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AN ALTERNATIVE APPROACH TO IDENTIFY KEY INDUSTRIES: ISSUES TO SELECTION CRITERIA

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Abstract. Within a process of modeling exercise, this study aimed to understand appropriate selection criteria to identify key industries. There are many key sector identification linkage measures in the subject matter and sensitivity issue among them can be tricky because many of these measures differ only slightly but can result in outcomes that are quite dissimilar. With this background, we proposed an alternate approach that helps to resolve this issue. The proposed approach utilizes in this study by five sub-methods and high degree of the frequency of their occurrences in sub-methods to determine the key sectors. The study approach is applied to Malaysia as the public sector investment remains a large share in the national economy, like other developing countries, and the correct identification is still a challenge for sectoral planning. The experiences from this study can be used to guide appropriate public investment in Malaysia and elsewhere with similar economic forms.

Keywords: key sector identification, selection criteria, investment, policy challenge, forward and backward linkages, input-output analysis.

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Introduction

Wassily Leontief introduced the input-output analysis in the mid-1930s which became a standard tool in development planning (Miller, Blair 2009). The analysis has the advantage of showing the impacts of a specific action, and the ripple-effects that the action or event has on other sectors of the economy. Within this analytical framework, Rasmussen (1956) and Hirschman (1958) respectively developed measures for intersectoral linkages and application of intersectoral linkages in the identification of key economic sectors to maximizing impacts of investment. They contended that developing economies should aim investment in key sectors that are known to have a high degree of forward and backward intersectoral linkages. Since Rasmussen (1956), researchers have

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suggested many measures to observe the strength of backward and forward linkages for identifying key sectors. Several measures are widely accepted as standard actions and influential than others for investment selection (Dietzenbacher *et al.* 1993; Hoen 2002). The linkage measures mostly designed to identify key sectors in terms of employment, value added or input consumption to the policy goal of expanding output. Interestingly, each of these measures has found slightly different in interpretations and applications but typically surrounding by dispute and controversy (Hewings 1982; Cella 1984; Sonis *et al.* 1995; Miller, Lahr 2001; Sanchez-Choliz, Duarte 2003).

Therefore, even though there is a good number of studies and applications of intersectoral linkage measures related to weak forward and backward linkages are existed in the subject but more could be done as the gap in key sectors' identification (classification) in the literature remain outstanding. As our knowledge goes, to minimize the gap no study has been considered in the area by comparing the use of different linkages sub-methods to identify key sectors for expansion of foreign direct investment (FDI) or no study has been measured probable policy goals by alternative selection criteria. In addition, no study has been deliberated to select key sectors by the frequency of their occurrences in the different linkage measures to justify potential outcomes. We understand from the literature that mostly developing and transitional economics suffered to identify the policy goal of expanding FDI and struggled to obtain potential output with limited investment. The evidence of planning challenge even can be found in large developing countries like in India, Argentina and Brazil where they struggled to implement the industrial strategies (Ma 1997; Mann 1997; UNCTAD 1996; Gulati 1997; Jiaqin, Huei 2002). As public sector investment considered a large share in those developing countries, and hence the potential efficiency gains supposed to guide public investment from an economic viewpoint.

Hence, the proper knowledge and appropriate selection of key sectors could help to guide correct investment in the key industries and benefit of investment could be maximized (McMann, Randolph 2011; OECD 2011; Fornahl *et al*. 2010; Hitt *et al*. 2009; Kuratko 2009; Audretsch 2009; Hsu 2007). Literature shows that to identify the effective policy goal of expanding FDI India, Brazil and Argentina have encountered lots of difficulties (Gulati 1997; Jiaqin, Huei 2002). Therefore, the arguments place again in the application of intersectoral linkages related to particular weak forward and backward linkage measure as many of those linkage measures differ only slightly but results in outcome that are fairly different (Ma 1997; Mann 1997; Gulati 1997; Jiaqin, Huei 2002). We understand that using the same data set different forward and backward linkage measures yield different selection of key sectors and thus resulting in different policy outcome, which may place complexities in policy design. Therefore, academia should come up with a precise linkage measure by alternative selection criteria in the application of intersectoral linkages. We identify that Malaysia is not an exception in the realm even though it has fundamentally a liberal foreign direct investment policy as the issue is concern.

Malaysia is basically considered a small open economy with a liberal foreign direct investment incentives' friendly provision to attract investment. Following FDI intensives in the 80s, its inflows have increased more than ten folds over the last three decades (Fig. 1). However, the average FDI inflow has been hanging in MYR15.0 billion per

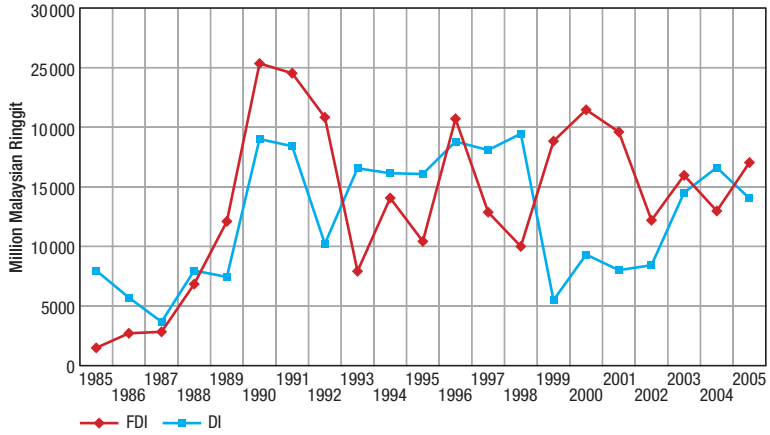

Fig. 1. Real foreign direct investment inflows and domestic direct investment, 1985–2005
Sources: MDP (2006); DOS (2006).

year without signs of increasing between the year 1990 and 2005 (Table 1). Eventually, FDI has decreased from MYR20.3 billion to 17.9 billion while domestic direct investment (DDI) increased from MYR8.1 billion to MYR13.2 billion between 1990 and 2005 (Table 2)[1]. It reveals from the Table 2 that some key sectors (i.e. identified by the Malaysian Second and Third Industrial Master Plan) experienced dropping tendency in FDI and DDI especially on textile and textile products; paper, printing and publishing; petroleum and petrochemical; non-metal manufactures; rubber products and beverage and tobacco. It should be noted that the Third Industrial Master Plan (2006–2020) targeted on key industries, which are (a) non-resource-based industries: electrical and electronics, medical devices, textiles and apparel, machinery and equipment, metals, transport equipment; (b) resource-based industries: petrochemicals, pharmaceuticals, wood-based, rubber-based, oil palm-based, and food processing (MMP 2009)[2].

