

Total Factor Productivity (TFP)- What is it?

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Overview

According to growth accounting methods, the three elements that contribute to the production of goods and services are labour, capital and technological progress (also known as total factor productivity [TFP])¹. Factors of production refer to capital goods (buildings, machinery etc.) and labour that are used in the production of products and provision of services.

TFP reflects the efficiency and effectiveness with which the factors of production are jointly used for the output of goods and services. It includes all of the qualitative factors that enable existing resources to be used optimally to produce more output per unit of input². TFP captures the effects of qualitative improvements that allow output to increase without any use of additional inputs. This means making smarter and better use of resources that are available, such as the introduction or upgrading of technology, innovation, better management techniques, gains from specialization, improvements in efficiency and workers' education as well as skills & experience. It cannot be denied that all of the three factors (labour, capital and TFP) are required to a certain extent for an economy to maintain sustained growth.

There are two ways in which a country's economy can grow. It can increase its output if the quantity of resources at its disposal (i.e. more workers or machines) is increased. This input-driven method, i.e. by adding more and more resources into the same production function is hard work for high growth maintenance because of the law of diminishing marginal returns. In economic jargon, the law of diminishing returns states that after reaching a certain level of employment and holding other inputs constant, a firm will find that each value-added worker increases output less than proportionately, i.e. output increases, but at a decreasing rate. Based on this theory, growth cannot be sustained indefinitely with increasing inputs. Alternatively, growth can occur if existing resources are used more efficiently. This form of growth is technology-driven, which brings into play increasing and sustainable returns, but is difficult to measure directly. However, what is not input-driven is by default technology-driven and has come to be called TFP growth. TFP growth measures the improvement in the qualitative aspect of labour and capital inputs, and the efficiency with which these inputs work together.

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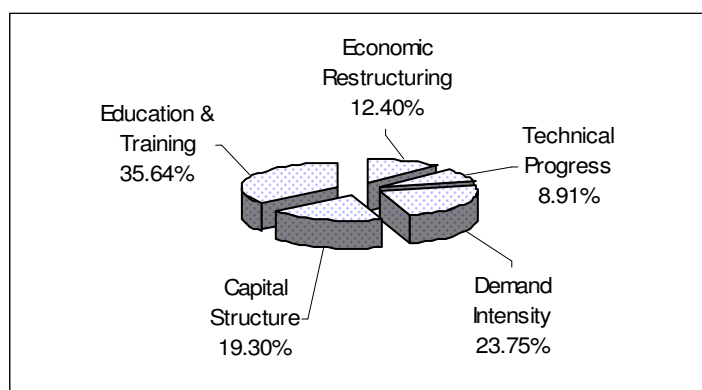
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¹Jajri, I., (2007), "Determinants of Total Factor Productivity Growth in Malaysia", *Journal of Economic Cooperation*, Vol. 28 (3), pp.41-58.

²www.npc.org.my.

TFP in Malaysia

Figure 1: Components of TFP Growth



Source: National Productivity Corporation (NPC)

Figure 1 shows the components of TFP growth in Malaysia. During the period 1997-2006, the main contributors of TFP growth can be decomposed into capital structure, education and training, demand intensity, economic restructuring and technical progress.

From Figure 1, it can be seen that demand intensity contributed to the TFP growth by 23.75%. It reflects the extent of utilization of the economy's productive capacity. An increase in demand will lead to an increase in the production and full utilization of existing machinery and equipment, which will subsequently expand the economy of scale (EOS), thus resulting in an increase in TFP growth. An early emphasis on the development of Malaysia as an industrialized nation focusing on the manufacturing sector as the main engine of growth was made with the implementation of the first Industrial Master Plan (IMP1) in 1986³. The result of this was the expansion of the manufacturing sector and a significant increase in the export of Malaysian manufactured products. The value of exports in 2000 was RM317.9 billion. This share expanded to RM588.9 billion in 2006⁴.

