06 | 0.35 | 1.32 | 0.92 | 1.19 | 1.35 | 1.31 | 1.31 | 0.98 |
| 32130 | 1.82 | 0.96 | 1.70 | 0.87 | 1.86 | 1.77 | 1.93 | 1.90 | 0.95 |
| 32150 | 1.77 | 0.66 | 1.96 | 0.69 | 1.21 | 1.35 | 1.12 | 1.75 | 0.69 |
| 32201 | 1.69 | 1.03 | 1.94 | 1.11 | 1.66 | 1.87 | 1.87 | 1.97 | 1.17 |
| 32310 | 1.22 | 0.37 | 1.25 | 0.29 | 1.36 | 1.95 | 1.54 | 1.11 | 0.22 |
| 33111 | 1.87 | 1.08 | 1.92 | 1.02 | 1.15 | 1.90 | 1.04 | 1.91 | 1.08 |
| 33113 | 1.18 | 0.66 | 1.68 | 0.95 | 1.52 | 1.72 | 1.79 | 1.52 | 0.66 |
| 34120 | 1.54 | 0.54 | 1.40 | 0.36 | 1.95 | 1.76 | 1.87 | 1.43 | 0.30 |
| 34190 | 1.58 | 1.06 | 1.42 | 1.03 | 1.53 | 1.96 | 1.82 | 1.36 | 1.06 |
| 34200 | 1.48 | 0.92 | 1.61 | 0.85 | 1.55 | 1.70 | 1.64 | 1.34 | 0.55 |
| 35120 | 1.03 | 0.09 | 1.36 | 0.35 | 1.92 | 1.94 | 1.93 | 1.22 | 0.25 |
| 35130 | 1.42 | 0.60 | 1.02 | 0.82 | 1.84 | 1.18 | 1.87 | 1.81 | 0.93 |
| 35210 | 1.03 | 1.19 | 1.55 | 1.15 | 1.87 | 1.62 | 1.79 | 1.54 | 1.25 |
| 35220 | 1.36 | 0.71 | 1.03 | 0.02 | 1.52 | 1.55 | 1.55 | 1.42 | 0.72 |
| 35231 | 1.16 | 0.07 | 1.46 | 0.64 | 1.65 | 1.79 | 1.87 | 1.35 | 0.36 |
| 35239 | 1.37 | 0.74 | 1.48 | 0.60 | 1.61 | 1.77 | 1.82 | 1.40 | 0.46 |
| 35290 | 1.20 | 0.65 | 1.52 | 0.85 | 1.59 | 1.61 | 1.63 | 1.57 | 0.92 |
| 35510 | 1.37 | 0.73 | 1.71 | 0.37 | 1.47 | 1.01 | 1.30 | 1.19 | 0.62 |
| 35591 | 1.46 | 0.51 | 1.68 | 0.73 | 1.90 | 1.90 | 1.98 | 1.47 | 0.28 |
| 35592 | 1.17 | 0.35 | 1.72 | 0.84 | 1.63 | 1.80 | 1.78 | 1.67 | 0.82 |
| 35600 | 1.66 | 0.94 | 1.69 | 0.99 | 1.70 | 1.69 | 1.75 | 1.74 | 0.98 |
| 36100 | 1.33 | 0.72 | 1.59 | 0.67 | 1.43 | 1.79 | 1.57 | 1.33 | 0.41 |
| 36200 | 1.59 | 1.18 | 1.84 | 1.06 | 1.47 | 1.79 | 1.53 | 1.85 | 1.54 |
| 36910 | 1.64 | 1.07 | 1.91 | 1.22 | 1.59 | 1.77 | 1.68 | 1.94 | 1.47 |
| 36991 | 1.95 | 1.35 | 1.67 | 1.26 | 1.72 | 1.69 | 1.75 | 1.57 | 1.27 |
| 37109 | 1.12 | 0.37 | 1.16 | 0.18 | 1.82 | 1.91 | 1.10 | 1.15 | 0.19 |
| 38120 | 1.76 | 0.92 | 1.55 | 0.55 | 1.82 | 1.81 | 1.91 | 1.78 | 0.81 |
| 38191 | 1.86 | 1.18 | 1.77 | 1.02 | 1.65 | 1.80 | 1.76 | 1.76 | 1.01 |
| 38192 | 1.82 | 1.41 | 1.84 | 1.06 | 1.53 | 1.81 | 1.67 | 1.78 | 1.18 |
| 38193 | 1.25 | 0.51 | 1.37 | 0.66 | 1.77 | 1.60 | 1.80 | 1.18 | 0.33 |
| 38199 | 1.55 | 1.23 | 1.03 | 1.28 | 1.63 | 1.04 | 1.50 | 1.68 | 1.23 |
| 38291 | 1.10 | 0.41 | 1.81 | 0.92 | 1.12 | 1.85 | 1.77 | 1.67 | 0.85 |
| 38310 | 1.26 | 1.10 | 1.70 | 1.69 | 1.29 | 1.93 | 1.86 | 1.86 | 1.03 |
| 38330 | 1.77 | 1.22 | 1.27 | 1.38 | 1.54 | 1.06 | 1.77 | 1.90 | 1.18 |
| 38392 | 1.34 | 0.92 | 1.77 | 0.94 | 1.44 | 1.80 | 1.80 | 1.69 | 0.84 |
| 38393 | 1.62 | 1.57 | 1.96 | 1.18 | 1.78 | 1.82 | 1.86 | 1.44 | 1.91 |