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[1] Since independence in 1957, Malaysia experienced relatively high economic growth that averaged about 6% in the 1960s and 1970s. During those decades, the major engines of growth were the agricultural plantation sector and the mining and quarry sector. The agricultural plantation sector largely comprised of rubber, cocoa, and oil palm while mining and quarry comprised mainly of tin ore mining. In spite of the large agriculture and mining dominance, Malaysia transformed itself into a manufacturing based export-oriented economy through a series of investment policies which started with the Pioneer Industries Ordinance of 1958. This ordinance promoted import-substitution of various manufacturing outputs. Later, the ordinance was replaced by the Investment Incentives Act of 1968 which stresses on exports.

[2] Yeoh and Zhao (2005) asserted that FDI were practically non-existent before the introduction of the 1968 Investment Incentives Act. However, following the act, FDI considered an important source of capital and technology. To further boost FDI inflow, the Promotion of Investment Act was introduced in 1986. In the same year Malaysia launched its First Industrial Master Plan and 12 key industrial sectors were identified to be developed. These industrial sectors were rubber, palm oil, food, wood-based industries, chemical and petrochemical, non-ferrous metals, non-metallic minerals, electrical and electronics, transport equipment, machinery and engineering, iron and steel, and textiles and apparel. In 1996, the second Industrial Master Plan was launched. Among other targets and concerns, this plan stressed on cluster-based approach to developing the industrial sector and on deepening industrial linkages.

Table 1. Sources of foreign direct investment for year 2000 and 2005

Country	2000	2005
Australia	0.7%	0.9%
Hong Kong	1.7%	0.6%
India	0.0%	3.1%
Japan	14.5%	20.5%
Rep Korea	3.6%	3.8%
Singapore	9.0%	16.3%
Taiwan	4.6%	2.4%
Thailand	0.1%	0.8%
U. K.	3.9%	0.6%
U.S.A.	37.7%	28.8%
GDR	8.3%	2.2%
Other countries	15.8%	20.0%
Total	100.0%	100.0%

Sources: MDP (2006); DOS (2006).

Table 2. Distribution of FDI and DDI by industries, 2000 and 2005 (million MYR; US$1 = MYR3.30)

Industries	2000		2005	
	FDI	DDI	FDI	DDI
Food processing	539.6	518.6	531.9	925.6
Beverage & tobacco	107.7	5.9	77.6	16.8
Textile & textile products	731.9	454.5	146.2	227.8
Leather & leather products	2.8	2.9	3.6	5.4
Wood & wood products	172.5	288.7	77.2	283.3
Furniture & fixtures	106.8	238.2	68.5	448.2
Paper, printing & publishing	2,118.9	1,312.2	123.8	829.7
Chemical & chemical products	585.6	377.1	869.5	851.6
Petroleum, & petrochemical	1,763.8	583.2	133.0	601.7
Rubber products	668.4	274.6	215.2	557.8
Plastic products	289.9	326.4	594.8	585.3
Non-metal manufactures	1,527.6	238.6	596.1	325.4
Basic metal products	428.0	358.6	430.5	2,774.5
Fabricated. metal manufactures	163.0	247.1	250.6	508.2
Machine manufactures	418.0	400.8	570.0	457.4
Electrical & electronic products	10,209.7	1,972.8	11,318.9	2,474.8
Transportation equipments	273.1	399.8	503.8	912.3
Measuring & scientific instruments	166.5	17.4	1,364.5	62.5
Other manufactures	50.7	49.6	12.4	325.5

Sources: MDP (2006); DOS (2006).

Following on the evidence of the last two decades our question is very straight forward: why the key sectors that are identified by the Malaysian Third Industrial Master Plan experienced negative tendency? Has the Malaysian Third Industrial Master Plan some lacking to identify key industries? If China able to attract international companies to place global competitiveness that driven many multinational companies to look for other alternative manufacturing avenues, then why Malaysia could not? Therefore, can we state that Malaysian did not identify the key sector's investment in right time? We understand that the identification of key sectors is fundamental; so that the limited foreign and domestic investment can correctly direct to key industries to achieve maximum development impacts. With this background, our goal is to show how the Malaysian economy has lost out from correct identification of key sectors in the Malaysian Third Industrial Master Plan. Apart from that, our aim is also to show the difference of key sectors' classification between this study and the Malaysian Third Industrial Master Plan (2006–2020).

As correct identification of key sectors remained a planning challenge in Malaysia to maximize economic outcomes; hence, to overcome of these problems, we proposed an alternate approach that allows for better selection of key sectors. We placed a one step forward strategy in the linkage measures by augmenting information from different key sector measures. The set of key sectors with the largest impacts are selected to identify key industries by our study. Our approach is based on three steps: (i) use of different methods to identify key sectors; (ii) the intended policy goals as a criterion of selection; (iii) the selection of the key sectors chosen according to the frequency of their occurrences in the different methods. The method employed in this paper is rigorous, which made its findings quite robust for the key sectors' selection criteria. In addition, the identification of key sectors is especially important for government to make corresponding policies to attract FDI and DDI to the sectors which may play vital roles in driving economic growth. Therefore, we believe that experiences from this study national policy maker would be able to implement a right industrial strategy in future.

