MAVCOM

TECHNICAL PAPER

AVIATION SECTOR MULTIPLIER | AUGUST 2017

This Technical Paper is a companion to the inaugural WAYPOINT report and outlines the Malaysian Aviation Commission's position with regards to the multiplier for the Malaysian aviation sector.

INTRODUCTION

In the past decade, the Malaysian aviation sector has been cited to have a multiplier of 12 – 12.5 times[1]. This is far higher than multiplier estimates that have been cited by other organisations and governments.

For instance, the latest estimates published by the International Civil Aviation Organization (ICAO) places the output and job multiplier for the global aviation sector both to be 2.7 times in 2005 (ICAO, 2005). This means that in 2005, every USD1 of output produced in the global aviation sector resulted in USD2.70 of total global output produced, while 1 job employed by the sector resulted in 2.7 people employed in the global economy. On the other hand, the latest output and jobs multiplier available for the US aviation sector stood at 5.69 and 7.69, respectively, in 2000 (also the most recent year for which such data are available)[2].

Meanwhile, we have estimated that the output multiplier for the Malaysian aviation sector[3] stood at 2.0 times, using the most recent Input-Output (I-O) Tables for Malaysia (2010, although the Tables were released in 2014).

These variations indicate several issues related to the multiplier. Firstly, there is no single definition of a 'multiplier effect'. For example, a claim that the "Malaysian aviation sector has a multiplier of 12 times" does not indicate whether it is a multiplier of output, sales revenue, spending, or employment. It also does not indicate if the impact is on Gross Domestic Product (GDP) or output—which are technically different, as we demonstrate in this paper—or employment. Third, estimations of even the same types of multiplier can vary depending on geographical coverage (global vs. the US vs. Malaysia). These shortcomings must be borne in mind when estimating or interpreting multiplier effects, particularly if they are part of an analysis of the economic impact of proposals requiring government support.

This paper, which discusses our position with regards to estimates and interpretation of the multiplier for the Malaysian aviation sector, is organised into the following sections:

- Estimating the air transport output multiplier for Malaysia
- The multiplier: Approach with caution
- MAVCOM's position on estimates and interpretations of the Malaysian aviation multiplier

[1] See e.g. Oxford Business Group (2008), The Star (2010), and The New Straits Times (2016).
[2] The estimates for the global and US aviation sector multipliers cited by ICAO do not include direct effects. For consistency with the methodology employed in this paper and elsewhere, we have included direct effects when citing these figures.
[3] This includes passenger and freight air transport, the operation of airports, and provision of cargo-handling services.

ABBREVIATIONS

Abbreviations	
ACI	Airports Council International
ATAG	Air Transport Action Group
DOS	Department of Statistics, Malaysia
E&E	Electrical and electronics
EU	European Union
GDP	Gross Domestic Product
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMPLAN	Impact Analysis for Planning model
I-O	Input-Output
IT	Information Technology
MAVCOM	Malaysian Aviation Commission
MSIC	Malaysian Standard Industrial Classification
OECD	Organization for Economic Co-operation and Development
RIMS II	Regional I-O Modelling System II
RM	Ringgit Malaysia
US	United States of America
USD	United States Dollars

GLOSSARY OF TERMS

Aggregate Demand
The total demand for goods and services in an economy at a given time

GDP
GDP is the sum of value added by all resident produces plus any product taxes (less subsidies) not included in the valuation of output.

Multiplier
A multiplier is the total effects (direct, indirect and/or induced) divided by the direct effects of tourism. This concept is based on the recirculation of income: recipients use some of their income for consumption spending, which then results in further income and employment.

Net Value-Added
The value of output less the values of both intermediate consumption and consumption of fixed capital.

Opportunity Cost
The opportunity cost of a resource is the value of the best alternative use of that resource.

Production Function
The relationship between the quantities of inputs used and the maximum quantity of output that can be produced, given current knowledge about technology and organization.

CONTENTS

ESTIMATING THE AIR TRANSPORT OUTPUT MULTIPLIER FOR MALAYSIA

MAVCOM employed the 2010 Malaysia I-O Tables to estimate the output multiplier[4] for the Malaysian aviation sector (see Box 1). An I-O table depicts the interlinkages between various sectors and factors (of both production and consumption) in an economy. This table of transactions includes matrices for the use of factors of production by industries, the market flow of products between industries, and sales from industries to households and other final users. Examples of such models include the US' IMPLAN model and Malaysia's I-O tables, the latest version of which was released in 2014, using 2010 data. The US also produces the RIMS II, which is a method of estimating regional I-O multipliers.

Box 1: Aviation in the 2010 I-O Tables

DOS releases the country's I-O Tables every five years, with the latest release, based on 2010 data, published in 2014. The previous I-O Tables were based on 2005 data while the next release will be based on 2015 data. The I-O Tables present the interlinkages between different sectors of the Malaysian economy, as part of either inputs, outputs, or sources of final demand. The assumption for the five-yearly intervals is that the structure of the Malaysian economy will be consistent over the period between the release of each set of I-O Tables, so that the 2010 Tables can be used to interpret the structure of the Malaysian economy from 2010 to 2014.