Appendix 2.19 (Continued)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 38399 | 1.38 | 1.54 | 1.13 | 1.50 | 1.42 | 1.07 | 1.86 | 1.84 | 1.23 |
| 38410 | 1.22 | 0.43 | 1.22 | 0.11 | 1.64 | 1.20 | 1.95 | 1.22 | 0.62 |
| 38439 | 1.83 | 0.89 | 1.74 | 0.14 | 1.94 | 1.84 | 1.98 | 1.51 | 0.46 |
| 38441 | 1.34 | 1.72 | 1.67 | 1.46 | 1.12 | 1.90 | 1.98 | 1.90 | 1.82 |
| 38449 | 1.20 | 0.52 | 1.60 | 0.70 | 1.04 | 1.73 | 1.90 | 1.60 | 0.67 |
| 39030 | 1.63 | 1.81 | 1.02 | 1.16 | 1.32 | 1.93 | 1.00 | 1.27 | 1.39 |
| 39092 | 1.26 | 0.50 | 1.36 | 0.37 | 1.80 | 1.88 | 1.11 | 1.58 | 0.54 |

Note: [a] Generalised Markup and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Markup and Returns to Scale assume existing market power and constant returns to scale

**Appendix 2.20**

Returns to scale and markups for Malaysian Manufacturing Industry with Large Size Industry

| Industry (1) | Generalised Primal Markup[a] (2) | Generalised Primal Returns to Scale[a] (3) | Generalised Dual Markup[a] (4) | Generalised Dual Returns to Scale[a] (5) | Adjusted Primal Markup(Hall)[b] (6) | Adjusted Dual Markup (Roeger)[b] (7) | Adjusted Primal & Dual Markup (Roeger)[b] (8) | Generalised Primal & Dual Markup[a] (9) | Generalised Primal & Dual Returns to Scale[a] (10) |
|---|---|---|---|---|---|---|---|---|---|
| 31129 | 1.08 | 1.48 | 1.55 | 1.69 | 1.76 | 1.85 | 1.91 | 1.93 | 1.01 |
| 31131 | 1.36 | 0.49 | 1.26 | 0.28 | 1.77 | 1.94 | 1.94 | 1.18 | 0.25 |
| 31180 | 1.28 | 0.33 | 1.63 | 0.49 | 1.33 | 1.02 | 1.15 | 1.50 | 0.44 |
| 32111 | 1.76 | 1.03 | 1.29 | 1.01 | 1.80 | 1.28 | 1.13 | 1.13 | 1.01 |
| 32112 | 1.51 | 0.74 | 1.66 | 0.39 | 1.79 | 1.40 | 1.36 | 1.37 | 0.99 |
| 32115 | 1.71 | 1.18 | 1.46 | 1.17 | 1.64 | 1.99 | 1.13 | 1.74 | 1.14 |
| 33112 | 1.85 | 0.94 | 1.79 | 0.85 | 1.91 | 1.88 | 1.69 | 1.69 | 0.99 |
| 34110 | 1.31 | 0.82 | 1.22 | 0.46 | 1.37 | 1.45 | 1.40 | 1.19 | 0.47 |
| 35300 | 1.19 | 0.38 | 1.06 | 0.23 | 1.69 | 1.59 | 1.62 | 1.14 | 0.22 |
| 35593 | 1.89 | 1.66 | 1.95 | 1.24 | 1.27 | 1.83 | 1.97 | 1.18 | 1.18 |
| 35599 | 1.44 | 0.60 | 1.56 | 0.71 | 1.71 | 1.73 | 1.80 | 1.46 | 0.33 |
| 36921 | 1.68 | 1.05 | 1.84 | 1.03 | 1.63 | 1.85 | 1.69 | 1.25 | 1.02 |
| 37101 | 1.17 | 0.23 | 1.41 | 0.22 | 1.02 | 1.67 | 1.00 | 1.07 | 0.14 |
| 37209 | 1.93 | 1.88 | 1.43 | 1.63 | 1.17 | 1.43 | 1.84 | 1.27 | 1.17 |
| 38321 | 1.59 | 0.99 | 1.30 | 0.31 | 1.53 | 1.53 | 1.47 | 1.76 | 0.38 |
| 38391 | 1.38 | 0.82 | 1.55 | 0.55 | 1.52 | 1.79 | 1.68 | 1.35 | 0.47 |
| 38432 | 1.28 | 0.85 | 1.10 | 0.64 | 1.37 | 1.36 | 1.64 | 1.18 | 0.52 |
| 38510 | 1.67 | 1.80 | 1.60 | 1.66 | 1.90 | 1.80 | 1.86 | 1.88 | 1.03 |

