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Impact of Scheduled Wastes on Growth: An Input-Output Approach

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Abstract:
Environmental of good quality is essential for maintaining human life and protecting natural ecosystems. As the economic development contributes in enhancing standard of living, modern lifestyles on the other hand lead to potential issues in disposing the general waste. For this reason, it is essential to study on the relationship between economic growth and waste management. The main purpose of this study is to analyze impact of growth on the scheduled wastes for year 2005 by selected industries in Malaysia, then investigate how the growth brings forward the pollution sources inventory (scheduled wastes) into our environment and also to examine the impact of output estimated by final demand for year 2010 and 2015. For this purpose, the method that we have applied is input-output models to measure the interrelation between the scheduled wastes for year 2005 and growth of final demand in year 2010 and 2015. Result show that the estimates of forecasting errors have direct and indirect relationship and it has been used to make corrections for the sector-level forecasts for scheduled wastes in Malaysia for the year 2010 and 2015.

Keywords: Environmental, scheduled wastes, growth, input-output**.**

1. Introduction

Environmental of good quality is essential for maintaining human life and protecting natural ecosystems. Based on Environmental Quality Act 1947, environment is defined as the physical factory of the surroundings of the human beings including land, water, atmosphere, climate, sound, odor, taste, the biological factors of animals and plants, and the social factors of aesthetics. Waste management is one of the global concerning matters. In this sense, it is an important issue to contemplate as Malaysian economics is highly contributed by its industrialization, in other words there is high potential of industrial waste leading to high level of pollution to the country's environment as a whole. Reynolds et al. (2012) defines waste as "a large and complex category of items that no longer serve their intended purpose or function". According to DEFRA (2011), an efficient waste policy assist in mitigating risks to growth sustainability in the long-run by ensuring that natural resources are not unsustainably used in present thus contribute towards lowering the GHG emissions. Waste which is inappropriately managed could cause negative consequences to society in terms of economics, environmental and health. Therefore, it is essential to construct policies for waste related to growth in order to analyze its relationship with the economic output.

Table 1: Quantity of Scheduled Wastes Generated by Industry for 2004 and 2005

Type of Industry	Quantity of Wastes (Metric Tonnes/Year)	
	2004	2005
Electronic	44,820.77	129,861.83
Chemicals	18,178.65	124,285.57
Automotive/Workshop	3,295.04	67,259.12
Metals	156,965.38	54,100.02
Industrial Gas	31,452.71	42,161.14
Pharmaceutical	90,070.18	33,238.81
Petroleum	8,818.92	23,283.25
Wood Based	135.87	8,320.94
Rubber & Plastic	14,769.50	5,534.46
Printing & Packaging	1,298.27	2,639.36
Others	99,778.79	58,231.60
Total	**469,584.08**	**548,916.10**

Source: Department of Environment Malaysia

Based on Table 1, a total of 548,916.10 metric tonnes of scheduled wastes is generated in 2005 as compared to 469,584.08 metric tonnes in 2004. Table 1 show that electronic industry has the highest quantity of waste which is 129,861.83 metric tonnes in year 2005 from merely 44,820.77 metric tonnes in 2004. This is in contrary with metals industry which experience major decline from 156,965.38 in 2004 to 54,100.02 in 2005. The lowest quantity of wastes can be seen in printing and packaging industry of 2,639.36 metric tonnes in 2005 while wood based industry is 135.87 metric tonnes in 2004. This study is prepared to estimate the total scheduled wastes generated at different level of the economic growth in Malaysia as evidence to the notion that the economy growth lead to pollution sources inventory. In addition, the total pollution sources inventory emitted by all economy activities, the influences by every sector in industrialization on the environment are more concerning. Through this study, the quantity of the scheduled wastes emitted by each sector can be estimated when it is increasing with its output or experience a growth. The purpose of this study is to analyze the impact of growth on the scheduled wastes in the selected industries in Malaysia. The specific objectives of the study are to examine the impact of different level of economic growth on sectoral output estimated by the component of final demand in year 2010 and 2015.The study also aims to estimate the impact of different unit of economic growth on scheduled wastes generated by industry for year 2005 and finally to measure the level of waste generated due to changes in economy growth in Malaysia.