Other jurisdictions, such as the US and the EU, also undertake official five-yearly estimates of their I-O tables using primary collection of data, but will make annual statistical adjustments to reflect potential changes in the structure of their economies.

The 2010 Malaysia I-O Tables consist of three matrices:

1. **Table A: Absorption Matrix of Domestic Production at Basic Prices, 2010, 124 Commodities × 124 Activities (RM '000):**
   A matrix of 124 commodities (in RM terms) that are required to produce output for 124 economic activities.
2. **Table B: Absorption Matrix of Domestic Production at Basic Prices, 2010, 124 Commodities × 124 Commodities (RM '000):**
   A matrix of 124 commodities (in RM terms) that are required to produce 124 commodity outputs.
3. **Table C: Absorption Matrix of Domestic Production at Basic Prices, 2010, 124 Activities × 124 Commodities (RM '000):**
   A matrix of 124 activities (in RM terms) that are required to produce outputs for 124 economic activities.

The definition of these commodities and activities are based on the MSIC 2008 ver1.0. According to this classification, for instance, the definition of 'Air Transport" as both a commodity and activity in the Malaysian 2010 I-O Table includes:

[4] See the Appendix for a discussion on multipliers.

- Passenger air transport: Transport of passengers over regular routes and on regular schedules, non-scheduled transport of passengers by air, renting of air-transport equipment with operators for the purpose of air transportation (leasing).
- Freight air transport: Transport freight by air over regular routes and on regular schedules, non-scheduled transport of freight by air, and renting of air-transport equipment with operators for the purpose of freight transportation.

Although the published version of the 2010 I-O Tables does not include the aviation sector as a commodity or activity by itself, MAVCOM has estimated the contribution of operation of terminals (airports) as well as other air-transport related services such as ground-handling, air traffic control, and fire-fighting and fire-prevention services at airports, based on data provided by DOS. Hence, the definition of Aviation Sector for the I-O Tables estimated by MAVCOM includes the sub-sectors listed above.

Table 1: A Truncated Version of Table C

Absorption Matrix of Domestic Production at Basic Prices, 2010 124 Activity × 124 Activity (RM'000)	⋮	Aviation Sector	Maritime Transport Sector	Land Transport Sector	⋮
…	…	…	…	…	…
Aviation Sector	…	884,430	583,126	894,794	…
Maritime Sector[1]	…	174,265	1,381,001	239,347	…
Land Transport Sector[2]	…	5,071	23,303	796,890	…
…	…	…	…	…	…
Total Output	**…**	**21,450,593**	**16,587,832**	**28,163,258**	**…**

Source: MAVCOM estimates & DOS, 2014

Note:
1. Water transport and the operation of ports
2. Land transport and highway, bridge, and tunnel operation services

Table C can be interpreted as follows: Producing RM21.5 bn of output in the aviation sector requires, among others, RM884.4 m of input from the sector itself, in addition to RM 174.3 m from the maritime transport sector, and RM5.1 m of input from the land transport sector, among others.

Calculations for the multiplier based on the 2010 Malaysia I-O Table entailed the following steps:

1. Calculating the Activity × Activity Direct Requirements Matrix for the aviation sector. The direct requirements matrix indicates the amount of additional output required from the sector itself, as well as other sectors in the economy which contribute inputs to it, in order to produce an additional RM1 of output. The Direct Requirements Matrix, focusing on the air transport sector is illustrated in Table 2:

Table 2: Direct Requirements Matrix

Direct Requirements Matrix of Domestic Production at Basic Prices, 2010 124 Activity × 124 Activity (RM'000)	⋮	Aviation Sector	Maritime Transport Sector	Land Transport Sector
…	…	…	…	…
Aviation Sector	…	0.041	0.035	0.032
Maritime Sector[1]	…	0.008	0.083	0.008
Land Transport Sector[2]	…	0.000	0.001	0.028
…	…	…	…	…
Total Output	**…**	**1.000**	**1.000**	**1.000**

Source: MAVCOM calculations & DOS, 2014

Note:
1. Water transport and the operation of ports
2. Land transport and highway, bridge, and tunnel operation services

Table 2 indicates that producing an additional RM1 of output in the aviation sector requires an additional RM0.041 of input from the sector itself, in addition to an extra RM0.008 from the maritime and land transport sectors, in addition to others.

2. Calculating the 'Leontief inverse' matrix, that is, a matrix of interdependence coefficients. The formula for this is defined as $(I - A)^{-1}$, where I is an identity matrix and A is the direct requirements matrix. The summation of the Leontief inverse for each column in Table 1 then gives the output multiplier for the relevant sector.

Utilising the methodology above, we estimate that the aviation sector multiplier stood at 2.0 times. This means that every RM1 of output produced in the sector results in RM2.00 of output produced in the economy. As stated in Box 1, this should apply to the Malaysian aviation sector between 2010 and 2014. More up-to-date estimations will have to be based on the 2015 Malaysia I-O Tables, scheduled to be released in 2019. This set of I-O Tables should represent the Malaysian economy between 2015 and 2019.