Note: [a] Generalised Markup and Returns to Scale assume existing of market power and non constant returns to scale

[b] Adjusted Markup and Returns to Scale assume existing market power and constant returns to scale

## Appendix 2.21

### Industry Descriptions

| *Industry description* | *Industry code* |
|---|---|
| *Slaughtering, preparing and preserving meat* | *31110* |
| *Ice cream* | *31121* |
| *Other dairy products* | *31129* |
| *Pineapple canning* | *31131* |
| *Other canning and preserving of fruits and vegetables* | *31139* |
| *Canning, preserving and processing of fish, crustacea and similar food* | *31140* |
| *Manufacture of coconut oil* | *31151* |
| *Manufacture of palm oil* | *31152* |
| *Manufacture of palm kernel oil* | *31153* |
| *Other vegetable and animal oils and fats* | *31159* |
| *Large rice mills* | *31162* |
| *Flour mills* | *31163* |
| *Sago and tapioca factories* | *31164* |
| *Other grain milling* | *31169* |
| *Biscuit factories* | *31171* |
| *Bakeries* | *31172* |
| *Sugar factories and refineries* | *31180* |
| *Manufacture of cocoa, chocolate and sugar confectionery* | *31190* |
| *Ice factories* | *31211* |
| *Coffee factories* | *31212* |
| *Spices and curry powder* | *31215* |
| *Other food products, n.e.c.* | *31219* |
| *Manufacture of prepared animal feeds* | *31220* |
| *Distilling, rectifying, blending spirits/Malt liquors and malt/Soft drinks and carbonated water industries* | *31310/30/40* |
| *Tobacco manufactures* | *31400* |
| *Natural fibre spinning and weaving mills* | *32111* |
| *Dyeing, bleaching, printing and finishing of yarns and fabric (other than batik)* | *32112* |
| *Handicraft spinning and weaving/Batik making* | *32113-14* |
| *Synthetic textile mills* | *32115* |
| *Manufacture of miscellaneous primary textiles* | *32119* |
| *Manufacture of made-up textile goods except wearing apparel* | *32120* |
| *Knitting mills* | *32130* |

Appendix 2.21 (Continued)