1. Methodology and study approach

The analytical approach is based on the Leontief's input-output framework (Miller, Blair 1985, 2009). Given an *n*-sector economy with intersectoral transaction matrix **Z** and sectoral total output vector **X**, the direct input requirement matrix, **A**, is given by:

$$A = Z\left(\hat{X}\right)^{-1}, \tag{1}$$

where, $\hat{X}$ is the diagonalized matrix of **X**. Elements in the direct input requirement matrix indicate the value of input from sector *i* used by sector *j* to produce one dollar's worth of output.

We understand that input-output model describes the relationships among economic sectors through the use of a system of linear equations that represent each sector's identity between the total output produced, and the output purchased and consumed by all the other sectors of the system. In matrix notation this system of linear equations is:

$$\mathbf{X} = \mathbf{AX} + \mathbf{Y}, \tag{2}$$

where, **Y** is final demand vector. Equation (2) is the fundamental equation of the open Leontief system, which states that the gross output (**X)** is the sum of all intermediate input demand (**AX)** and final demand (**Y)**. Solving equation (2) for total output yields equation (3) where **I** is an *n* by *n* identity matrix and **B** is the Leontief inverse or total requirement matrix.

$$\mathbf{X} = \mathbf{(I - A)}^{-1}\mathbf{Y} = \mathbf{BY}. \tag{3}$$

To measure the intersectoral linkage of a particular sector means we must compute and evaluate its forward linkage (*FL*) and backward linkage (*BL*) with the rest of the economy.[3] Note however, since the forward linkage essentially deals with downstream output supply, despite some reservation by some authors (Oosterhaven 1988; Oosterhaven 1996; Dietzenbacher 1997), researchers generally use the Ghosh supply-side model in the computation of *FL* (Miller, Blair 1985). The supply-side direct output coefficients are given by:

$$\vec{\mathrm{A}} = \left(\hat{\mathrm{X}}\right)^{-1} \mathrm{Z}, \tag{4}$$

where, r is the scalar diagonalized matrix of A (i.e. direct output coefficients). It follows that the Ghosh direct and indirect output coefficients are given by (Miller, Blair 1985):

$$\vec{\mathrm{B}} = \left(\mathrm{I} - \vec{\mathrm{A}}\right)^{-1} \tag{5}$$

where, r is the scalar diagonalized matrix of B (i.e. direct and indirect output coefficients). Based on the Leontief framework, Rasmussen (1956) and Hirschman (1958) suggested (6) and (7) below as indicators of strength of *BL* and *FL*.

$$BL = \frac{1}{n}\sum_{i=1}^{n} b_{ij} = \frac{1}{n}\mathrm{B}_{\bullet j} \tag{6}$$

and

$$FL = \frac{1}{n}\sum_{j=1}^{n} b_{ij} = \frac{1}{n}\mathrm{B}_{i\bullet}, \tag{7}$$

where, B is the Leontief inverse matrix (i.e. total requirement matrix of the equation (3)) and parameters B*j* and B*i* indicate the value of inputs from sector *i* used by sector *j* to produce one dollar's worth of output in the economy. In addition, b_{ij} are the coefficients of matrix B, where Hazari (1970) suggested modification to the measures by dividing the terms in (6) and (7) by a global average as in (8) below:

$$\text{Global average} = \frac{1}{n^2}\sum_{j=1}^{n}\sum_{i=1}^{n} b_{ij} = \frac{1}{n^2}\sum_{j=1}^{n}\mathrm{B}_{\bullet j} = \frac{1}{n^2}\sum_{i=1}^{n}\mathrm{B}_{i\bullet}, \tag{8}$$

where, *n* indicate the numbers of industry in the economy. This would allow inter-industry comparison. With normalizations procedure, the linkage indicators become:

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[3] When a sector increases its production, there will be additional demand for inputs from other sectors of the economy that are related to it. This kind of direct and indirect upstream input-relationships is termed backward linkage. From another perspective, increased output in one sector means more is available to be used as input in other sectors of the economy. This kind of direct and indirect downstream output-relationships is termed forward linkage.

$$BL = U_j = \frac{\frac{1}{n}\mathrm{B}_{\bullet j}}{\frac{1}{n^2}\sum_{j=1}^{n}\mathrm{B}_{\bullet j}} \tag{9}$$

and

$$FL = U_i = \frac{\frac{1}{n}\mathrm{B}_{i\bullet}}{\frac{1}{n^2}\sum_{i=1}^{n}\mathrm{B}_{i\bullet}}, \tag{10}$$

where, *BL* is the backward linkage and *FL* is the forward linkage. In addition, U*j* and U*i* indicate the value of inputs from sector *i* used by sector *j*. Under this method, a sector is said to have strong backward linkage if $U_j > 1$ and strong forward linkage if $U_i > 1$. A key sector is defined as those sectors having U_j and U_i greater than 1.

To eliminate selection error due to extreme values in the calculation of average, Hazari (1970) also suggested using the coefficient of variation to complement (9) and (10) in identifying key sectors (Bharadwaj 1966). Following Hazari (1970), Lenzen (2003), and Cai, Leung (2004), the coefficients of variations associated with *BL* and *FL* are defined as in (11) and (12) respectively:

$$V_j = \frac{\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(b_{ij} - \frac{1}{n}\mathrm{B}_{\bullet j}\right)^2}}{\frac{1}{n}\mathrm{B}_{\bullet j}} \tag{11}$$

and

$$V_i = \frac{\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(b_{ij} - \frac{1}{n}\mathrm{B}_{i\bullet}\right)^2}}{\frac{1}{n}\mathrm{B}_{i\bullet}}, \tag{12}$$

where, *Vj* indicates the coefficients of variations associated with *BL* and *Vj* indicate the coefficients of variations associated with *FL*. Under this method, a sector is said to have strong backward linkage if $U_j > 1$ and small V_j. Similarly, a sector has strong forward linkage if $U_i > 1$ and small V_i.