2. Literature Review

According to Xu et al. (1995), concepts and methods of input-output analysis can be used to develop a better understanding of the world humans are creating, and advance the study of economic and environmental systems and thus sustainability. By using the input-output analysis showed that only some material categories can be effectively influenced by changes of economic structure. Contained by EE, ideas can be found about economic structural change, particularly, relating to "industrial ecology" and "industrial metabolism" (Ayres, 1998; Duchin et al., 1994; Graedel & Allenby, 1995; & Socolow et al., 1994). These underline spatial and sectoral adjustments of economic activities to realize a minimal environmental pressure caused by substance and material flows. For this purpose, a balance between strategies such as "dematerialization", recycling and reuse, waste management and increasing stability of products is needed. The relationship between trade liberalization, economic growth, and the environment in Asia-Pacific has not yet been charted (Strutt & Anderson, 1998). Conceptual framework and evidence from Malaysia reveals that trade openness has both positive and negative impacts on the environment and that economic integration constrains national environmental policymaking. According to Xie and Saltzman (2000) study, computable input-output model consider as a linear programming to develop an integrated economics policy impacts of environmental policy analyzing the environmental impacts of an economic policy.

According to a study by Tisdell (2001) study, to discover the relationship between economic globalization on pollution levels that required to sustainable development through show demonstrates the margins of environmental Kuznets curve (EKC)-analysis. Based on Kofoworola and Gheewala (2008) most of the greenhouse gases attributes to Thailand originate from the demand of electricity and by unit production activity. This study using the IO analysis, the 180 × 180 table was selected for this analysis. The aim of this study is to estimate the amount of CO2 for Thailand economy. Based on Wahid and Huda (2009) is primarily an effort to review the relationship between trade and environment in Malaysia. The findings of the study show no evidence of inverted-U shaped Environmental Kuznets Curve (EKC) for any selected environmental pollutants in Malaysia.

3. Data and Methodology

The data in this study is obtained from Environmental Quality Report (EQR). The time period data been used in this study. This study used input-output table in 2005 at the national level. All of the tables are constructed by Department of Environmental (DOE), Malaysia. The main sectors in Tenth Malaysia Plan (10th MP) have been chosen in this study. Sectors are as follows: private consumption, government expenditure, investment and exports for year 2010 and 2015 are obtained directly from the Ten Malaysia Plan published by the Economic Planning Unit (EPU). Since the study employs a multi-sectoral general equilibrium model, it requires details of the Gross Domestic Product (GDP) components associated by 11 industries of the production sector. Thus, each of the sectoral final demand components is distributed by using the 2010 and 2015 final demand structures. In order to

measure the interrelation between the environment and economy activity, the analysis of structural change using input-output tables goes back to Leontief's Model. The theoretical background of Leontief's input-output Analysis is based on Walras' General Equilibrium Theory as was repeatedly stressed by Leontief himself (Leontief, 1941, 1966, & 1986). The use of extended input-output tables to estimate wastes and other discharges of residuals has become an important instrument to assess environmental problems at the macroeconomic level (for a review, see Forsund, 1985; the methodology adopted in this section is based on Pedersen, 1993). The most common procedure is to assume that wastes are linearly related to the gross output of each sector, in a way that each industry generates residuals in fixed proportions to the sector output. The waste coefficient of pollutant *h* by sector *i* (ef_{hi}) can be obtained by dividing the total waste of a sector (em_i) by the total output of the same sector *(xi):*

$$ef_{hi} = em_{hi} / X_i \quad (1)$$

Given this assumption, it is possible to obtain the total waste caused by the *f*-category of final demand through the use of waste coefficients for each sector. The Ten Malaysia Plan, final demand estimated by the Economic Planning Unit (EPU) will be our exogenous variables. The EPU has estimated the components of Gross Domestic Product (GDP) which comprise of private consumption, government expenditure, investment and exports for year 2010 and 2015. In formal terms, this is expressed by:

$$Z_{hf} = diag\,(ef_h)\,.\,X_f = diag\,(ef_h)\,.\,(I - A)^{-1} F_f \quad (2)$$

where Z_{hf} is the *nx1* vector containing the total waste of pollutant h (in this study h refers to scheduled wastes) per sector associated to the *f*-category of final demand, and $diag\,(ef_h)$ is the *nxn* matrix containing in its principal diagonal the waste factors of pollutant *h* for each sector, and zeroes elsewhere (Pedersen, 1993).

4. Result and Discussion

4.1 The Impact of Growth on Sectoral Output

Output plays an important role in determining the amount of the scheduled wastes of the industry. Each of the additional output produced by the production will produce some amount of wastes. The study measures the impacts of the different level of final demands on sectoral output by using the Leontief inverse matrix prior to looking at the impact of growth on scheduled wastes emission. Since the study employs multisectoral equilibrium of the input-output model, the information of the value of the final demand in different production sectors should be prepared first, then later estimate the total outputs. In the input-output model, the vector of final demand is assumed exogenous or given. The output can be determined after the value of various final demands in 2010 and 2015 is applied into the different production sectors. The final demands divided into four categories; private consumption, government expenditure, gross fixed capital formation/investment, and exports. Table 2 show the total output generated by the private consumption, government expenditure, gross fixed capital formation/investment, and export during 2010 and 2015. The amount of outputs in the tables is in thousands of ringgit. Table 3 and Table 4 present the sectoral output which generated by the different level of final demands in 2010 and 2015. For each ringgit of final demand for a product, the total output of its own sector increase while the other also increase due to the interrelations among different sector. The results for any sector the output required exceed final demand because indirect relationships are expressed in the system. According to Table 2, there is RM 1,084,695.75 thousand of outputs generated in year 2010 and in year 2015 the outputs generated increase to RM1,350,442.10 thousand produces from the final demand. The highest final demand output is produced by exports category with RM 598,943.15 thousand in 2010 and RM 740,199.04 thousand in 2015. This is followed by increasing final demand of private consumption with the output of RM 293,980.64 thousand in 2010 and RM 369,802.15 thousand in 2015. It is also found that government expenditure output is the lowest among the final demand categories with merely RM 69,252.73 thousand and RM 80,335.45 in 2010 and 2015 respectively.

Table 2: Total Output Generated by the Component of Final Demand in 2010 and 2015 (RM'000)

Final Demand	2010	2015
Private Consumption	293,980.64	369,802.15
Government Expenditure	69,252.73	80,335.45
Gross Fixed Capital Formation/Investment	122,519.23	160,105.47
Exports	598,943.15	740,199.04
Total Output	**1,084,695.75**	**1,350,442.10**

Source: Computed from equation

Table 3 and Table 4 show that the quantity of output generated by each production sector in different categories of final demand. According to table unit demanded in different sector and table quantity output produced, for each sector, the amount of output produced normally is more than the unit demanded due to the interrelationship among production sectoral. Nevertheless, occasionally the exceptional result is also occurred with what had happen in the case that the output is less than final demand in export category. Moreover, the zero demand is not necessary equal to zero output. To look into more detail, the total estimated output of different sectors which generated by the final demand in each category in 2010 and 2015 is discussed. Table 3 shows the sectoral output generated by final demands in 2010 and 2015. In 2010, the output generated by the electronic sector recorded the highest final demand in exports category with RM 485,640.4701 thousand. This is followed by private consumption, gross fixed capital formation and government expenditures category in final demand with RM 238,368 thousand, RM 99,342 thousand and RM 56,152 thousand respectively within the same sector. Furthermore, in 2015, the total estimated output which summation of all the fourteen productive in each category has been increased. It is indicated that in 2015 that the electronic sector and chemicals sector still generated a high amount of output to satisfy the demand in all the categories. With the changes in final demand, the electronic sector generated about RM 299,846 thousand in private consumption category, RM 65,138 thousand in government expenditure, RM 129,818 thousand in gross fixed capital formations / investment, and RM 600,175 thousand in exports. The value of output of electronic sector obviously raise in 2015 by compared with 2010. It is resulted by the increasing in its quantity of final demand. Chemicals sector recorded the high amount of output due to the strong indirect effect to boost the over depending on the inter-industry relationship. Industrial gas sector also is a necessity for the country although the final demand is lower than others. Moreover, the industrial gas sector exists as the third high output generated industry in private consumption, but it is to be the highest output required in exports by final demand.