| | |
|---|---|
| *Cordage, rope and twine industries* | *32150* |
| *Clothing factories* | *32201* |
| *Tanneries and leather finishing* | *32310* |
| *Manufacture of products of leather and leather substitutes, except footwear and wearing apparel* | *32330* |
| *Manufacture of footwear except vulcanised or moulded rubber or plastic footwear* | *32400* |
| *Sawmills* | *33111* |
| *Plywood, hardboard and particle board mills* | *33112* |
| *Planing mills, window and door mills and joinery works* | *33113* |
| *Manufacturing of prefabricated wooden houses/Manufacture of other wood products* | *33114-19* |
| *Manufacture of wooden and cane containers and small cane ware* | *33120* |
| *Manufacture of furniture and fixtures* | *33200* |
| *Manufacture of pulp, paper and paperboard* | *34110* |
| *Manufacture of containers and boxes of paper and paperboard* | *34120* |
| *Manufacture or pulp, paper and paperboard articles, n.e.c.* | *34190* |
| *Printing, publishing and allied industri* | *34200* |
| *Manufacture of fertilizers and pesticides* | *35120* |
| *Manufacture of synthetic resins, plastic and materials and man-made fibres except glass* | *35130* |
| *Manufacture of paints, varnishes and lacquers* | *35210* |
| *Manufacture of drugs and medicines* | *35220* |
| *Manufacture of soap and cleaning preparations* | *35231* |
| *Manufacture of perfumes, cosmetics and other toilet preparations* | *35239* |
| *Manufacture of chemical products, n.e.c.* | *35290* |
| *Crude oil refineries* | *35300* |
| *Manufacture of miscellaneous products of petroleum and coal* | *35400* |
| *Tyre and tube industries* | *35510* |
| *Rubber remilling and rubber latex processing* | *35591* |
| *Rubber smokehouses* | *35592* |
| *Manufacture of rubber footwear* | *35593* |
| *Manufacture of rubber products, n.e.c.* | *35599* |
| *Manufacture of plastic products, n.e.c.* | *35600* |
| *Manufacture of pottery, china and earthenware* | *36100* |
| *Manufacture of glass and glass products* | *36200* |
| *Manufacture of structural clay products* | *36910* |
| *Manufacture of hydraulic cement* | *36921* |
| *Manufacture of lime and plaster* | *36922* |

Appendix 2.21 (Continued)

| | |
|---|---|
| *Cement and concrete products* | *36991* |
| *Cut-stone and stone products* | *36992* |
| *Other non-metallic mineral products n.e.c.* | *36999* |
| *Primary iron and steel industries* | *37101* |
| *Foundries* | *37102* |
| *Other iron and steel basic industries* | *37109* |
| *Other non-ferrous metal basic industries* | *37209* |
| *Manufacture of cutlery, handtools and general hardware except tinsmithing and blacksmithing* | *38111* |
| *Manufacture of furniture and fixtures primarily of metal* | *38120* |
| *Manufacture of structural metal products* | *38130* |
| *Manufacture of tin cans and metal boxes* | *38191* |
| *Manufacture of wire and wire products* | *38192* |
| *Manufacture of brass, copper, pewter and aluminium products* | *38193* |
| *Manufacture of other fabricated metal products, n.e.c.* | *38199* |
| *Manufacture of engines and turbines/Manufacture of agricultural machinery and equipment* | *38210-20* |
| *Manufacture of metal and wood working machinery* | *38230* |
| *Manufacture of special industrial machinery and equipment except metal and wood working machinery* | *38240* |
| *Manufacture of refrigerating, exhaust, ventilating and air-conditioning machinery* | *38291* |
| *Machinery and equipment, n.e.c.* | *38299* |
| *Manufacture of electrical industrial machinery and apparatus* | *38310* |
| *Radio and television sets, sound reproducing and recording equipment* | *38321* |
| *Manufacture of electrical appliances and housewares* | *38330* |
| *Cables and wires* | *38391* |
| *Manufature of dry cells and storage batteries* | *38392* |
| *Manufacture of electric lamps and tubes* | *38393* |
| *Manufacture of miscellaneous electrical apparatus and supplies, n.e.c.* | *38399* |
| *Shipbuilding and boat-building and repairing* | *38410* |
| *Manufacture of motor vehicle bodies* | *38431* |
| *Manufacture and assembly of motor vehicles* | *38432* |
| *Manufacture of motor vehicle parts and accessories* | *38439* |
| *Manufacture and assembly of motor cycles and scooters* | *38441* |
| *Manufacture and assembly of bicycles, tricycles, trishaws and their parts and accessories* | *38449* |
| *Manufacture of professional and scientific and measuring and controlling equipment, n.e.c.* | *38510* |

Appendix 2.21 (Continued)

| | |
|---|---|
| *Manufacture of spring and athletic goods* | *39030* |
| *Manufacture of brooms, brushed and mops* | *39091* |
| *Manufacture of pens, pencils, office and artists' supplies* | *39092* |
| *Other manufacturing industries, n.e.c.* | *39099* |

**Appendix 3.1**

## DERIVATION OF EQUATION (3.2)

In a famous paper, Solow (1957) derived relationship involving output growth, product price, capital and labour input, and the wage rate, under the assumptions of perfect competition and constant returns to scale. The relationship is,

$$\Theta_{it} = \Delta q_{it} - \alpha_{it}\Delta n_{it} \qquad (1)$$

The first term on the right hand side of equation (1) $\Delta q_{it}$ is the growth rate of output per capital $\left(\Delta \log\left(\frac{Q}{K}\right)\right)$ and in the second term, $\alpha_{it}$ is the share of labour in total revenue (ratio of compensation *wN* to total revenue *PQ*), and $\Delta n_{it}$ is the rate of growth of the labour per capital ratio $\left(\Delta \log\left(\frac{N}{K}\right)\right)$, $\Theta_{it}$ is the rate of Hicks-neutral technical progress $(\Delta \log \Theta_{it})$.