By comparison, the output multipliers for the maritime and land transport sectors stood at 2.0 and 1.8 times, respectively. In general, the aviation sector generates the 28th largest output multiplier effect, with the oils and fats sector producing the highest output multiplier, at 2.6 times (see Table 3). The relatively high multiplier effects for the resources-based sectors are expected given their high proportion of local inputs to imported inputs. By comparison, although the E&E manufacturing sector contributes more than 20% of GDP, their output multipliers are lower than those for the aviation sector, given their high import content. (For a full list of output multipliers, please see Appendix 2).

Table 3: Output Multipliers for Selected Sectors, 2010

Rank	Sector	Output multiplier
1	Oils and Fats	2.6
2	Rubber Products	2.6
3	Wooden and Cane Containers	2.6
4	Preservation of Seafood	2.5
5	Rubber Gloves	2.5
6	Veneer Sheets, Plywood, Laminated & Particle Board	2.5
7	Builders' Carpentry and Joinery	2.5
8	Sawmilling and Planning of Wood	2.4
9	Rubber Processing	2.3
10	Financial Institution	2.3
11	Concrete & Other Non-Metallic Mineral Products	2.2
12	Meat and Meat Production	2.2
13	Other Wood Products	2.2
14	Building & Repairing of Ships & Boats, Manufacture of Bicycles & Invalid Carriages	2.2
15	Other Transport Services	2.1
16	Repair & Maintenance	2.1
17	Forestry and Logging	2.1
18	Telecommunications	2.1
19	Paper and Paper Products and Furniture	2.1
20	Maritime Transport	2.0
21	Residential	2.0
22	Tyres	2.0
23	Restaurants	2.0
24	Cement, Lime and Plaster	2.0
25	Dairy Production	2.0
26	Non Residential	2.0
27	Other Chemicals Product	2.0
28	Aviation	2.0
29	Civil Engineering	2.0
30	Basic Chemicals	2.0

Source: MAVCOM calculations & DOS, 2014

How to Get the Multiplier Wrong? An Example

ATAG[5] publishes the Aviation Benefits Beyond Borders report annually. The report presents global, regional, and national analyses of the impact of aviation on national income and employment. Table 4 provides a sample of country-level and regional-level GDP impacts published in the report for selected countries in the Asian region, using 2014 figures.

Table 4: Impact of Aviation Sector in Selected Countries, 2014

	Direct (A)	Indirect (B)	Induced (C)	Tourism (D)	Total (A+B+C+D)
GDP for countries (USD million)					
Malaysia	1,975	2,594	369	6,301	11,239
Thailand	4,345	4,098	912	38,972	48,327
Indonesia	4,307	4,016	1,030	14,371	23,724
Singapore	11,884	6,208	2,013	14,823	34,928
Australia	13,771	12,941	7,475	30,219	64,405
United Kingdom	30,945	32,400	22,723	47,584	133,652
United Arab Emirates	9,461	7,453	4,183	25,732	46,829
GDP for regions (USD billion)					
Asia Pacific	133.3	158.2	72.9	261.8	626
Middle East	36.8	41.5	19.2	59.7	157.2
Europe	192.8	233.4	105.2	328.1	707.5

Source: ATAG Aviation Benefits Beyond Borders, July 2016

The report defines the direct, indirect, induced and tourism impacts of aviation as follows:

- **Direct:** The operational spending airlines, airports, civil aircraft manufacturers, airport operators, air navigation service providers, and firms that serve tourists undertake to generate profits and employ people at their operational sites.
- **Indirect:** The aviation sector's procurement of inputs of goods and services from other businesses in the economy. This spending supports additional jobs and GDP contributions along the sector's supply chains.
- **Induced:** Wage payments to staff, assumed to be subsequently spent in the consumer economy, which supports further economic activity and jobs in retail and leisure outlets and their supply chains.

Indirect and induced impacts are estimated at the country level using multipliers that Oxford Economics (which ATAG had commissioned to estimate the impact) calculated from 51 I-O tables sourced from the OECD and official national statistical websites.

- **Tourism:** Oxford Economics' estimates of tourism impacts, which are based on IMF Balance of Payments data on tourist activities and expenditures, and equal to the amount of GDP supported by tourists who travel to their destinations by air.

[5] ATAG is a coalition of member organisations across the aviation sector value chain, such as airports, airlines, airframe and engine manufacturers, air navigation service providers, airline pilot and air traffic controller unions, chambers of commerce, tourism and trade partners, ground transportation, and communications providers. Members include IATA and ACI.