In addition, for the other sector in Malaysia, the product is only demanded by the consumers in domestic and foreign nations/exports, also lower demands by the government and investment. Thus, other product is produced at the lowest amount of output if compared to others. Rubber and plastic industry also generate low amount of output from the final demand in each category. As a result, from a low income agrarian nation dependent on rubber and tin, Malaysia has emerged as a modern, industrial, high middle income nation with strong economic fundamentals. Finally, the high final demand is not to express that the high output would be generated. Although the changing in final demand leads a direct changing in the output, the output is also depends on its inter-industry relationship. With the strong inter-industry relationship, there is a large quantity of output will be produce otherwise it is less.

Table 3: Output generated by 2010 & 2015 Final Demand (RM'000)

Sector	Private Consumption	Government Expenditures	Gross Fixed Capital Formation	Exports	Total
	2010				
Electronic	238,368	56,152	99,342	485,640	**879,503**
Chemicals	17,332	4,083	7,223	35,312	**63,951**
Automotive/Workshop	1,113	262	464	2,267	**4,106**
Metals	9,452	2,227	3,939	19,257	**34,875**
Industrial Gas	15,800	3,722	6,585	32,189	**58,295**
Pharmaceutical	6,197	1,460	2,583	12,625	**22,864**
Petroleum	2,181	514	909	4,443	**8,047**
Wood Based	1,588	374	662	3,236	**5,860**
Rubber & Plastic	363	86	151	741	**1,341**
Printing & Packaging	1,306	308	544	2,661	**4,820**
Others	280	66	117	571	**1,035**
	2015				
Electronic	299,846	65,138	129,818	600,175	**1,094,978**
Chemicals	21,803	4,736	9,439	43,640	**79,619**
Automotive/Workshop	1,400	304	606	2,802	**5,112**
Metals	11,890	2,583	5,148	23,799	**43,420**
Industrial Gas	19,874	4,318	8,605	39,781	**72,577**
Pharmaceutical	7,795	1,693	3,375	15,602	**28,465**
Petroleum	2,743	596	1,188	5,491	**10,018**
Wood Based	1,998	434	865	3,999	**7,296**
Rubber & Plastic	457	99	198	915	**1,670**
Printing & Packaging	1,643	357	711	3,289	**6,000**
Others	352.6899	76.618	152.6968	705.9471	**1,287.95**

Source: Computed from equation

4.2 The Impact of Growth on Sectoral Scheduled Wastes

As previously estimated, the output produced depends on the final demand of different categories, such as consumption, government expenditure, investment and export. The trend of output reflects the economy of country where a country experiences an economic growth with the increasing of output on the whole economy. However, the economic growth brings the benefits and also harmful impacts to society. With the main objective of study, in this section, the impact of economic growth on sectoral

scheduled wastes emission is estimated by using the scheduled wastes multiplier and output generated during the period of 2010 and 2015. The scheduled wastes emissions generated by different component of final demand during 2010 and 2015 are displayed in Table 4. Scheduled wastes emission is measured in unit metric tonnes. According to the result in Table 2, the total output in Malaysia has been estimated to grow up during 2010 and 2015. Therefore, the extending of output leads to the increasing of total scheduled wastes emission during both years. Total scheduled wastes emission emitted by the productive sector in 2010 is 31,173.73 metric tonnes whereas the total scheduled wastes emission in 2015 is expected to rise until it reaches 38,811.17 metric tonnes. Export captures a large share of scheduled wastes emission in both years. It is about 55.22 per cent of total scheduled wastes emission in 2010. For 2015, it estimated that the total scheduled wastes emission will increase to 21,273.03 metric tonnes although its percentage has decreased. With zero demand, the government expenditure is the lowest source in producing scheduled wastes emission pollutant. The share of the scheduled wastes emission of government expenditure is merely 6.38 per cent in 2010 while 5.95 per cent in 2015.