Solow had in mind the calculation of the rate of growth of productivity, $\Theta_{it}$, separately for each year. Because productivity growth seems to have a substantial random effect, it is natural to view $\Theta_{it}$ as the sum of constant underlying growth rate, $\Theta$, and a random term, $\varepsilon_{it}$. Then equation (1) becomes

$$\Theta_{it} + \varepsilon_{it} = \Delta q_{it} - \alpha_{it}\Delta n_{it} \qquad (2)$$

Let consider the idea of measuring marginal cost and comparing it with price in order to measure market power. The mark-up ratio (price over marginal cost) is a good measure of market power. Consider the problem of measuring marginal cost for a firm with a fixed capital stock and an unchanging technology over time. From one period to the next the change in its labour input is $\Delta N$. A reasonable approximation to its change in labour cost, abstracting from changes in wages, is

$w\Delta N$, where $w$ is the current wage. The corresponding change in output is $\Delta Q$. Let $x$ be marginal cost. Then a good measure of marginal cost is

$$x = \frac{w\Delta N}{\Delta Q} \tag{3}$$

The only element of approximation here arises from the use of finite differences; the corresponding expression in derivatives is exact. It is convenient to rewrite the expression for marginal cost as a relation between the rate of growth of output and the rate of growth of labour input:

$$\frac{\Delta Q}{Q} = \frac{wN}{xQ} \bullet \frac{\Delta N}{N} \tag{4}$$

This is, the rate of growth of output is the factor share, $wN/xQ$, times the rate of growth of labour input. Recall that in the competitive case considered by Solow, the denominator was revenue. Here it is output valued at marginal cost, $xQ$. Again, the factor share measures the elasticity of output with respect to input, independent of the form of the technology.

Now let $\mu$ be the mark-up ratio, $\mu = P/x$, and as before, let $\alpha$ be labour's observed share in revenue. The relation between these variables can be written in the earlier notation as

$$\Delta q_{it} = \mu_{it}\alpha_{it}\Delta n_{it} \tag{5}$$

No assumption of constancy of either $\mu$ or $\alpha$ is made. In what follows, $\alpha_{it}$ will always be considered time-series data. Under the null hypothesis of competition, $\mu$ has the constant value of one, but there is no assumption of constancy under the alternative hypothesis. Equation (5) holds for any demand function and any technology when the capital stock is constant.

Equation (5) also holds with a slight modification and reinterpretation for a firm whose capital stock varies over time and that enjoys technical progress. The measure of marginal cost that is analogous to equation (3) is

$$MC = \frac{w\Delta N + r\Delta K}{\Delta Q - \Theta Q} \tag{6}$$

The change in cost in the numerator now includes a term $r\Delta K$, which is the cost of the change in the capital stock, $\Delta K$, evaluated at the actual service cost of the new capital, $r$. The denominator in the calculation of marginal cost has an additional term, $-\Theta Q$, representing an adjustment for the amount by which output would have risen in the absence of additional capital or labour, assuming that Hicks-neutral technical progress is occurring at rate $\Theta$.

Again, it is convenient to rewrite the equation for marginal cost as a relation between the rate of growth of output and the rate of growth of inputs:

$$\frac{\Delta Q}{Q} = \frac{wN}{xQ} \bullet \frac{\Delta N}{N} + \frac{rK}{xQ} \bullet \frac{\Delta K}{K} + \Theta \tag{7}$$

Unlike its counterpart, equation (4), this relation is not directly usable because the shadow value of capital, $r$, is not generally observed. Under constant returns to scale, however, it is possible to eliminate $r$ from equation (7). With constant returns, the two shares $wN/xQ$ and $rK/xQ$ are competitive factor shares; that is, they sum to one. Inserting this constraint into equation (7) and rearranging gives

$$\frac{\Delta Q}{Q} - \frac{\Delta K}{K} = \frac{wN}{xQ}\left(\frac{\Delta N}{N} - \frac{\Delta K}{K}\right) + \Theta \tag{8}$$

In the notation used earlier, this is

$$\Delta q_{it} = \mu_{it}\alpha_{it}\Delta n_{it} + \Theta_{it} \tag{9}$$

Equation (9) is the relation between price and marginal cost can be found by comparing the actual growth in the output/capital ratio with the growth that would be expected given the rate of technical progress and the growth in the labour/capital ratio.