All indices mentioned above are pure measure of sectoral interdependence that do not account for the level of economic activities and/or the policy context of key sectors computation (Lenzen 2003; Soofi 1992; Cuello, Mansouri 1992). To remedy this deficiency, researchers recommended incorporating weighting scheme into *BL* and *FL* measures (Rasmussen 1956; Hirschman 1958, Hazari 1970; Laumas 1976; Soofi 1992; Cuello, Mansouri 1992). Following Soofi (1992), Claus, Li (2003), the weighted *BL* and *FL* measures are calculated as follows.

Let the final demand weighted Leontief inverse elements be b_{ij}^{w} where:

$$b_{ij}^{w} = b_{ij} \frac{y_i}{\sum_{i=1}^{n} y_i} \text{ and } B_{\bullet j}^{w} = \frac{1}{n} \sum_{j=1}^{n} b_{ij}^{w}. \quad (13)$$

Similar to (7) and (8), the corresponding weighted *BL* and *FL* are:

$$BL = U_j^w = \frac{\frac{1}{n} B_{\bullet j}^{w}}{\frac{1}{n^2} \sum_{j=1}^{n} B_{\bullet j}^{w}}, \quad (14)$$

$$FL = U_i^w = \frac{\frac{1}{n} \mathrm{B}_{i\bullet}^{w}}{\frac{1}{n^2} \sum_{i=1}^{n} \mathrm{B}_{i\bullet}^{w}}, \quad (15)$$

where, *w* (i.e. sectoral final demand over total final demand) indicates the weights of *BL* and *FL*, and b_{ij} are the coefficients of Leontief inverse matrix. The same calculations could be made using other schemes of weights. For an open economy, export weighted *BL* and *FL* are also appropriate. Under this method, a sector is considered to have strong backward linkage if $U_j > 1$ and a strong forward linkage if $U_i > 1$.

Another measure of sector potential that account for relative size of a sector is based on output-to-final demand elasticity (Mattas, Chandra 1994; Ciobanu *et al.* 2004; Miller, Blaire 2009). Simply put, this measure of sector potential quantifies the impact of one percent change in final demand to the percentage change in total output. Following Mattas, Chandra (1994), the output-to-final demand elasticity of sector *j*, which can be indicated by OE_{xyj}, is calculated as follows:

$$BL = OE_{xyj} = \sum_{i=1}^{n} b_{ij} \frac{y_j}{x} = \mathrm{B}_{\bullet j} \frac{y_j}{x}. \quad (16)$$

Essentially, OE_{xyj} (backward linkage in the output-to-final demand elasticity of sector *j*) is similar to equation (6) or (13) but is weighted by the ratio of final demand to total output. As such, OE_{xyj} is a measure of *BL* and taken together with a similarly weighted forward measure, could be used for key sectors' identification. The forward linkage output-to-final demand elasticity which can similar be indicated by OE_{xyi} can is calculated as follows:

$$FL = OE_{xyi} = \sum_{j=1}^{n} b_{ij} \frac{y_j}{x} = \mathrm{B}_{i\bullet} \frac{y_j}{x}, \quad (17)$$

where, OE_{xyi} (forward linkage in the output-to-final demand elasticity of sector *i*). Under this method, strong backward linkage is associated with larger value of OE_{xyj}. Similarly, strong forward linkage is associated with larger value of OE_{xyi}[4].

[4] Weights in (14), (15), (16) and (17) could easily accommodate other policy goals such as employment, value added, or pollution by changing the weights to those associated with the particular policy goals. These weights could also be appropriately changed to accommodate combined policy goals.

Each of the measure presented in this section will result in different key sector selection albeit many overlapping. To discriminate among the selections, we propose simulating the planned investment impact on the targeted economy-wide variables such as on output, value added and employment. In the next section, we demonstrated the application of this proposed methodology.

2. Method application and results

To reveal the proposed alternate approach, we studied the frequency of occurrence by our five different scenarios on Malaysian economy. The government of Malaysia seeks to expand output of key manufacturing sectors by encouraging direct investment into these sectors through provisions of appropriate incentives. Assume also that the targeted level of investment is 10 percent increase in direct investment in key manufacturing sectors and 5 percent for manufacturing sectors that are strong in either *BL* or *FL*.

We used Malaysian Input-output Table (2000) for *BL* and *FL* computations and 2005 Malaysian Investment Statistics for simulating investment impacts (DOS 2006). The original input-output table comprised 94 sectors but was aggregated into 30 sectors exactly following 9th Development Plan (MDP 2006). However, Malaysian 9th Development Plan considered 19 sectors for national planning (i.e. Table 2) but we used 11 more industries to identify better outcomes to support the 10th Malaysian Development Plan (RMK-10). The value-added row in the input-output table was proportionate into 30 sectors to fulfill our objectives. We also collected additional value-added data from Malaysian capital composition matrix. And finally, employment data are collected from DOS (2006). Appendix A provides the detail sector classification and the corresponding line number of the Input-Output Table. Our estimation comprised of 19 manufacturing industries (line 3 to line 21 of the new table) with the rest being in the agricultural and mining (line 1 and line 2) and service sectors (line 22 to line 30).

For the purpose of identifying key manufacturing sectors, our alternate approaches were computed based on Input-Output relative methods on linkage measures. They are:

1. Method I: Based on (9) and (10) with standard I-O linkage measures.
2. Method II: Based on combination of coefficient of variation both for *BL* and *FL*. That is *BL* and *FL* as in Method I but is complemented by (11) and (12).
3. Method III: Based on (13), (14) and (15) with final demand weights on output; value-added and employment.
4. Method IV: Based on (14) and (15) with export weights.
5. Method V: Based on *BL* and *FL* output-to-final demand elasticity in (16) and (17) respectively.