Although it would seem as if the multiplier effects for aviation could be estimated by dividing the total GDP impacts for each country and region in Table 4 by their direct impacts, such estimates would be inaccurate. This is due to the following factors:

- The operational spending of the aviation sector classified under direct spending is not segregated from the sector's procurement of inputs from other businesses in the economy. For instance, the procurement of IT services could be classified under both operational expenditure and indirect inputs. This could lead to double-counting the impact of such spending.
- The assumption that wages are fully spent leads to overestimation as it discounts the fact that savings are a leakage in the economy.
- It is also unclear whether the operational spending included in the direct and indirect impact has been adjusted for operating cost, depreciation and amortization, as well as, interest and financial charges. If they have not, this means that the figures provided are not nett value-add, but are instead, gross value-add, and therefore not equivalent to real GDP.
- The problem of overestimation is compounded if tourism effects are included as part of the total impact (i.e. the numerator) in the multiplier estimate. Typically, tourism expenditure does not desegregate imported factors of production used in producing tourism goods and services. Unless leakages via imports are accounted for, estimates of the impact of aviation on tourism, and therefore as a contribution to GDP, will be inflated.

Table 5 illustrates the potential aviation sector multipliers if we were to utilise the figures provided by the ATAG report. As these hypothetical figures indicate, the inclusion of tourism (which can also be defined as 'catalytic' impacts) can lead to multiplier figures that exceed more conventional multiplier estimates.

Table 5: Impact of Aviation Sector in Selected Countries, with Hypothetical Multipliers

	Direct (A)	Indirect (B)	Induced (C)	Tourism (D)	Total (A+B+C+D)	"Multiplier"[6] 1 = (A+B)/A	"Multiplier" 2 = (A+B+C)/A	"Multiplier" 3 (with tourism) = (A+B+C+D)/A
GDP for countries (USD million)								
Malaysia	1,975	2,594	369	6,301	11,239	2.31	2.50	5.69
Thailand	4,345	4,098	912	38,972	48,327	1.94	2.15	11.12
Indonesia	4,307	4,016	1,030	14,371	23,724	1.93	2.17	5.51
Singapore	11,884	6,208	2,013	14,823	34,928	1.52	1.69	2.94
Australia	13,771	12,941	7,475	30,219	64,405	1.94	2.48	4.68
UK	30,945	32,400	2,2723	47,584	133,652	2.05	2.78	4.32
UAE	9,461	7,453	4,183	25,732	46,829	1.79	2.23	4.95
GDP for regions (USD billion)								
Asia Pacific	133.3	158.2	72.9	261.8	626	2.19	2.73	4.70
Middle East	36.8	41.5	19.2	59.7	157.2	2.13	2.65	4.27
Europe	192.8	233.4	105.2	328.1	707.5	2.21	1.97	3.67

Source: MAVCOM estimates, ATAG Aviation Benefits Beyond Borders, July 2016

ESTIMATING MULTIPLIERS: APPROACH WITH CAUTION

There is an extensive literature on the possible abuses of economic multipliers, particularly when they are used to justify the use of government funds for certain projects, whether directly or via incentives.

Typically, such projects would not be deemed viable by purely financial measures, and economic multipliers are therefore employed as a proxy for external or social welfare benefits. These social benefits may include the development of the local economy because of catalytic effects due to tourism, increased employment in the region, and/or improved economic performance due to enhanced connectivity and ease of doing business. Hence, it is imperative that policymakers and regulators are aware of the limitations of the multiplier and their potential for abuse.

There have been papers that have documented the ways in which multipliers can be misused, both in the general case and in specific industry contexts. For general purposes, Bess and Ambargis (2011) present common mistakes when using multipliers generated from RIMS II models, such as ignoring offsetting effects and inappropriate averaging or summing of economic multipliers.

[6] While the term "multiplier" is used here, it does not indicates that these are the official aviation sector multiplier estimates for the countries and regions used in the example.

Zak and Getzner (2014) critically examine estimates of economic multipliers for a range of Central European airports and provide some explanations as to why these estimates may be problematic. For example, the authors found that all of the studies they have assessed present their findings in gross, rather than net terms. These papers do not account for the opportunity costs of building airports; neither do they consider other methods that can achieve similar improvements in connectivity such as rail or highways. Presenting these estimates as "net economic effects" is thus misleading.

I-O models are also ill-equipped to account for external benefits and costs to other industries. To take two examples, the role of airports in providing essential services to travelers to facilitate business and tourism, and the airport's impact on the environment and health, are not accounted for by standard I-O models (Wollersheim, 2011). The main reason for this flaw is that these external effects are not accounted for in I-O matrices such as the ones we used above, and are the main source for multiplier estimates.

The use of fixed production coefficients in such studies may also be tenuous. Whilst such an assumption may be realistic for small projects, large projects like airports can have effects on the underlying demand and production system, leading to changes in the production function itself.

Recall that multiplier estimates are generated from I-O tables. If the I-O tables no longer accurately represent the underlying structure of the economy, the estimates of the multiplier will be compromised as well (Niemeier, 2001).

The treatment of direct, indirect, induced, and catalytic effects of the aviation sector should also be assessed critically, rather than taken at face value. Estimates of the multiplier can vary depending on how these various effects are categorised, and different studies may use different ways to categorise these effects. For example, ATAG's categorisation referred to earlier in this paper may not be shared by other studies and assessments, and thus can lead to different estimates of the multiplier, even if similar data is used.

