Energy Costs and Cost Structures in East Asia: Implications for Location Decisions of Multinational Enterprises

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Abstract

After examining how one might evaluate environment-related costs, including energy costs, this paper uses industrial census and survey data to compare the cost structures of manufacturing plants in five East Asian economies around 2006. The aim of this comparison is to provide insight into how important energy costs might be to foreign multinational enterprises (MNEs) when choosing production locations. Expenditures on raw materials (including parts and components) accounted for the largest shares (usually about half or more of output) in all economies. In contrast, wage shares were usually much smaller, 8-10 percent in Japan and Korea and 3-6 percent in Malaysia, Thailand, and Indonesia. Shares of purchased energy (electricity and fuels) were even smaller, 2 percent in Japan, Korea, and Malaysia, and 4 percent in Thailand and Indonesia. This suggests that energy costs were a relatively unimportant cost component in most plants in all economies. Comparisons of foreign multinational plants (MNEs) and local plants in the three Southeast Asian economies reveal large variation of MNE-local differentials of cost component shares among economies or industries. On average, energy and wage shares were lower in MNEs than in local plants and MNEs had lower energy and wage shares than local plants in most of the 15 industries examined. However, most differentials were relatively small and MNEs had higher energy shares in a number of instances. The most important implication of these comparisons is that reducing the costs of raw materials is the largest potential source of cost reduction for both local plants and MNEs in these three Southeast Asian economies. Potential gains from reducing energy costs (and wage costs) are much more limited for the average MNE. These empirical patterns reinforce the general academic consensus that energy and labor costs are usually minor factors in MNE location decisions. And because energy costs are a major portion of environment-related costs, this suggests that environmental costs may also be a minor factor for most MNE location decisions. However, cost structures vary among industries and firms or plants, and some MNEs do reap substantial gains from reducing labor and/or energy costs.

Keywords: multinational enterprise, manufacturing, location choice, labor costs, energy costs
JEL Categories: F23, J31, L60, O53, Q40
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1. Introduction

This primary purpose of this paper is to document the role of energy costs and other major cost components in the manufacturing industries of five major East Asian economies. This exercise is motivated by the desire to provide evidence about how the importance of energy and other environment-related costs vary among economies and industries. The ultimate goal is to shed light on how energy and other environment-related costs might affect location decisions in multinational enterprises (MNEs) operating in the region.

The paper is descriptive in nature and begins with a short literature review, including discussion of how the literature views energy and environment-related costs (Section 2). This is followed by a description of the primary data sources used (Section 3), a comparison energy and other cost component shares in Japan, Korea, Malaysia, Thailand, and Indonesia (Section 4), and a comparison of energy and other cost component shares in MNEs and local plants operating in the three Southeast Asian economies. The final section (5) concludes.

2. MNE Location Decisions and Energy or Environment-Related Costs: A Review

There is a growing literature that attempts to examine the so-called pollution-haven hypothesis that MNEs tend to locate relatively dirty activities in economies with relatively lax environmental regulation, most of which are relatively low or middle-income developing economies. However, this and other economic literature on the environmental impacts of firm activity pay relatively little attention to the related question of how important energy and other environmental costs are, and how important energy-related pollution is.

2a. The Pollution Haven Hypothesis

As mentioned above, the pollution haven hypothesis suggests that MNEs will tend to locate pollution-intensive activities in developing economies with relatively lax environmental

regulations. Most of the analysis of this hypothesis is performed by estimating models of MNE location choice and adding variables that reflect the extent of environmental regulation in host economies or regions. In general, the evidence supporting this hypothesis is weak (Dean et al. 2009; Eskeland and Harrison 2003; Kirkpatrick and Shimamoto 2008; Smarzynska and Wei 2001), but there is some evidence consistent with the hypothesis (He 2006; Wagner and Timmons 2008).