For each of the method, we also estimated the economy-wide impact of additional investments in identified key manufacturing sectors under the assumption that government will encourage direct investment increased provide incentives to stimulate 10 percent increase in total direct investment in key industries but only 5 percent increase in total direct investment for industries that are strong in either *BL* or *FL*.

Method I

Results in Table 3 were obtained by applying equations (9) for backward linkage and (10) for forward linkage. Details of the result are presented in Table B1 in Appendix B under column heading Method I. For the 19 manufacturing industries, key sectors' results using this method are as follows.

a) Weak *BL* and weak *FL*: 21.1% (4 of 19).
b) Weak *BL* and strong *FL*: 10.5%; (2 of 19).
c) Strong *BL* and weak *FL*: 42.1%; (8 of 19).
d) Strong *BL* and strong *FL*: 26.3%. (5 of 19).

Based on the outcome and the assumed investment scenario mentioned above, the total additional output generated would amount to MYR1.70 billion (US$ 1 = 3.3RM).

Table 3. Summary of results using Method I

$U_j > 1$ but $U_i < 1$	$U_j > 1$ and $U_i > 1$
Beverage and tobacco	Food processing
Textile & textile products	Paper, printing & publishing
Leather & leather products	Chemical & chemical products
Wood & wood products	Petroleum and petrochemical
Furniture and fixtures	Non-metal manufactures
Rubber products	
Transportation equipments	
Other manufactures	
$U_j < 1$ and $U_i < 1$	$U_j < 1$ but $U_i > 1$
Plastic products	Basic metal products
Machine manufactures	Fabricated metal manufactures
Electric & electronic products	
Measuring & scientific instruments	

Method II

Results in Table 4 were obtained by applying equations in (9) and (10), but each is complemented by coefficients of variations in (11) and (12) respectively. Details of the result are presented Table B1 in Appendix B under column heading Method II. Key sectors' results using this method are as follows.

a) Weak *BL* and weak *FL*: 21.1% (4 of 19).
b) Weak *BL* and strong *FL*: 10.5%; (2 of 19).
c) Strong *BL* and weak *FL*: 42.1%; (8 of 19).
d) Strong *BL* and strong *FL*: 26.3%. (5 of 19).

As expected, relative to results of Method I, Method II resulted in fewer key sectors where food processing industry and paper, printing and publishing industry were filtered out by coefficient of variations. Under the same investment scenario, the total additional output generated is MYR1.45 billion.

Table 4. Key sectors, Method II

$U_j > 1$ & $V_j < 4$ but $U_i < 1$ & $V_i < 4$ or $U_i > 1$ & $V_i > 4$	$U_j > 1$ & $V_j < 4$ and $U_i > 1$ & $V_i < 4$
Beverages and tobacco	Chemical & chemical products
Textile & textile products	Petroleum and petrochemical
Leather & leather products	Non-metal manufactures
Wood & wood products	
Furniture and fixtures	
Rubber products	
Transportation equipments	
Other manufactures	
Food processing	
$U_j < 1$ & $V_j > 4$ and $U_i < 1$ & $V_i > 4$	$U_j < 1$ and $U_i > 1$
Plastic products	Basic metal products
Machine manufactures	Febricated metal manufactures
Electric & electronic products	Paper, printing & publishing
Measuring & scientific instruments	

Method III

Results in Table 5 were obtained by applying final demand weights on *output, value-added and employment* in the calculation of (13) and (14–15). Details of the result are presented in Table B2 in Appendix B under column heading Method III. Summary of the outcome on out put using this method are as follows.

a) Weak *BL* and weak *FL*: 78.9% (15 of 19).
b) Weak *BL* and strong *FL*: 0%; (0 of 19).
c) Strong *BL* and weak *FL*: 0%; (0 of 19).
d) Strong *BL* and strong *FL*: 21.1%. (4 of 19).

Table 5. Key sectors, Method III

$U_j > 1$ and $U_i < 1$	$U_j > 1$ and $U_i > 1$
	Machine manufactures
	Petroleum & petrochemical
	Food processing
	Electric & electronic products
$U_j < 1$ and $U_i < 1$	$U_j < 1$ and $U_i > 1$
Rubber products	
Plastic products	
Non-metal manufactures	
Basic metal products	
Fabricated metal manufactures	
Transportation equipment	
Measuring & scientific instruments	
Other manufactures	
Leather & leather products	
Wood & wood products	
Furniture and fixtures	
Chemical & chemical products	
Paper, printing & publishing	
Beverage and tobacco	

Outcome of this method is radically different from those obtained using Method I and Method II. All of the manufacturing sub-sector fell either in the "Weak *BL* and weak *FL*" or the "Strong *BL* and strong *FL*" category with petroleum and petrochemical industry being common to all methods thus far. Additional output using this method is also the highest, i.e., MYR2.40 billion. This figure is considerably much higher than the additional output obtained in method I and method II.

Summary of the outcome on value-added using method III (Table 5 and Table C1 in Appendix C) are as follows.

a) Weak *BL* and weak *FL*: 78.9% (15 of 19).
b) Weak *BL* and strong *FL*: 0%; (0 of 19).
c) Strong *BL* and weak *FL*: 0%; (0 of 19).
d) Strong *BL* and strong *FL*: 21.1%. (4 of 19).

The outcome of this method is very similar from those obtained on output. The weights on Table C1 indicate that like final demand impacts, the value-added also placed similar impacts in the manufacturing sub-sectors and those are different from those obtained using Method I and Method II.

Method IV

Results in Table 6 were obtained by applying export weights (i.e. as an alternative of foreign exchange earnings) in the calculation of (14) and (15). Details of the outcomes are presented in Table B2 (Appendix B). Under this scheme, the 19 manufacturing industries are distributed to fulfill our goal as follows.

a) Weak *BL* and weak *FL*: 74.9% (14 of 19).
b) Weak *BL* and strong *FL*: 0.0%; (0 of 19).
c) Strong *BL* and weak *FL*: 5.2%; (1 of 19).
d) Strong *BL* and strong *FL*: 21.0%. (4 of 19).