In addition to the reasons outlined above, there are other factors that mean that estimates of economic multipliers may not be accurate, or be directly compared across different studies. For example, the choice of geographical units and the availability of sub-national level data can affect multiplier estimates for airports (Hakfoort et al, 2001). As we mentioned earlier, regions within the same country can differ in their economic structures, and thus a national proxy may not be an accurate representation of these regional differences.

Other papers have also explored the misuse of the multiplier in the port industry (Hall, 2004), education (McHenry, Sanderson and Siegfried, 2006) and tourism (Crompton, 2006) among others.

Governmental and regulatory agencies themselves are also aware of the potential misuse of economic multipliers to promote certain projects or developments. For example, the Treasury Department of New South Wales, Australia, notes that

> *"I-O analysis, however, will always indicate positive impacts—activity—without providing guidance as to whether such impacts correspond with net benefits. Poor investments, perhaps in heavily subsidised fields of endeavour, could be associated with greater levels of activity than good investments". (Gretton, 2013)*

The Auditor-General of the Victorian government (2007) similarly notes that

> *"By effectively not accounting for crowding out effects and price changes, IO analysis can exaggerate the benefits of projects to an economy."*

Other authorities have either produced guidance on the appropriate usage of economic multipliers, or internal research notes that discuss the importance of ensuring that proposed impact analyses survive scrutiny. Some authorities have gone as far as providing in-house tools that can be used to cross-check analyses from external sources (Horne, 2008; Chervin and Kyle, 2009).

CONCLUSION

Based on the 2010 Malaysia I-O Tables, the output multiplier for the Malaysian aviation sector is 2.0 times, which means that every RM1 of output produced by the aviation sector leads to RM2 of output produced for the Malaysian economy.

Notwithstanding the shortcomings in I-O based estimations highlighted in the previous section, MAVCOM is of the view that the officially-released Malaysia I-O Tables provide the most accurate representation of Malaysia's economic structure at the national level, compared to other methodologies. Robust estimates of aviation sector multipliers for Malaysia therefore, should be based on the I-O approach. Such estimations however, should bear in mind the geographical area of coverage, as well as the time period referred.

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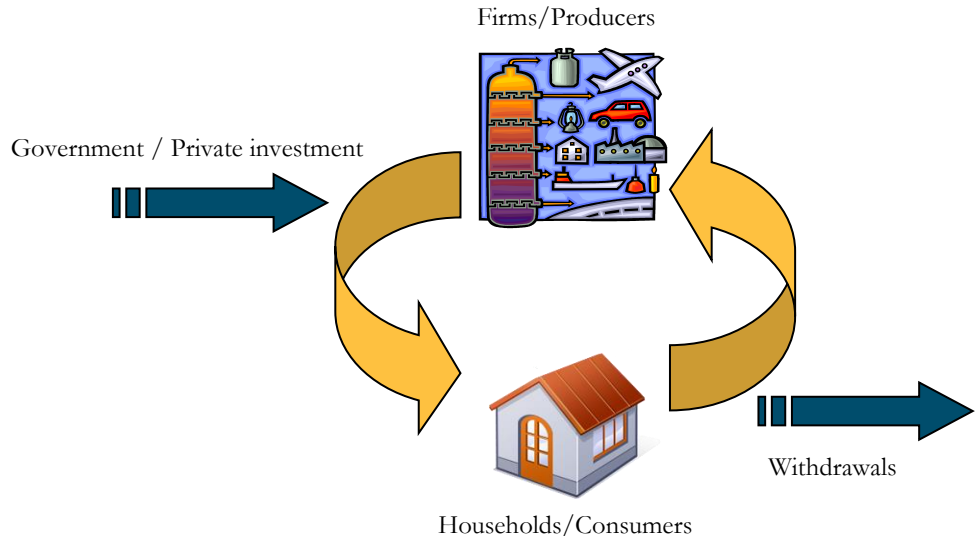
APPENDIX 1

What Is the Multiplier?

The Keynesian Multiplier

The origin of the multiplier concept can be traced back to economist John Maynard Keynes (1936) and his advocacy for using fiscal policy as a tool for macroeconomic stabilisation. The Keynesian multiplier, also known as the fiscal multiplier, denotes the total change in national income that results from an initial injection of aggregate demand via government spending, such as the building of an airport. The central idea underlying the Keynesian multiplier is the circular flow of income (see Figure A1a).

Figure A1a: The Circular Flow of Income



Source: MAVCOM

Referring to Figure A1a, when a new airport is built, all things remaining equal, the budgeted sum would go to construction companies, which would hire more workers to complete the project. The initial government investment would be distributed as wages (to workers) and profit (to shareholders of the construction firms). The households of these workers and shareholders will then spend their income on goods and services, generating more economic activity. Hence, the initial government investment is "multiplied".

The Keynesian multiplier in this case can therefore be defined as:

$$\frac{Change\ in\ GDP(\$)}{Change\ in\ Goverment\ Spending(\$)}$$

In other words, the Keynesian multiplier denotes the total change in GDP in response to RM1 change in government spending. If, within the year, the change in GDP due to a RM10bn government investment is RM30bn, the multiplier effect of the former is three times.