Equation (9) could be used in two ways. First, if the data contain no errors and the rate of technical progress is known, then it can be solved for $\mu$ in each year:

$$\mu = \frac{\Delta q_{it} - \Theta_{it}}{\alpha_{it}\Delta n_{it}} \tag{10}$$

Second, in practice the rate of productivity growth will not be known. The statistical model of productivity growth introduced earlier considers it a constant, $\Theta$, plus a random disturbance, $u_{it}$. Then Solow residual under market power is

$$\Delta q_{it} - \alpha_{it}\Delta n_{it} = (\mu - 1)\alpha_{it}\Delta n_{it} + \Theta_{it} + u_{it} \tag{11}$$

By subtracting $\alpha_{it}(\Delta n_{it} - \Delta k_{it})$ from both sides of the equation, the so-called Solow Residual (SR) can be obtained.

$$SR = \Delta q_{it} - \alpha_{it}\Delta n_{it} - (1-\alpha_{it})\Delta k_{it} = (\mu - 1)\alpha_{it}(\Delta n_{it} - \Delta k_{it}) + \Theta_{it} + u_{it} \tag{12}$$

## Appendix 4.1

### Business Cycles in Malaysia: 1981-2002

The reference series for the Malaysian business cycles is the monthly index of the Malaysian industrial production, covering the period from January 1981 to March 2002. Turning points of business cycles in Malaysian economy is reported in Table 1 and plotted in Figure 3 where shaded areas correspond to downturns and unshaded areas upturns in the reference series; a cyclical peak is indicated by the left-hand edge of any particular shaded block, whilst a subsequent trough is represented by the right-hand edge of the block.

Table 1

Business Cycles in Malaysia: 1981-2002

| Trough | Date | Duration of Upturn (Months) | Peak | Date | Duration of Downturn (Months) |
|---|---|---|---|---|---|
| T1 | April 83 | 16 | P1 | August 84 | 33 |
| T2 | May 87 | 43 | P2 | Dec 90 | 34 |
| T3 | Oct 93 | 46 | P3 | Aug 97 | 15 |
| T4 | Nov 98 | 22 | P4 | Sept 00 | 15 |
| T5 | Dec 01 | - | | | |
| Average | | 31.8 | | | 24.3 |

Note: T denotes trough and P denotes peak

There were five troughs and four peaks in the Malaysia economy during 1981-2002. The average duration of downturn is about 24 months and of upturn is 32 months. During the period, there were four complete upturn: T1-P1 (April 1983 – August (1984), T2-P2 (May 1987- Dec 1990), T3-P3 (Oct. 1993-August 1997), and T4-P4 (Nov 1998-Sept 2000); four complete downturn: P1-T2 (Aug 1984-

May 1987), P2-T3 (Dec 1990-Oct 1993), P3-T4 (Aug 1997-Nov 1998), and P4-T5 (Sept 2000-Dec 2001).

According to Pillay (2000), during the period of 1984-1987 (P1-T2) downturns in Malaysian economy was quite severe. "Exporting earnings suffered a massive contraction, with commodity price plunging to unprecedented lows due to lower demand in the developed countries. The government was unable to engage in countercyclical spending due to its earlier investment in heavy industry. This investment had been financed by external borrowings. In the early 1980s, given its petroleum resources, banks had lined up to lend to Malaysia. Therefore, when the recession hit, Malaysia had exhausted its borrowings capacity."

The downturn of P3-T4 was associated with the 1997 Asian financial crisis that was triggered initially by the speculative attack on the Thai currency (Baht). This led to deterioration in market sentiments and erosion in investor confidence, which in turn resulted in the massive outflow of short-term capital, the drastic decline in the value of the Malaysian Ringgit and the fall in the stock market. Despite the adverse effects on sections of society, Malaysia successfully avoided the extreme effects experienced by some regional economies, such as high unemployment, mass poverty, massive bankruptcies and civil unrest. This was made possible by strong initial condition, both in terms of the real economy and the financial sector, as well as the swift, pragmatic and innovative measures introduced by the Government (Economic Report 2002/2003).

The last upturn in Malaysian Economy started in December 2001.