Table 6. Key sectors, Method IV

$U_j > 1$ and $U_i < 1$	$U_j > 1$ and $U_i > 1$
Petroleum and petrochemical	Food processing
	Chemical & chemical products
	Machine manufactures
	Electric & electronic products
$U_j < 1$ and $U_i < 1$	$U_j < 1$ and $U_i > 1$
Beverage and tobacco	
Textile & textile products	
Leather & leather products	
Wood & wood products	
Furniture and fixtures	
Paper, printing & publishing	
Rubber products	
Plastic products	
Non-metal manufactures	
Basic metal products	
Fabricated metal manufactures	
Transportation equipment	
Measuring & scientific instruments	
Other manufactures	

Result of this scheme based on weights is presented in Appendix C (Table C1) which is overall similar to outcome obtained from Method III, except petroleum and petrochemicals. This is expected since petroleum and petrochemical industry has a final demand weight than export weight. On the other hand, chemicals and chemical product industry has a higher export weight than final demand weight (Appendix C). Under the same investment scenario, total additional output generated is MYR2.7 billion.

Method V

Results in Table 7 were calculated by applying (16) and (17). Details of the result are presented in Table B2 in Appendix B under column heading Method V. For the 19 manufacturing industries, *BL* ranges from a maximum of 0.2046 (electrical and electronic industry) to a minimum of 0.0010 (leather and leather product industry).

Table 7. Key sectors, Method V

$OE_{xyj} > 1$ and $OE_{xyi} < 1$	$OE_{xyj} > 1$ and $OE_{xyi} > 1$
	Food processing
	Petrol and coal industries
	Machinery manufacture
	Electrical & electronic products
	Chemical & chem product manufacture
$OE_{xyj} < 1$ and $OE_{xyi} < 1$	$OE_{xyj} < 1$ and $OE_{xyi} < 1$
Beverage and tobacco	
Textiles, Fabrics and apparel	
Leather and foot wear	
Sawmill and wood products	
Manufacture of furniture	
Paper, board, and printed products	
Chemicals and chemical products	
Rubber industries and products	
Manufacture plastic products	
Non-metal ore manufactures	
Iron and steel industries, and non-ferrous manufacture	
Metal and metal fabrication industries	
Transportation equipments manufacture	
Measurement and scientific equipments manufacture	
Other manufacturing	

FL ranges from a maximum of 0.1774 (electrical and electronic industry) to a minimum of 0.0008 (leather and leather product industry). *BF* and *FL* averaged 0.0312 and 0.0278 respectively. Under this scheme, we defined key industries as those industries with *BF* and *FL* greater than 0.0278[5]. Under this scheme we found that the 19 manufacturing industries are distributed s follows.

[5] We took the lower of the two means as demarcation for key sector so as to exclude the possibility inadvertent exclusion of potential sector. This demarcation is still arbitrary because other cut-off measure would work as well and would result in larger or smaller list of key sector.

a) Weak *BL* and weak *FL*: 73.7% (14 of 19).
b) Weak *BL* and strong *FL*: 0%; (0 of 19).
c) Strong *BL* and weak *FL*: 5.3%; (0 of 19).
d) Strong *BL* and strong *FL*: 21.1%. (5 of 19).

Outcome of this scheme is exactly the same as those obtained using Method III. Under the same investment scenario, total additional output generated is MYR2.70 billion.

Finally, we estimated the outcomes on employment using equation no (13) and the weights are presented on Table C1 (column 5) in Appendix C. Here we used Malaysian 2005 labor force data (DOS 2006: 232) and based on our findings and rankings the top key weighted sectors are as follows:

1. Electric and electrical products (row 18 in Table C1).
2. Machinery manufacture (row 17 in Table C1).
3. Food processing (row 3 in Table C1).
4. Petrol and coal industries (row 11 in Table C1).
5. Chemicals and chemical products (row 10 in Table C1).

The key sector identification was prepared with a high degree of the frequency of their occurrences in five sub-methods to determine the key sectors. As our knowledge goes, so far this is the first time that key sectors' identification was done based on frequency of occurrences by simultaneously using five different methods in any economy, particularly in Malaysia. Summary of findings based on frequency of occurrence are as follows:

1. Food processing: Methods I, II, III, IV, and V.
2. Chemical and chemical product manufacture: Methods I, II, IV, and V.
3. Petroleum and petrochemical industries: Methods I, II, III, and V.
4. Machinery manufacture: Methods III, IV, and V.
5. Electrical and electronic products: Methods III, IV, and V.
6. Paper, printing and publishing: Method I and II.
7. Non-metal manufacture: Method I and II.

By our alternative approach, we identified key industries in Malaysia taking those sectors that had appeared in at least three methods, which are food processing, machinery manufacture, electrical and electronic products, chemical and chemical product manufacture, and petroleum and petrochemical industries. In this way, while not all method results in the same key manufacturing industries, it at least allows us to identify the important sectors that are key industry to the economy. On the other hand, by taking key weighted scheme on employment, we found that the key manufacturing industries in Malaysia are electrical and electrical products; machinery manufacture; food processing; petrol and coal industries; and chemicals and chemical products which are similar as in our proposed alternate approach.

Since all methods are the legitimate methods for key sectors' computation, hence we select key sectors based on the potential impact on output, value-added and finally on employment by using frequency of occurrence. In this study, we thus conclude that key manufacturing industries following on the impacts on output, value-added, employment

and with exports weights or alternatively foreign exchange earners in Malaysia, as identified and classified are (i) food processing, (ii) machinery manufacture, (iii) electrical and electronic products, (iv) chemical and chemical product manufacture, and (v) petroleum and petrochemical industries. These results differ from the Malaysian Third Industrial Master Plan (MMP 2009).