Ratio-approach Multipliers

However, due to difficulties in isolating the linkages between spending by particular households and the initial investment when estimating induced effects, 'ratio approach' multipliers are utilised when estimating multipliers to calculate the total economic impact of particular investments, whether private or public. These multipliers can be expressed in terms of direct, indirect, and induced effects of an economic variable over revenue, or sales:

$$\frac{Direct\ X + Indirect\ X + Induced\ X}{Direct\ Sales\ (\$)}$$

Where X is the economic variable of interest. We define the direct, indirect and induced effects as follows (PricewaterhouseCoopers, 2014):

The **direct effect** is defined as the value added by activities directly related to the project or development (the operation of the airport in the context of aviation). For example, direct employment can include airline staff and handling agents, airport catering and retail staff, airport management, and maintenance among others (Optimal Economics, 2011). Direct spending can thus be any expenditure relating to these activities.

Indirect effects or economic impacts are generated by activities in the upstream of the project or activity in question. In the context of aviation, upstream activities refer to activities by businesses providing goods and services to the airport. For example, this can include increased sales of raw ingredients to restaurants in airports and any associated employment related to this transaction. Another example may include the provision of cargo transport via lorries to and from the airport.

Induced effects are the result of increased spending of those directly or indirectly employed by the project or industry in question. In the aviation context, induced effects could be the result of the spending of airport and airline staff on the wider economy.

There are also **catalytic effects** that certain projects or sectors can have on the local economy. These are not typically included in multipliers due to the difficulties in estimating them. For the aviation sector, catalytic effects can include:

a. The impact of airports in developing local tourism
b. The impact of airports in facilitating business
c. The potential for local clusters such as aerotropolises (airport cities).

The definition of the multiplier as the summation of direct, indirect and induced effects over directly-generated sales also means that the multiplier can be expressed in terms of output, income, or employment:

Output multiplier

$$\frac{Direct\ Output(\$) + Indirect\ Output(\$) + Induced\ Output(\$)}{Direct\ Revenue(\$)}$$

The output multiplier thus translates changes in initial direct output to changes in total output for the wider economy, that is how much output (in currency terms) is generated for an amount of money spent directly within the project or sector.

Income multiplier

$$\frac{Direct\ Income(\$) + Indirect\ Income(\$) + Induced\ Income(\$)}{Direct\ Revenue(\$)}$$

The income multiplier thus translates changes in initial output to changes in income, that is how much income is generated for an amount of money spent.

Employment multiplier

$$\frac{Direct\ Employment\ (pax) + Indirect\ Employment(pax) + Induced\ Employment(pax)}{Direct\ Revenue(\$)}$$

This formulation translates changes in initial output to changes in employment, that is how many additional jobs are generated for an amount of money spent. An alternative formulation for the employment multiplier can be presented as follows:

$$\frac{Direct\ Employment(pax) + Indirect\ Employment(pax) + Induced\ Employment(pax)}{Direct\ Employment\ (pax)}$$

This formulation is useful for translating changes in initial employment to changes in total employment, in terms of how many additional jobs are generated in the wider economy for one job generated in the industry or project under assessment.

Issues with Multiplier Estimates and Interpretations

In reality, multiplier estimations—especially when utilised to estimate the potential impact of government (or private) investment on GDP—are not as straightforward, and are open to overestimations and misinterpretations. This is due to several factors:

1. Confusion regarding the different measurements of GDP

GDP is typically measured in three distinct ways as seen in Table A1a below:

Table A1a: Measurements of GDP

Type of GDP	Components
GDP by expenditure	Private and public consumption + private and public investment + exports – imports
GDP by industry (net value-added)	Summation of net value-added of economic sectors (e.g. agriculture, manufacturing, services, construction and mining)
GDP by income	Compensation of employees + operating surplus (profits, rents, interest) + mixed income + taxes - subsidies on production

For example, if the building blocks of a GDP multiplier for new shops in an airport includes a combination of both the total amount of construction spending for building the shops (an investment included in the estimation of GDP by expenditure) in addition to the wages paid to the construction employees (included in the measurement of GDP by income), this is double-counting the impact of building the shops, and the multiplier calculated from such figures would be an overestimation.

We demonstrate this using GDP figures published by DOS, calculated based on the three approaches. Note that the three approaches lead to the same final figure for GDP. Hence, attempting to sum items across different approaches will not produce accurate estimates of GDP (see Tables A1b, A1c, and A1d).