Education and training accounted for 35.64% of growth. This involves the upgrading of skills and knowledge. Higher skilled and more efficient workers would lead to an increase in the quality of products and services, which ultimately means an improvement in overall productivity. In tandem with the IMP and government initiatives to achieve industrialization, increasing the level of education and skills of the workforce was emphasized to enable them to participate actively in the economy. The structure of education has changed significantly over the years. Education and training was the largest contributor to TFP growth from 1997-2006. Those with upper secondary and tertiary qualifications increased significantly from 8.8% in 1990 to 14% in 2000 and are expected to increase to 35% by 2010.

Capital structure relates to the proportion of investment in productive capital inputs and contributed 19.30% to the TFP growth. Investment in machinery and equipment, which are productive capital inputs, will yield a more perceptible direct output as compared to investment in infrastructure, plant and building, which have a longer lag period. Thus, the production of capital that has not been efficiently allocated and fully utilized will lead to a slower TFP growth. The contribution of capital structure was the third largest for TFP growth during the period from 1997-2006. The average growth in terms of capital

³Total Factor Productivity Growth: Survey Report (2004), Report of the Asian Productivity Organization (APO) Survey on Total Factor Productivity 2001/2002.

⁴National Productivity Corporation (NPC), Productivity Performance of Malaysia: Key Productivity Statistics.

was the third largest for TFP growth during the period from 1997-2006. The average growth in terms of capital structure from 1997-2006 is highest for the manufacturing sector at 2.39%⁵.

Technical progress refers to the effective and efficient utilization of technology, innovation, work attitudes and management as well as organizational effectiveness. With high technological capabilities, a motivated workforce and effective management, higher value-added products and services will be produced at competitive costs. It was the lowest contributor to TFP growth from 1997-2006, registering at 8.91%.

Economic restructuring consisted of 19.30% of TFP growth (TFPG) and relates to movements of resources from less productive to more productive sectors of an economy. The various stages of development are associated with the restructuring of economies towards higher value-added activities. The actual pace of progress from one stage to another is determined by how successful the process of economic restructuring from less productive to more productive industries is handled.



Table 1: Contributions to GDP Growth

Factor	Components of TFPG (1997-2006)	
	Growth	% of GDP
Labour	1.93	34.31
Capital	2.06	34.69
TFP	1.63	29.00

Source: National Productivity Corporation (NPC)

Table 2: Science, Technology and Innovation Indicators

	2000	2005
National Goss Expenditure on R&D (RM Million)	167.5	2500.6
Public	703.6	867.5
Private	967.9	1633.1

Source: National Productivity Corporation (NPC)

From Table 1, for the period 1997-2006, total factor productivity (TFP) grew by 1.63%, contributing 29% to GDP growth. Also, Table 2 shows that all economic sectors recorded TFP growth that ranged from 0.90% to 1.93%. This growth rate was supported by sustained expansion in exports as well as public and private productivity (Table 3) and quality enhancement initiatives. Also, from Table 2, it can be seen that the manufacturing sector registered a 1.22% growth in TFP, while the utilities sector exhibited the highest TFP growth of 1.93%. By the year 2010, there is the expectation that TFP will grow by 2.2%, contributing 35.80% to the growth in GDP.

⁵Similar to footnote 4

Table 3: Total Factor Productivity (TFP) Growth for the Major Economic Sectors (1997-2006)

Growth (%)	
Sectors	TFP
Agriculture	0.90
Mining & Quarrying	0.70
Manufacturing	1.22
Utilities	1.93
Transport	1.69
Trade	1.24
Finance	1.73
Other Services	0.56

Source: National Productivity Corporation (NPC)



Penang

In Penang's manufacturing sector, the small and medium enterprises (SMEs) play a vital role in generating employment and supporting the multi-national corporations (MNCs)⁶. With a small capital requirement and a medium level of technology input, SMEs are able to exert a pull on numerous new entrepreneurs to start up their own businesses; i.e. the SMEs play the role as a starting point to those young and aspiring entrepreneurs. Employment can be generated by the SMEs, because of their production capacity that tends to be more labour intensive with low to medium-technology requirements. The role of SMEs as supporting industries to the MNCs can be viewed as an interdependency relationship between the two entities, where parts, inputs and components are provided by the SMEs to the MNCs. In 1996, the Malaysian government in the Second Industrial Master Plan (IMP2) emphasized the linkages between the two industries. Dependency on the import market for obtaining intermediate inputs will be lessened if these linkages can be strengthened, therefore contributing significantly to improving the balance of payment in Penang.