Table 4: Scheduled Wastes Per Metric Tonnes of Final Demand in 2010 and 2015

Final Demand	2010	2015
Private Consumption	8,448.89	10,627.97
Government Expenditure	1,990.30	2,308.81
Gross Fixed Capital Formation/ Investment	3,521.15	4,601.37
Exports	17,213.39	21,273.03
Total Output	**31,173.73**	**38,811.17**

Source: Computed from equation

Table 5 and Table 6 show the scheduled wastes emission per metric tonnes generated by each productive sector in 2010 and 2015. Scheduled wastes emission for each sector is obtained using the scheduled wastes multiplier for various sectors multiplied by the total output required from aggregate demand. Assuming scheduled wastes multiplier is constant, the changing of the output gives direct impacts on the scheduled wastes emission. Hence, with the vary amount of the output required, the rank of the scheduled wastes emission is different. This is to identify the sector which generated a large amount of scheduled wastes emission among production sectors and each level emission emitted by each sector. According to the Tenth Malaysia Plan has been formulated with various new approaches towards becoming a high income and high productivity economy, in line with the New Economic Model. During the Tenth Malaysia Plan, the gross national income per capita is targeted to increase to USD 12,140 in 2015. This requires achieving real GDP growth of 6 per cent per annum. Growth will be led by the services and manufacturing sectors, in addition to revitalizing the agriculture sector towards higher value added as well as the adoption of ICT, biotechnology and other relevant technologies. A key challenge of the Tenth Malaysia Plan is to stimulate private sector investments to grow at 12.8 per cent per annum or 115 billion ringgit per annum.

According to Table 5, the petroleum sector and chemicals are the top waste contributors among the sectors in final demands for both years. Petroleum sector emitted the largest amount of scheduled wastes during the production processing in 2010. The scheduled waste produced is about 21,812 metric tonnes. This is due the fact that Malaysia is known as one of the largest petroleum producer in the world. However, the total amount of output generated by final demand does not match with the total amount of scheduled wastes generated by the final demand for both years. The second largest scheduled wastes contributor is from chemical sector. It contributed about 2,336 metric tonnes of scheduled wastes. Although both sectors are not the highest output producer, they emitted the largest emission owing to the factor of scheduled wastes multiplier. With the highest scheduled wastes multiplier, every addition of output produced causes a vast amount of wastes produced. Furthermore, in 2010, metal is a sector which generated a smaller amount of scheduled wastes emission with the scheduled wastes emission released for approximately 65 metric tonnes.

In 2015, scheduled wastes emission generated by each sector has risen due to the increasing of output. Petroleum sector and chemicals sector are still the highest waste-producing sectors. Petroleum sector generated 21,812 metric tonnes of scheduled wastes emission in 2010 has increased to 27,156 metric tonnes in 2015 by 24.50 percent. However, for chemicals sector, its scheduled wastes emission during 2015 has been increased from 2,336 metric tonnes to 2,908 metric tonnes from 2010 to 2015. The less polluted sector, metal sector has also

emitted an increasing amount of scheduled wastes emission due to the growth in its sector. With 24.50 percent increasing in output, metal sector contributed 15 metric tonnes of scheduled wastes emission. Finally, there is a significant positive relationship between economy growth and scheduled wastes produced which shows that the amount of scheduled wastes produced released into the air would be increased if the output grows. According to the result analysis, the rate of output and scheduled wastes emission increase simultaneously. The output grew 24.50 percent from 2010 to 2015 lead to an approximately 24.50 percent increasing of scheduled wastes emission during the same period.