Table A1b: GDP by Industry, 2015, Malaysia

GDP by Industry 2015 (RM billion, current prices)		
Agriculture		97.8
Mining and Quarrying		103.7
Manufacturing		263.7
Construction		54.1
Services	Utilities	31.2
	Wholesale and Retail Trade, Food & Beverage and Accommodation	216.7
	Transportation and Storage	101.9
	Information and Communication Finance, Insurance, Real Estate and Business Services	125.7
	Other Services	50.1
	Government Services	97.3
Plus Import Duties		14.7
Total		**1,157.1**

Source: DOS, 2016

Table A1c: GDP by Income, 2015, Malaysia

GDP by Income 2015 (RM billion, Current Prices)	
Gross Operating Surplus	700.0
Compensation of Employees	402.7
Taxes less Subsidies on Production and Imports	54.4
Total	**1,157.1**

Source: DOS, 2016

Table A1d: GDP by Expenditure, 2015, Malaysia

GDP by Expenditure 2015 (RM billion, Current Prices)		
Final Consumption Expenditure	Government	152.0
	Private	626.2
Changes in Inventories and valuables		-12.6
Gross Fixed Capital Formation		302.9
Exports of Goods and Services		820.5
(less) Imports of Goods and Services		731.9
Total		**1,157.1**

Source: DOS, 2016

2. Confusion between real GDP (net value-added), output, and sales revenue.

Referring to the different definitions of ratio multipliers, some I-O multiplier calculations may ignore the distinction between real GDP—which is defined as the total amount of value-added of goods and services in an economy (net of transfers)—output, and sales revenue. These distinctions can be illustrated by examining the definitions of the three concepts developed by the United Nations (United Nations, 2000).

a. Output

$$\begin{aligned} Output &= Sales\ Revenue - Cost\ of\ Intermediate\ Inputs \\ &= Sales\ Revenue \\ &\quad - (Operating\ Cost - Depreciation\ and\ Amortisation - Staff\ Cost) \\ &= EBITDA + Staff\ Cost \\ &= Gross\ Value\ Added\ (\text{GVA}) \end{aligned}$$

b. Real GDP

$$\begin{aligned} Real\ GDP &= \Sigma Net\ Value\ added\ of\ Sectors\ or\ Industries \\ &= GVA - interest\ and\ financial\ charges \\ &= Profit\ before\ tax + Depreciation\ and\ Amortisation + Staff\ Cost \end{aligned}$$

By extension then, a multiplier derived from sales revenue figures without adjusting for costs cannot be interpreted as a GDP multiplier, as it would be an overestimation.

For instance, if, while estimating the indirect effect of airport retail outlets as part of estimating the output multiplier of an airport, we were to take the sales revenue of the shops without adjusting for their operating cost or interest and financial charges, we would be using an inflated figure for output. An estimate derived from such a method then, cannot be interpreted as a GDP, or even an output, multiplier.

3. Overestimating induced effects

Multiplier estimates may inflate the value of induced effects, particularly if they include consumption spending by households. For instance, a multiplier analysis of the impact of the aviation sector in Malaysia, such as increased investment in aircraft, may include not only the increase consumption spending by aviation sector employees (pilots, ground-crew) manning the additional aircraft and flights (provided their wages also rise), but also the wages and consumption of the employees of the suppliers of products and services they consume (e.g., consumption by the waiters of restaurants these employees frequent) in addition to the consumption and wage increases experienced by employees in backward-linked sectors, such as employees of the catering company serving the additional flights. This may lead to an 'explosion' of the multiplier effect, leading in some cases, to double-digit projections.

4. Using inappropriate proxies when estimating multiplier effects for different geographical units (world vs. regions vs. countries vs. states)

In some cases, particularly in economies where statistical data collection methods are still developing, 'official' sector-specific multipliers may not be available. In these cases, the multiplier being estimated may be derived using proxies from other, more detailed economic models. This may result in a misrepresentation of the multiplier, as the structure of the economy being used as proxy may differ significantly from that of the economy being assessed.

This is evident by the differences between the aviation sector output multiplier figures for the US and the world. The same is true when utilising national-level multipliers for sub-national economies, such as regions or states. This is due to the fact that the linkages between sectors, markets, and household demand may differ significantly from region to region, and between a region and the Malaysian figures. For instance, estimating the multiplier effect of an airport built in Sarawak on the state's economy by using the Malaysian aviation sector multiplier as a proxy needs to take into account the fact that the production flows between sectors in Sarawak may not be reflected at the national level, and may lead to an overestimation of the overall impact. As a general rule, multipliers estimated for the country as a whole will always be larger than those estimated for any one region of that country.

5. Ignoring effects of leakages/withdrawals from the economy

When estimating the total impact of an initial investment or project in an economy—including the indirect and induced effects included in the multiplier—care must be taken to include only the effects accrued to the local economy. For example, when estimating the impact of an investment in the tourism sector, a common error would be obtaining the total sales effects by multiplying the sales multiplier by the total tourism spending (spending by locals should not be taken into account when estimating the impact of investments into the tourism sector, as these would likely constitute transfers) (Stynes, 1999). Goods bought by tourists may either be produced by factories located outside the area being analysed, or use imported components. Before applying a multiplier to tourism spending in this case, the producer prices of all imported goods purchased by tourists have to be deducted. Generally, the 'leakage rate' of imports in an economy is about 30.0%.