The Ministry of International Trade and Industry (MITI) of Malaysia has outlined the major role of the SMEs as follows:

- (1) SMEs are a catalyst of economic growth through their contribution to output, value-added production and employment. To make this role more effective, SMEs are required to produce a high-quality sustainable output to compete in the global market.
- (2) The problems of sectorial and regional growth imbalances can be reduced through the promotion of SMEs in the industrial zones where economic growth is still relatively low or moderate.
- (3) SMEs can contribute in creating job opportunities through relatively low-intensive production techniques.
- (4) SMEs can also increase the sectorial value added through the processing of primary commodities locally before exportation in conjunction with agro-based industries.

⁶Idris, J., & Rahmah, I., 2007. "Source of Output Growth in Small and Medium Scale Enterprises in Malaysia", *MPRA Paper No. 277*, University Library of Munich, Germany.

In Penang, the majority of manufacturing establishments are small and medium in size (SMEs). Even though the SMEs are abundant in Penang, their contribution to the value of fixed assets is less than that of larger enterprises. The SMEs are mostly affected in the fast changing industrial production process from relatively low to high technology as they form the majority of the manufacturing establishments. Some SMEs are able to adapt well with the change in industrial needs and current market requirements. However, there are a number of SMEs that struggle to cope with the manufacturing development processes as a result of liberalization and globalization.

In order for local SMEs to be able to compete more effectively in the global market, one of the most important attributes that should be adopted by the SMEs is their efficiency in the usage of imports. With the increase in efficiency, there would be a comparable reduction in the cost of production and output price can be kept relatively lower. Through this method, the SMEs are able to penetrate the export market if the quality of their output is high enough. Therefore, to increase SME efficiency, TFP should be developed and augmented.

One of the measures to be taken into account is the improvement of the quality of labour by enhancing human resource development. There are insufficient programmes to train and upgrade the labour force by the SMEs. "The Facilities from Human Resource Development Fund (HRDF) are underutilized by the SMEs despite the fact that they register with the council (HRDC). Therefore, capital from HRDF must be utilized or harnessed through greater enforcement and participation with the government providing the facilities". Many of the SMEs are of the opinion that the procedures used to train workers using the HRDF are too restricted with red tape and are difficult to follow⁷. Also, improvement in the quality of capital through the adaptation of appropriate technology should also be in tandem with the needs and skills that are available from the SMEs.

In addition, the intensification of continuous improvements in R&D is important for the SMEs to develop their own indigenous technology. Emphasis on the development of scientists, researchers, technologists and educators should be made while fostering creativity and innovativeness as well as raising the level of general scientific and technological awareness. However, there are concerns among the local SMEs in Penang that the investment in R&D is minimal because there is no capacity to employ people to invest in R&D⁸. The concern is that only large investments in R&D are carried out by bigger firms, whereas most SMEs in Penang are too small to spearhead big R&D investments. A possible solution may be to increase funding as well as provide tax incentives for R&D. Also, the promotion of co-financing and joint programs in research among both the public and private sectors locally and internationally as well as intensification of research in priority areas in the private sector can also be made.

These qualitative improvements in management and organization are vital for the increase in TFP growth for the SMEs. Structural changes and increases in the investment of human resource development ensure the utilization and management of new technologies and systems. The management is responsible for productivity and competitiveness improvements of firms and worker co-operation plays an important role. Good management will lead to increased efficiency through better understanding among workers. Also, the production process and linkages, as well as the flow of information from one division to another would become smoother. These factors will help to increase the SME efficiency, productivity and marketability of their products.