Table 5: Scheduled Wastes (metric tonnes) Generated by the Component of Final Demand in 2010

No	Sector	Private Consumption	Government Expenditures	Gross Fixed Capital Formation	Exports	Total
1	Electronic	169	40	71	345	**625**
2	Chemicals	633	149	264	1,290	**2,336**
3	Automotive/Workshop	475	112	198	968	**1,752**
4	Metals	18	4	7	36	**65**
5	Industrial Gas	549	129	229	1,119	**2,027**
6	Pharmaceutical	408	96	170	831	**1,505**
7	Petroleum	5,912	1,393	2,464	12,044	**21,812**
8	Wood Based	42	10	18	86	**156**
9	Rubber & Plastic	171	40	71	347	**629**
10	Printing & Packaging	45	11	19	91	**165**
11	Others	28	6	11	56	**102**

Source: Computed from equation

Table 6: Scheduled Wastes (metric tonnes) Generated by the Component of Final Demand in 2015

No	Sector	Private Consumption	Government Expenditures	Gross Fixed Capital Formation	Exports	Total
1	Electronic	213	46	92	426	778
2	Chemicals	797	173	345	1,594	2,909
3	Automotive/Workshop	597	130	259	1,196	2,182
4	Metals	22	5	10	44	80
5	Industrial Gas	691	150	299	1,383	2,523
6	Pharmaceutical	513	111	222	1,027	1,873
7	Petroleum	7,436	1,615	3,220	14,885	27,156
8	Wood Based	53	12	23	107	195
9	Rubber & Plastic	214	47	93	429	783
10	Printing & Packaging	56	12	24	112	205
11	Others	35	8	15	69	127

Source: Computed from equation

5. Summary and Conclusion

5.1 Summary

The study applied the input-output (I-O) model to examine the growth and its impacts on the scheduled wastes emission in the selected industries in Malaysia during 2004 and 2005. The data of the output produced to satisfy the additional of different components of final demand and total scheduled wastes emission generated by each sector in 2004 and 2005 are obtained in this study. The scheduled wastes multiplier and total output requirement have been defined to estimate the impacts of growth of each sector on scheduled wastes emission. As a conclusion of the study, the changes of technical coefficient of scheduled wastes emission provide huge impacts on scheduled wastes multiplier. The highest releasing of petroleum scheduled wastes and lesser amount of total inputs used lead to the increasing of technical coefficient of scheduled wastes. Therefore, the increment of technical coefficient of scheduled wastes causes the scheduled wastes multiplier increases. Finally, the amount of scheduled wastes produced generated by each production sector adds to for every additional ringgit of output demand. Thus, to restraint the scheduled wastes pollution, reducing the use of means of production with high petroleum scheduled wastes produced is needed to control the scheduled wastes multiplier. Petroleum sector and chemicals sector contributed to the highest amount of oil and hydrocarbon scheduled wastes emission during the production progress have been generated a highest technical coefficient and lead to the largest scheduled wastes multiplier. On the other hand, metals sector is the most clean and just produces lesser scheduled wastes sector with the highest inputs used has been caused the smallest index of technical coefficient and multiplier. It is noted that every changing demand of a sector will directly increase its own output produced. However, according to the analysis of study, the amount of output produced by each sector is also highly depending on its inter-industry relationship. Thus, the phenomena that sometime the quantity of output in a sector is larger produced than the unit demanded, and respectively. With the strong interrelationship among sectoral, a sector still produces its output in spite of zero demand. Finally, a significant positive relationship is found between output growth and total scheduled wastes produced. The expansion of output causes the increasing

amount of scheduled wastes released into the environment. The scheduled wastes multiplier is also an important determinant in the estimation of scheduled wastes emission. With the largest scheduled wastes multiplier, for every addition output produced generated a large amount of scheduled wastes emission. However, with small scheduled wastes multiplier, for every addition output produced would also generate an emission, but possibly in a small amount. Shortly, the economy growth causes the increasing of scheduled wastes emission, but the quantity/amount of emission is determined by scheduled wastes multiplier.

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