APPENDIX 2

Output Multipliers for all Sectors, 2010

Rank	Sector	Output multiplier	Rank	Sector	Output multiplier
1	Oils and Fats	2.6	21	Residential	2.0
2	Rubber Products	2.6	22	Tyres	2.0
3	Wooden and Cane Containers	2.6	23	Restaurants	2.0
4	Preservation of Seafood	2.5	24	Cement, Lime and Plaster	2.0
5	Rubber Gloves	2.5	25	Dairy Production	2.0
6	Veneer Sheets, Plywood, Laminated & Particle Board	2.5	26	Non-Residential	2.0
7	Builders' Carpentry and Joinery	2.5	27	Other Chemicals Product	2.0
8	Sawmilling and Planning of Wood	2.4	28	Aviation	2.0
9	Rubber Processing	2.3	29	Civil Engineering	2.0
10	Financial Institution	2.3	30	Basic Chemicals	2.0
11	Concrete & Other Non-Metallic Mineral Products	2.2	31	Finishing of Textiles	1.9
12	Meat and Meat Production	2.2	32	ICT & Computer Services	1.9
13	Other Wood Products	2.2	33	Soap, Detergents, Perfumes, Cleaning & Toilet Preparations	1.9
14	Building & Repairing of Ships & Boats, Manufacture of Bicycles & Invalid Carriages	2.2	34	Preservation of Fruits and Vegetables	1.9
15	Other Transport Services	2.1	35	Plastics Products	1.9
16	Repair & Maintenance	2.1	36	Accommodation	1.9
17	Forestry and Logging	2.1	37	Special Trade Works	1.9
18	Telecommunications	2.1	38	Iron and Steel Products	1.9
19	Paper and Paper Products and Furniture	2.1	39	Sheet Glass and Glass Products	1.9
20	Maritime Transport	2.0	40	Real Estate	1.9

Rank	Sector	Output multiplier	Rank	Sector	Output multiplier
41	Other Transport Equipment	1.9	61	Leather Industries	1.7
42	Soft Drink	1.9	62	Casting of Metals	1.7
43	Yarn and Cloth	1.9	63	Electrical Machinery and Apparatus	1.7
44	Business Services	1.9	64	Other Fabricated Metal Products	1.7
45	Bakery Products	1.9	65	Footwear	1.7
46	Fishing	1.8	66	Petroleum Refinery	1.7
47	Animal Feeds	1.8	67	Communications	1.7
48	Amusement and Recreational Services	1.8	68	Fertilizers	1.7
49	Structural Metal Products	1.8	69	Printing	1.7
50	Defence and Public Order	1.8	70	Other Financial Institution	1.7
51	Clay and Ceramic	1.8	71	Banks	1.6
52	Motorcycles	1.8	72	Medical, Surgical and Orthopaedic Appliances	1.6
53	Grain Mills	1.8	73	Other Textiles	1.6
54	Poultry Farming	1.8	74	Industrial Machinery	1.6
55	Cinema, Video and Television Activity	1.8	75	Publishing	1.6
56	Other Livestock	1.8	76	Insurance	1.6
57	Sewerage, Waste Collection & Remediation Activities	1.8	77	Publishing Activity	1.6
58	Paints and Varnishes	1.8	78	Motor Vehicles	1.6
59	Land Transport	1.8	79	Rubber	1.6
60	Other Food Processing	1.7	80	Public Administration	1.6

Rank	Sector	Output multiplier	Rank	Sector	Output multiplier
81	General Purpose Machinery	1.6	102	Other Manufacturing	1.4
82	Private Non-Profit Institution	1.6	103	Semi-Conductor Devices, Tubes and Circuit Boards	1.4
83	Wearing Apparel	1.6	104	Optical Instruments and Photographic Equipment	1.4
84	Wholesale & Retail Trade and Motor Vehicle	1.6	105	Professional	1.4
85	Electric Lamps and Lighting Equipment	1.6	106	Metal Ore Mining	1.3
86	Domestic Appliances	1.6	107	Office, Accounting and Computing Machinery	1.3
87	Electricity and Gas	1.6	108	Tobacco Products	1.3
88	Watches and Clocks	1.5	109	Oil Palm	1.3
89	Confectionery	1.5	110	Other Private Services	1.3
90	Special Purpose Machinery	1.5	111	Vegetables	1.3
91	Other Mining and Quarrying	1.5	112	Stone Clay and Sand Quarrying	1.3
92	Basic Precious and Non-Ferrous Metals	1.5	113	Education	1.3
93	Health	1.5	114	TV, Radio Receivers & Transmitters & Associated Goods	1.3
94	Measuring, Checking & Industrial Process Equipment	1.5	115	Flower Plants	1.2
95	Insulated Wires and Cables	1.5	116	Fruits	1.2
96	Wine and Spirit	1.5	117	Food Crops	1.2
97	Other Electrical Machinery	1.4	118	Other Public Administration	1.2
98	Rental and Leasing	1.4	119	Other Agriculture	1.2
99	Waterworks	1.4	120	Crude Oil and Natural Gas	1.2
100	Pharmaceuticals, Chemicals & Botanical Product	1.4	121	Paddy	1.2
101	Ownership of Dwellings	1.4	122	Research and Development	1.1

Source: MAVCOM calculations & DOS, 2014

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