⁷Ismail, R., cited in Idris, J., & Rahmah, I., 2007. "Source of Output Growth in Small and Medium Scale Enterprises in Malaysia", *MPRA Paper No. 277*, University Library of Munich, Germany.

⁸Focus Group Discussion on Total Factor Productivity (TFP) organized in collaboration with the National Productivity Corporation (NPC) at PSDC (11th December 2007).

Conclusion

This article started with a brief overview on total factor productivity (TFP). It then went on to identify the determinants of TFP growth in Malaysia. On average, the growth rate of Malaysia's GDP was 5.62% from 1997-2006. Also, during that period, TFP exhibited a growth of 1.63%. Such growth was driven by demand intensity (23.75%), technical progress (8.91%), economic restructuring (12.40%), education & training (35.64%), and capital structure (19.30%). TFP growth is crucial for the development of firms, especially the SMEs for the expansion of the manufacturing sector in Penang. There is a need to develop TFP over time so that the dependence on physical inputs can be reduced. In order to increase TFP growth, appropriate technology transfer and R&D are required. One way of achieving this is through government funding or its agency, in terms of financial facilitation. Also, a higher level of human capital as well as managerial expertise and the fostering of innovative values are needed in order to achieve an economy that is efficient and technology-driven.

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Moving Towards a “Lean” Environment

Abstract

This article identifies environmental pollution as a result of unnecessary use of scarce resources or a substance released to the air, water, or land that could harm human health or the environment. It is proposed that instead of incurring cost to remedy an environmental disaster or to prevent pollution through investment in carbon intensive energy infrastructure, a more practical and cost effective approach is adopted. This approach requires ‘lean thinking’ that is premised on the identification and elimination of non-value added activities that consume valuable resources and emit substances that pollute the environment. By doing so, the environmental impact due to industrial growth can be curtailed and the cost of operations will be reduced as well. This will enable organizations to be more profitable and at the same time reduce the degree of pollution emitted into the environment. Both the industry as well as society will benefit from this exercise.



Key words:

‘lean thinking’, environmental waste, value-adding activities, non-value adding activities, waste.

It has been noted that based on the United Nations Human Development report, we are currently emitting twice the ‘permissible level’ of CO₂ into the global environment. According to the report, this level of emission can effect world climate changes that will ultimately lead to shortages of food and fresh water resources, rising sea levels, ecosystem imbalances and emerging health risks.

In Malaysia, carbon emissions have increased by 221 per cent since 1990. This represents the highest growth rate among the world’s top polluters. Malaysia has a population of only 27 million people, which represents 0.4 percent of the world’s population, but we account for as much as 0.6 percent of global emissions. Dr Khairulmaini of the Center for Climate Change in Universiti Malaya, identified the industrial sector, particularly the transport industry as the main contributor to this problem.

Rich, developed countries such as Britain are able to invest heavily in climate defense infrastructure as well as in carbon intensive energy infrastructure to curtail and control the effect of emissions into the environment. This, however, is not a sustainable option for a developing country such as Malaysia that depends heavily on industrial growth to fuel the economy and for organizations that are barely profitable given the rising cost of raw materials.

We appear to face a dilemma between expanding our industrial growth to meet business and economic challenges and curtailing our carbon emissions into the environment. Given the stark reality on the ground, the former appears to be a more attractive option.

In reality, there is no dilemma. We do not have to choose between the two as they are not mutually exclusive. They are in fact complementary if we adopt ‘lean thinking’ in both our manufacturing as well as service practices. The concept of ‘lean thinking’ rests on the premise that we can do more with less. We need to be mindful of what we do and do only what is required by our customers, no more, no less. If we adopt the principles of ‘lean thinking’, we begin to realize that we actually use more labor, more materials, more space and more time to provide a service or to manufacture something that could be delivered with a higher quality, at a lower cost and in a shorter lead time by utilizing fewer resources.