However, these analyses face numerous problems which have yet to be sorted out. First, internationally comparable and meaningful data on location choice by MNCs and the severity of environmental regulations are not easy to obtain. For example, the level of foreign direct investment (FDI) is often used to proxy MNE location choice, but FDI represents only a portion of equity and loans (corporate finance) in recipient affiliates and is often poorly correlated (both over time and across economies) with employment, sales, the number of affiliates, and other real activities in recipient affiliates (Ramstetter 2012). Second, modeling MNC location choice is a rather imprecise art and most of the literature lacks sufficient data to analyze the effects of all potentially important determinants (Ramstetter 2011). For example, Kirkpatrick and Shimamoto (2008) find a positive correlation between Japanese firm presence and host country participation in international environmental agreements, but fail to account for other factors related to good governance (e.g., strong and impartial legal and political institutions, effective economic policy implementation), which are likely to be positively correlated with participation in international environmental agreements.

In the econometric literature on MNE location choice, cost-related determinants are often found to be insignificant statistically. However, demand-side factors, especially measures of host market size are more consistently significant. In other words, the “relentless search to find new markets and expand existing ones is one of the most pervasive characteristics of MNCs and an important subject of many studies” (Ramstetter 2011, p. 199). There is

probably a fairly strong, positive correlation between market size and the stringency of environmental regulation, and an even stronger positive correlation between per capita income, another important determinant of market-seeking FDI and environmental regulation. These correlations make it easy to confuse demand and cost-side effects of FDI determinants.

In addition, I have been able to find very little literature that addresses two key questions: (1) precisely what are the environment- or pollution-related expenditures that firms seek to minimize when exploiting pollution havens; and (2) how important are those costs to investing MNEs? Most of the literature seems to assume that the costs being minimized are those related to pollution abatement, including prevention, which are relatively high in countries with stringent environmental regulation. However, I have never seen explicit discussion of taxes on energy and other resources in discussions of MNE location determinants. This is a potentially important omission because taxes are one of the most powerful weapons governments use to encourage reductions of pollution related to the use of energy and other resources. Moreover, I have never seen energy costs be characterized explicitly as and environmental cost when analyzing firm behavior, probably because a large portion of energy costs are necessary for inputs into the production process. And it is often difficult to separate the generic factor cost of energy from costs related to energy taxes and portions of energy costs related to pollution abatement. In order to take a first step toward distinguishing these types of energy costs, the following section provides a rough overview of how much pollution is generated by energy consumption and the types of energy costs accounted for in existing data.

2b. Evaluating the Importance of Energy and Other Environment-Related Costs

In the introduction, I said energy consumption is a large source of pollution, especially air pollution. Table 1 illustrates this fact for four major air pollutants in Korea and Japan in recent

years. Industry (broadly defined to include manufacturing and non-manufacturing activities) was among the largest direct sources of sulphur oxides in both countries and of nitrogen oxides, and carbon monoxide in Japan. Power stations were another important source of sulphur oxides and nitrogen oxides, while motor vehicles were among the largest sources of nitrogen oxides and carbon monoxide. Moreover, energy consumption is a key, necessary input into the pollution generation process by industry, power stations, and motor vehicles. Therefore, it is reasonable to conclude energy consumption was a large, if not the largest, ultimate source of these three important pollutants emitted by industry, power stations, and motor vehicles.

Table 2 reinforces this perception for Japan, showing that energy sources accounted for 93-94 percent of all the greenhouse emissions in 1990, 2000, 2006, and 2010. Manufacturing production was the largest single contributor, accounting for 41 percent of the total in 1990, but its contribution fell to 36 percent in 2000 and just over one-third in recent years. Conversely, the share of residential energy use grew from 14 percent in 1990 to 19 percent in 2006, before falling back to 18 percent in 2010. Motor vehicle use accounted for 17 percent of the total in 1990, 2006, and 2010, and 19 percent in 2000. Among manufacturing industries, ferrous basic metals have always been the largest source (13-15 percent of the total), but all other individual industries in the table (excluding the aggregated, heterogeneous category of "other manufacturing") had much lower shares (5 percent or less).