Table 2

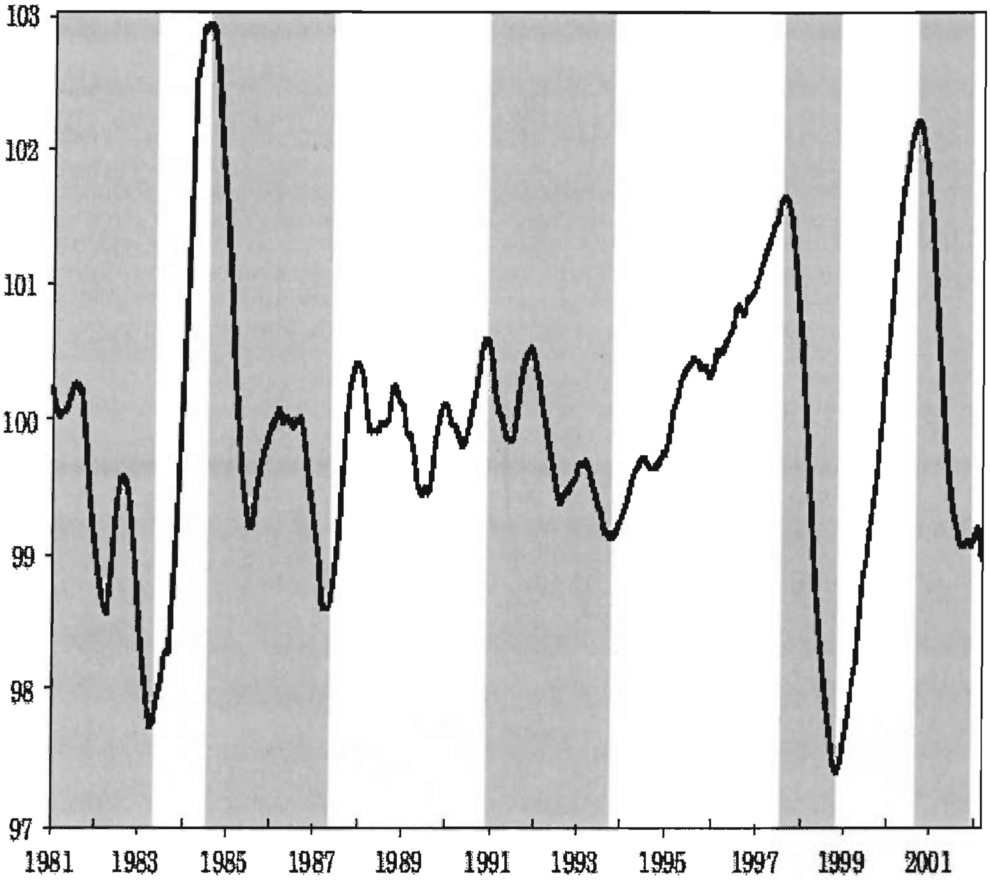
Duration of Upturns and Downturns (months)

| Country | Average Duration of Upturn (Months) | Average Duration of Downturn (Months) |
|---|---|---|
| Malaysia | 31.8 | 24.3 |
| Philippines | 33.3 | 28.0 |
| US | 24.4 | 17.3 |
| UK | 33.3 | 25.3 |
| Japan | 24.5 | 18.6 |
| France | 26.9 | 24.5 |

Note: Turning point dates and length of duration were obtained from Artis *et al.* (1995a).

Many studies such as Artis et al. (1995a) found an asymmetry in duration between upturns and downturns of business cycles, with the duration of upturns in general longer than that of downturns. In Table 2, comparisons durations of upturns and downturns in Malaysia with those of Philippines, US, UK, Japan and France are presented. The table 2 shows that there is such an asymmetry in Malaysia and Philippines. In the US, UK, Japan and France for example, on average, the upturn duration are about 25 months, 33 months, 25 months and 27 months and downturn duration about 17 months, 25 months, 19 months and 25 months. The average upturn duration was about 32 months for the two Asian economies, and downturn duration is about 24 months for Malaysia and 28 months for the Philippines.