In Malaysia, there is an imperative need to adopt a business model that emphasizes on reducing wastage or excess use of resources while delivering quality products at the lowest cost to customers. Corporations should shift from a blind pursuit of increasing profits to focus on reducing production resource requirements, increasing manufacturing velocity and flexibility while at the same time improving the quality of products or services delivered. This approach will lead to businesses having a more positive cash flow, higher profits as well as better returns on investment.

This requires the adoption and propagation of a continual improvement-based, waste elimination culture. In such an environment, concerted attempts to identify and eliminate non-value adding activities that consume additional resources and increase production cycle time should be pursued in earnest. Shochihiro Toyoda, the former president of the Toyota Motor Corporation describes such non-value adding activities as “anything other than the minimum amount of equipment, materials, parts, space and workers’ time, which are absolutely essential to add value to the product”. This means identifying and eliminating the unintended overuse of scarce resources due to neglect or habitual practice.

This is an important first step as it has been found that in many industrial processes, non-value adding activities that do not contribute directly to the requirements of the customer comprise up to 90 percent of a factory’s total activity. The identification of wasteful, non-value adding activities not only improves an organization’s ability to compete effectively but also reduces the production of environmental waste.

By definition, environmental waste is an unnecessary use of resources or a substance released to the air, water, or land that could harm human health or the environment. It can also occur when companies use more resources than absolutely necessary to provide products or services to customers, and/or when customers use and dispose of products. Therefore, minimizing unnecessary usage of materials, labor, fuel, equipment and space not only reduces time and improves efficiency but also curtails environmental degradation. It also has the effect of reducing emission of harmful pollutants into the air as well reducing noise pollution that can affect the health of employees.

The lean approach to manufacturing requires a consistent focus on eliminating rejects in the manufacturing process. By doing so, the excess raw materials used and energy consumed in making defective products is reduced. Defective components that require recycling or disposal may be minimized, reducing both space required as well as energy used for heating, cooling and lighting.

Lean thinking requires the production of only what is needed by the customer. Producing more than is necessary is another wasteful activity. By producing in excess of the minimum needed by the customer, more raw materials, hazardous materials and energy will be consumed, leading to extra emissions, waste disposal, and worker exposure to hazards. The extra products are stored and may become obsolete requiring disposal that adds to environmental waste.

Producing more than is needed requires more processing of raw materials and equipment. This causes more parts and raw materials to be consumed per unit of production. This unnecessary processing increases wastes, energy use, and emissions that contribute to environmental waste.

Excessive production and consumption of resources lead to other forms of wastage that have equally damaging effects on the environment. One of these is the extra transportation needed in moving as well as processing additional products. Excessive transportation leads naturally to more energy use for transport, excessive emissions from transport, more space required for movement as well as increased lighting, heating, and cooling demands and energy consumption.

Excessive production and transportation activities that occur are usually overlooked and deemed as being a normal requirement for business. These are considered as costs of a business and identified as expenditure incurred in running a business. The lean approach clearly distinguishes between cost and expenditure. Cost is the monetary value associated

with the consumption of resources needed to undertake a value-added activity. Anything over and above this is wastage

Expenditure incurred should therefore be understood as a combination of cost and wastage. Assuming they are the same leads to a “business as usual” mindset in a company that fails to differentiate between value-adding and non-value adding activities. It is imperative that a clear distinction between expenditure and cost is made so that wasteful activities that consume expenses but do not add value to a product or service may be identified and eliminated altogether. This is important because failure to do so leads to increasing expenses that erode profits and at the same time pollutes the environment.

The Environmental Protection Agency in the US has documented a number of instances where the adoption of lean manufacturing had a positive impact on the environment. Over a three-day event, an interdepartmental team of the [Baxter Healthcare Corporation](#) developed value stream maps (VSM) that detailed the plant’s use of water and identified processes with potential for improvement . Using this VSM system, the team developed an implementation plan that will save 170,000 gallons of water *per day* and over \$17,000 over three months, with little or no dedicated capital investment.