Most energy expenditures by manufacturing plants are not usually considered environmental costs by statistical authorities, who usually focus on measuring pollution abatement costs. The only recent data I have been able to gather for East Asia cover end-of-pipe capital expenditures on pollution abatement equipment by samples Japanese firms (Table 3). In 2006, these expenditures amounted to 4.2 percent of capital expenditures by sample manufacturing firms and 3.5 percent in non-manufacturing. Relative to industry totals,

these expenditures were by far the largest in oil refining (21 percent), followed by non-metallic mineral products (8.0 percent), and ferrous basic metals (6.7 percent). Not surprisingly, these three industries have long been characterized as relatively dirty and the high levels of expenditure on abatement equipment reflect the effects of Japan's relatively strict regulations in these industries.

However, data from OECD (2007) indicate that end-of-pipe capital expenditures were only one-fourth of the level of current expenditures on capital abatement by Japan's private firms in the late 1990s (28 percent in 1995-1999). Among Korean business firms, the same ratios were about two times larger in 2001-2002 (51 and 60 percent, respectively). Manufacturing firms accounted for the majority of both capital and current expenditures of Korean firms in 2002 (63 and 77 percent, respectively).

Unfortunately, I have been unable to locate more recent data for Japan or Korea, but there data on U.S. manufacturing that may be illustrative. Tables 4a and 4b show that current abatement expenditures were about 3.5 times larger than capital abatement expenditures in manufacturing plants in 2006. The largest capital expenditures were in oil and coal products and chemicals, followed by basic metals. Relative to total capital expenditures, capital expenditures were largest in oil and coal products, paper products, chemicals, and basic metals, while current expenditures were largest relative to total shipments in basic metals, paper, chemicals, and oil and coal products. The pattern is similar to Japan in that abatement expenditures were relatively large in heavy industries, which tend to be relatively dirty.

The U.S. data are particularly useful because they allow disaggregation of current abatement expenditures less depreciation by industry and category, and comparisons with overall current expenditures in each category and industry in 2005 (Table 4c). Perhaps not surprisingly, energy expenditures accounted for largest portion of these current abatement expenditures (US$5.7 billion), followed by contracted work (US$5.2 billion) and labor

(US$4.1 billion). Excluding depreciation, chemicals and oil and coal products were the largest categories. Relative to total current expenditures, abatement's share was especially large for contracted work (11 percent) and energy (5.7 percent) but much smaller for labor and materials. As in the East Asian cases (see below), raw materials were by far the largest component amounting to 47 percent of total shipments. Thus, abatement expenditures were relatively large shares of smaller components (contracted work and energy), but not of the largest component, raw materials. Energy-related abatement expenditures were largest relative to total energy expenditures in oil and coal products (12 percent), transportation machinery (8.4 percent), and chemicals (6.2 percent). Abatement's shares of contracted work were generally largest, over one-third in oil and coal, food, paper, and chemicals.

One important question raised by examination of the U.S. data is: do the energy expenditure data in Asia manufacturing censuses or surveys include abatement expenditures? My reading of the original source data suggests that energy expenditure data in the Asian data do not include explicit abatement expenditures and I am quite sure this interpretation is correct in the three Southeast Asian cases. I am less sure of the precise definitions used in the Korean and Japanese cases, but I strongly suspect explicit abatement expenditures are excluded for these countries as well. However, it is also important to understand that abatement efforts may affect the level of generic energy costs. For example, if a plant increases reliance on natural gas and reduces use of coal, and gas is more expensive than coal, energy expenditures will increase and emissions will fall. This kind of increase could be considered an expenditure on abatement, but it is usually embodied in total energy expenditure levels and not distinguished.

Most importantly, the review of the U.S. data makes it clear that there are distinct types of energy expenditures that have different environmental impacts. Expenditures on natural gas generate far less air pollution than coal expenditures, for example. Explicit abatement

expenditures, if effective, may reduce pollution per unit of energy consumption even if the energy mix is unchanged. On the other hand, higher energy expenditures generally result from greater consumption, and greater energy use usually increases pollution.