Conclusions

Since the 1950's, many key sectors' identification measures have been developed. While these measures are very similar, their outcomes on key sectors are quite different as an application for policy choice. Therefore, we proposed an alternative approach that resolves this issue. Our approach provided a potential outcome to take account of further initiatives and justified why one method is chosen over others for a right investment decision directed to key industries. We further applied this alternative approach to select key sectors in Malaysia as the public sector investment still remains a large share in the national economy. We utilized the magnitude of impacts on output, value-added, employment, export earning for the identification process and based on the outcomes the key industries identified are (i) food processing, (ii) machinery manufacture, (iii) electrical and electronic products, (iv) chemical and chemical product manufacture, and (v) petroleum and petrochemical industries. Hence, the classification of key sectors in this study is quite straight forward to find out a future guideline to minimize Malaysian previous policy gap and to set a possible way forward for future investment decision.

The major contribution of this study (a) the formation of an alternate approach to identify key sectors, (b) the explanation why Malaysia is distress to identify the correct key sectors in the concurrent policy goal. It is very reasonable that unless selecting the right industrial sectors for investment decision, sustain economic growth may turn down in the future. We notice from the Malaysian Second and Third Industrial Master Plan that some key sectors such as textile and textile products; paper, printing and publishing; petroleum and petrochemical; non-metal manufactures; rubber products and beverage and tobacco are experienced negative impacts on FDI and DDI. Our purpose for this study is to help finalizing correct key industries, especially for the Malaysian forthcoming Development Plan. We understand that Malaysian government may have different economic and political agendas to uphold economic growth by other ways, but the correct identification of key sectors is crucial so that both limited foreign and domestic investment are directed to key industry's to achieve maximum growth. We suggest that this study would offer a specific direction for the concern policy maker to implement a right future industrial strategy in Malaysia.

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APPENDIX A

Table A1. Sector classification

Line no.	Line number in original table	Sectors/industries
(1)	(1), (2), (3), (4), (5), (6), (7), (8)	Agriculture, forestry & fisheries
(2)	(9), (10), (11)	Mining & quarry
(3)	(12), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22)	Food processing
(4)	(23), (24), (25)	Bevearage and tobacco
(5)	(26), (27), (28), (29)	Textile & textile products
(6)	(30), (31)	Leather & leather products
(7)	(32), (33)	Wood & wood products
(8)	(34)	Furniture and fixtures
(9)	(35), (36)	Paper, printing & publishing
(10)	(37), (38), (39), (40), (41)	Chemical & chemical products
(11)	(42)	Petroleum and petrochemical
(12)	(43), (44)	Rubber products
(13)	(45)	Plastic products
(14)	(46), (47), (48), (49)	Non-metal manufactures
(15)	(50), (51)	Basic metal products
(16)	(52), (53), (54)	Fabricated metal manufactures
(17)	(55), (56)	Machine manufactures
(18)	(57), (58), (59)	Electrical & electronic products
(19)	(60), (61), (62), (63)	Transportation equipment
(20)	(64)	Measuring & scientific instruments
(21)	(65)	Other manufactures
(22)	(66), (67)	Utilities
(23)	(68)	Construction
(24)	(69)	Wholesale & retail trade
(25)	(70)	Hotel & rest.
(26)	(71), (72)	Transportation & communication
(27)	(73), (74), (75)	Finance & insurance
(28)	(76), (77)	Real estate & house ownership
(29)	(78), (79), (81), (83), (84), (85), (86), (87), (88), (89), (90)	Business & individuals service
(30)	(80), (82), (91), (92), (93), (94)	Government services

APPENDIX B

Table B1. Key sectors: Method I and Method II

		Method I		Method II			
Line	Sector	U_j	U_i	U_j	U_i	V_j	V_i
1	Agriculture, forestry & fisheries	0.935	1.304	0.935	1.304	4.130	3.161
2	Mining & quarry	0.719	1.052	0.719	1.052	5.004	3.551
3	Food processing	1.550	1.313	1.550	1.313	3.687	4.361
4	Beverage and tobacco	1.042	0.823	1.042	0.823	3.615	4.690
5	Textile & textile products	1.020	0.855	1.020	0.855	4.095	4.999
6	Leather & leather products	1.151	0.849	1.151	0.849	3.132	4.373
7	Wood & wood products	1.280	0.885	1.280	0.885	3.190	4.312
8	Furniture and fixtures	1.133	0.754	1.133	0.754	3.336	5.143
9	Paper, printing & publishing	1.039	1.274	1.039	1.274	4.089	3.373
10	Chemical & chemical products	1.144	1.110	1.144	1.110	3.619	3.786
11	Petroleum and petrochemical	1.049	1.180	1.049	1.180	3.827	3.273
12	Rubber products	1.140	0.920	1.140	0.920	3.737	4.701
13	Plastic products	0.929	0.853	0.929	0.853	3.971	4.402
14	Non-metal manufactures	1.097	1.308	1.097	1.308	3.807	3.517
15	Basic metal products	0.978	1.202	0.978	1.202	4.297	3.602
16	Fabricated metal manufactures	0.944	1.237	0.944	1.237	3.975	3.187
17	Machine manufactures	0.799	0.723	0.799	0.723	4.522	5.089
18	Electrical & electronic products	0.849	0.750	0.849	0.750	4.468	5.168
19	Transportation equipment	1.017	0.994	1.017	0.994	4.317	4.504
20	Measuring & scientific instruments	0.896	0.737	0.896	0.737	4.118	5.123
21	Other manufactures	1.028	0.990	1.028	0.990	3.585	3.769
22	Utilities	0.916	1.465	0.916	1.465	4.089	2.567
23	Construction	1.073	0.743	1.073	0.743	3.312	4.892
24	Wholesale & retail trade	0.801	1.308	0.801	1.308	4.456	2.806
25	Hotel & rest.	1.156	0.998	1.156	0.998	3.188	3.677
26	Transportation & communication	0.966	1.006	0.966	1.006	4.064	3.969
27	Finance & insurance	0.811	0.761	0.811	0.761	4.565	4.967
28	Real estate & house ownership	0.775	0.936	0.775	0.936	4.920	4.133
29	Business & individuals services	0.902	0.983	0.902	0.983	4.137	3.859
30	Government services	0.863	0.687	0.863	0.687	4.134	5.330