In another case, [Boeing Everett](#) realized resource productivity improvements of 30-70 percent from lean initiatives. They were able to eliminate the use of 350 cubic feet of cardboard and bubble wrap packing material per 747 wing panel set and thus reduced chemical usage per airplane by 11.6 percent.

[Boeing Auburn](#) succeeded in reducing defects from 1,200/10,000 in 1996 to fewer than 300/10,000 presently and at the same time reduced floor space by 200,000 square feet due to the lean manufacturing approach adopted.

To simultaneously improve business competitiveness as well as reduce environmental waste such as emissions of CO₂ into the environment, a two-pronged approach is needed. This approach should involve an integration of relevant expertise as well as a propagation of ‘lean thinking’.

The first would be to combine the expertise and resources of the Environmental Protection Agency, the Occupational Safety and Health Agency as well as the Federation of Malaysian Manufacturers to form a comprehensive environmental protection plan that complements ‘lean thinking’ in manufacturing and addresses environmental as well as health concerns. This plan would provide a framework of reference for best practices related to reducing environmental waste that at the same time improves business profits and returns on investment.

The second will require top management in organizations to show commitment and support for lean initiatives undertaken in organizations. Environmental waste considerations need to manifest themselves in lean training efforts. These wastage factors need to be made visible and simple for systematic elimination.

To inculcate awareness of the impact industrial operations have on the environment, it is recommended that environmental metrics are added to lean metrics for the purpose of monitoring and managing operational cost as well as minimizing environmental pollution. In this regard, it will be helpful if environmental waste considerations are included in lean training efforts.

By undertaking such efforts not as a one-off activity but on a continual basis rooted in an improvement-based, waste-elimination culture, there is every indication that Malaysia will begin to enjoy increasing profits and at the same time curtail environmental gas emissions. This will enable the country to develop as a model economy that successfully balances industrial growth with sustainable production management and environmental pollution control.

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International Headlines

Real Estate Market Quiet As Uncertainty Looms in US

Asia One, 21st January 2008

The Singapore property market has turned somewhat jittery in the face of growing fears about a recession in the United States. Apart from worries that a US recession might hurt growth in Singapore, some also believe last year's price spurt in high-end homes was overdone. Singapore's property market is stable but said there is a risk that prices could fall. If US sub-prime woes force mortgage insurers to write off bad insurance, this could trigger construction industry layoffs, as well as defaults on consumer credit-card rollover debt and car loans. Some sellers appear to have lowered their expectations, particularly for high-end homes. But their asking levels are likely to remain above the purchase prices. Developers are unlikely to cut prices, which should provide support for the market while buyers who plan to live in their new homes, especially if they're using collective sale gains, have less to worry about, though choices in the primary market might be limited.



Japan Carmakers Ask: What Recession?

Business Week, 1st February 2008

Subprime, a rising yen, shrinking sales at home, and high oil prices aren't hurting earnings at Honda, Nissan, and other Japanese auto companies. It has been a rough ride for Japan's economy of late. The government has trimmed its growth figure for the current financial year to 1.3%, from 2.1% a year ago; average monthly wages slipped 0.7% in 2007. One reason for the lack of investor appetite is the mature markets may get worse before they get better. There are also worries about emerging carmakers from India and China, whose cheap autos will increase competition, particularly at the lower end of the market. For the time being, though, Japan's automakers, unlike the country's wider economy, look first-class.

India Can Be Attractive Healthcare Destination

India News Online, 22nd February 2008

India has the potential of becoming an ideal healthcare destination. India has generated estimated revenue of around 600 million dollars from over five hundred thousand international healthcare travellers including non-residents that visited India in 2006. The promotion of healthcare tourism would result in development of associated sectors, such as medical equipment manufacturing, telemedicine, medical diagnostics, outsourcing of hospital administration and insurance. The increasing popularity of India's traditional wellness systems and rapid strides made in information technology is also an advantage for the country, it added. The total market for healthcare tourism is estimated to be in the range of 150 billion dollars globally and India has less than one per cent share of it.

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