Figure 3: Business Cycle in Malaysia 1981-2001



## Appendix 4.2

## MATHEMATICAL DERIVATIONS

**First Order approximation for the variable mark-up (Oliveira-Martins *et al.*, 1999)**

A variable mark-up does not affect the expression for the primal Solow residual (Equation 4.1 in Chapter 4), but it does affect the dual Solow residual (Equation 4.2 in Chapter 4). In order to show this point; let recall the basic relationship between prices and marginal cost:

$$P = \mu \bullet MC \text{ or } P = \frac{1}{1-B} \bullet MC \qquad (1)$$

where $\mu$ is the mark-up ratio and $B$ is the *Lerner Index* $\left( B = \frac{1}{1-\mu} \right)$. By assuming the variable mark-up as:

$$\mu = \bar{\mu} + \lambda_1 Cycl \qquad (2)$$

where $Cycl$ is the cyclical variable. By taking the total differential of Equation (2), putting it into a growth rate form and replacing $\mu$ by expression Equation (2) one gets:

$$\Delta mc = \Delta p - \lambda_1 \bullet \frac{\Delta Cycl}{\mu} \qquad (3)$$

where lower case variables are natural logarithms. Under a fixed mark-up the second RHS term would be zero. Under constant returns to scale, the rate of growth of marginal cost can also be defined as (see Roeger, 1995):

$$\Delta mc = \frac{WN}{C(\bullet)} \bullet \Delta w + \left[1 - \frac{WN}{C(\bullet)}\right] \bullet \Delta r - \Theta \quad (4)$$

By merging Equation (3) and (4) one gets a new expression for the dual Solow residual:

$$DSR = \alpha \Delta w + (1-\alpha)\Delta r - \Delta p = -(\mu - 1)\alpha(\Delta w - \Delta r) - \lambda_1 \frac{\Delta Cycl}{\mu} + \Theta \quad (5)$$

The nominal Solow residual (Equation 4.3 in Chapter 4) is then defined as:

$$DSR = \overline{\mu}\alpha\left[\Delta(n+w) - \Delta(k+r)\right] - \lambda_1 \left\{ \alpha Cycl\left[\Delta(n+w) - \Delta(k+r)\right] + \frac{\Delta Cycl}{\mu} \right\}$$
(6)

Equation (5) is not linear in the parameters. In the context of a variable mark-up, an alternative and more tractable approach can be followed. Let define a different functional form for the relationship between price margin and the cycle based on the *Lerner Index*, as follows:

$$B = \overline{B} + \lambda_2 Cycl \quad (7)$$

in this context Equation (3) becomes:

$$\Delta mc = \Delta p - \lambda_2 \frac{\Delta Cycl}{(1-B)} \quad (8)$$

and Equation (5) can be re-written as:

$$DSR = \alpha \Delta w + (1-\alpha)\Delta r - \Delta p = -B(\Delta p - \Delta r) - \lambda_2 \Delta Cycl + (1-B)\Theta \quad (9)$$

and finally the nominal Solow residual can be expressed as:

$$NSR = \overline{B}\left[\Delta(p+q) - \Delta(k+r)\right] - \lambda_2\left\{Cycl\left[\Delta(p+q) - \Delta(k+r)\right] + \Delta Cycl\right\}$$

(10)

This equation is linear in both $\overline{B}$ and $\lambda_2$ parameters and can be easily estimated.

**Appendix 4.3**

MG+ estimator results for an individual $i$'th manufacturing industry mark-up

| Industry | $\gamma_1 = \mu - 1$ | $\phi(ECM)$ | h-test |
|---|---|---|---|
| Food, Beverages and Tobacco | 0.42* (0.09) | -1.21* (0.07) | 0.04 (0.92) |
| Textiles, Apparel and Leather | 0.43* (0.07) | -1.17* (0.06) | 1.14 (0.84) |
| Wood Products | 0.49* (0.08) | -1.23* (0.07) | 0.12 (0.73) |
| Paper Product, Printing and Publishing | 0.46* (0.07) | -1.19** (0.04) | 0.07 (0.79) |
| Chemical, and Petroleum, Coal, Rubber and Plastics Products | 0.48* (0.08) | -1.21* (0.07) | 0.05 (0.95) |
| Non-Metallic Mineral Products | 0.53* (0.09) | -1.19** (0.05) | 0.08 (0.78) |
| Metallic Mineral Product | 0.49* (0.08) | -1.18** (0.04) | 0.48 (0.49) |
| Metal Product, Machinery and Equipment | 0.48* (0.09) | -1.16* (0.06) | 0.02 (0.89) |
| Other Manufacturing | 0.52* (0.07) | -1.20** (0.05) | 0.30 (0.58) |

(*** denotes Significance at 1% level, ** denotes Significance at 5% level, * denotes Significance at 10% level, ECM= Error Correction Measurement, p-values in parentheses)

+Mean Group (MG) estimator allows for heterogeneity of all parameters

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