Table B2. Key sectors: Method III, Method IV and Method V

		Method III		Method IV		Method V	
Line	Sector	U_j	U_i	U_j	U_i	U_j	U_i
1	Agriculture, forestry & fisheries	0.916	1.406	0.716	1.007	0.03136	0.04291
2	Mining & quarry	1.079	1.777	1.404	2.418	0.03776	0.05422
3	Food processing	1.595	1.589	1.464	1.558	0.05831	0.04847
4	Beverage and tobacco	0.449	0.148	0.405	0.091	0.00581	0.00450
5	Textile & textile products	0.709	0.614	0.702	0.615	0.02277	0.01875
6	Leather & leather products	0.432	0.025	0.431	0.030	0.00104	0.00075
7	Wood & wood products	0.905	0.451	0.942	0.673	0.02030	0.01378
8	Furniture and fixtures	0.587	0.253	0.672	0.379	0.01182	0.00772
9	Paper, printing & publishing	0.435	0.334	0.332	0.184	0.00846	0.01019
10	Chemical & chemical products	0.941	0.911	1.185	1.401	0.02917	0.02780
11	Petroleum and petrochemical	1.129	1.174	1.116	0.898	0.03245	0.03584
12	Rubber products	0.643	0.392	0.693	0.537	0.01511	0.01197
13	Plastic products	0.547	0.444	0.568	0.497	0.01503	0.01356
14	Non-metal manufactures	0.470	0.222	0.514	0.301	0.00580	0.00679
15	Basic metal products	0.525	0.485	0.687	0.729	0.01227	0.01481
16	Fabricated metal manufactures	0.326	0.222	0.363	0.279	0.00526	0.00677
17	Machine manufactures	2.880	3.274	4.193	4.963	0.11244	0.09992
18	Electrical & electronic products	4.905	5.814	7.208	8.855	0.20460	0.17743
19	Transportation equipment	0.711	0.654	0.440	0.234	0.02079	0.01997
20	Measuring & scientific instruments	0.458	0.188	0.588	0.273	0.00709	0.00573
21	Other manufactures	0.616	0.144	0.786	0.175	0.00463	0.00438
22	Utilities	0.452	0.341	0.331	0.028	0.00662	0.01039
23	Construction	1.703	1.685	0.553	0.128	0.07567	0.05143
24	Wholesale & retail trade	0.607	1.035	0.544	1.045	0.01970	0.03159
25	Hotel & rest.	0.972	0.799	0.457	0.010	0.02875	0.02437
26	Transportation & communication	1.574	1.908	1.489	1.770	0.05700	0.05823
27	Finance & insurance	0.497	0.440	0.264	0.190	0.01459	0.01343
28	Real estate & house ownership	0.639	0.838	0.062	0.001	0.02157	0.02558
29	Business & individuals services	0.932	1.081	0.672	0.702	0.03085	0.03300
30	Government services	1.364	1.349	0.218	0.029	0.05266	0.04117

APPENDIX C

Table C1. Key sector weights

Line	Sector	Final demand Weights	Export Weights	Value-added weights	Employment weights
1	Agriculture, Forestry and Fisheries	0.0323	0.0227	0.0226	0.4377
2	Mining and quarrying	0.0506	0.0676	0.0354	0.0183
3	Food processing	0.0362	0.0349	0.0253	0.7201
4	Beverage and tobacco	0.0054	0.0033	0.0038	0.1074
5	Textiles, Fabrics and Apparel	0.0215	0.0211	0.0151	0.4277
6	Leather and footwear	0.0009	0.0010	0.0006	0.0179
7	Sawmill and wood products	0.0153	0.0224	0.0107	0.3044
8	Manufacture of furniture	0.0100	0.0148	0.0070	0.1989
9	Paper, board, and printed products	0.0078	0.0042	0.0055	0.1552
10	Chemicals and chemical products	0.0246	0.0371	0.0172	0.4894
11	Petrol & coal industries	0.0298	0.0224	0.0209	0.5928
12	Rubber industries and products	0.0128	0.0171	0.0090	0.2546
13	Manufacture plastic products	0.0156	0.0171	0.0109	0.3103
14	Non-metal ore manufactures	0.0051	0.0068	0.0036	0.1015
15	Iron & steel industries, and non-ferrous manufacture	0.0121	0.0178	0.0085	0.2407
16	Metal and metal fabrication industries	0.0054	0.0066	0.0038	0.1074
17	Machinery manufacture	0.1356	0.2018	0.0949	2.6975
18	Electric and electrical products	0.2322	0.3474	0.1625	4.6192
19	Transportation equipments manufacture	0.0197	0.0069	0.0138	0.3919
20	Measurement and scientific equipments manufacture	0.0076	0.0109	0.0053	0.1512
21	Other manufacturing	0.0043	0.0052	0.0030	0.0855
22	Electricity & gas, and waterworks	0.0070	0.0006	0.0049	0.0040
23	Building and construction	0.0679	0.0051	0.0475	0.3117
24	Wholesale & retail trade	0.0237	0.0235	0.0166	0.3840
25	Hotels & restaurants	0.0240	0.0003	0.0168	0.1612
26	Transport & communication	0.0568	0.0518	0.0398	0.3094
27	Finance and insurance	0.0173	0.0073	0.0121	0.0427
28	Real estate & ownership dwellings	0.0268	0.0000	0.0188	0.1313
29	Business and private services	0.0329	0.0210	0.0230	0.1612
30	Government services	0.0588	0.0012	0.0412	0.4284

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