3. The Data

Because details on energy costs are not published for the three Southeast Asian economies, they are compiled from plant-level data underlying censuses and/or surveys of manufacturing for 2004 from Malaysia, Department of Statistics (various years) and for 2006 from Thailand National Statistical Office (2009) and Indonesia, BPS-Statistics (2008). This paper focuses on data for 2006 primarily because Thai data are only available for this year and because coverage of Indonesian plants was much better in this census year than in surrounding survey years. Data for Malaysia refer to 2004 because I have not been able to obtain necessary details for more recent years. The focus on 2006 (or 2004) is also useful because this was a rather normal period in these five economies, sandwiched in between macroeconomic turbulence after the Asian Financial Crisis in the late 1990s and early 2000s, and again after the World Financial Crisis in the late 2000s.

Partially because Indonesian data cover medium-large plants with 20 or more employees, data for Malaysia and Thailand are also compiled for plants with 20 or more workers. Focusing on these medium-large plants also facilitates more reliable comparisons with Japanese plants, for which the data refer to even larger plants (30 employees or more). Korean plants, like Japanese plants, also tend to be relatively large compared to Southeast Asian plants on average. Comparisons of MNEs and local plants in the three Southeast Asian economies are also more meaningful in samples of medium-large plants, because small plants are predominantly local, and small plants differ from large plants in important ways, including how they use energy. Thus, comparisons of MNEs and local plants in samples that include

predominantly local plants are likely to confuse distinctions among size groups and the two ownership groups more than comparisons in samples of medium-large plants.[1] The following subsections summarize important details about each of these data sources.

3a. Malaysia

Compilations for Malaysia come from a data set comprised of the 2000 census of manufacturing (Malaysia, Department of Statistics 2002) and smaller, stratified manufacturing surveys for 2001-2004 (Malaysia, Department of Statistics various years) identify three types of ownership groups, majority-local plants, 50-50 joint ventures, and majority-foreign plants. In this study, joint ventures are included with majority-foreign plants and referred to as majority-foreign MNEs because MNE partners are usually assumed to control 50-50 joint ventures. This definition of foreign MNEs is narrow by international standards, which define foreign MNEs (i.e., FDI plants) as plants in which a single, foreign owner or group has a share of 10 percent or more.

If samples are limited to plants with viable basic data (i.e., positive values of paid workers, output, worker compensation, and fixed assets), there were 18,799 plants in the 2000 census, but samples were 30-37 percent smaller in the 2001-2004 surveys.[2] However, most of the difference between the census and survey samples results from the census' inclusion of small plants with limited production. For example, in 2000 there were 8,540 medium-large plants with 20 or more paid employees and viable basic data, while the 2001-2004 surveys contained 7,406-7,581 plants meeting these criteria. Although these medium-large plants only comprised 56 percent of the number of plants with viable basic data, they accounted for the 98 percent of both gross output and energy expenditures in 2000-2004. Thus, focusing on the sample of

[1] MNEs also tend to be considerably larger than local plants even in samples of medium-large plants. Thus, even when small plants are excluded, some of the differences observed between MNEs and local plants are related to size differences.

[2] Data in this paragraph come from Ramstetter and Haji Ahmad (2012).

medium-large plants excludes very little production or energy expenditures.

3b. Indonesia

For Indonesia, this paper uses data from the 2006 census of medium-large plants (those with 20 or more workers) conducted for 2006 (Indonesia, BPS-Statistics 2008), primarily because this census was more comprehensive than annual surveys of medium-large plants conducted for other recent years (Indonesia, BPS-Statistics various years).[3] These data include precise foreign shares, but the definition of MNEs is also narrower than normal because a number of plants are jointly owned by MNEs, state-owned enterprises (SOEs), and/or private firms, making distinctions among these ownership groups are potentially ambiguous. In order to avoid ambiguity, joint ventures with MNE shares of 33 percent or more are classified as MNEs, and non-MNE joint ventures with SOE shares of 33 percent or more are classified as SOEs. In other words, if there are equal shares among ownership groups in joint ventures, MNEs are assumed to have the largest influence over management, followed by SOEs, and lastly private partners. Although this assumption is likely to be violated in some cases, it is probably realistic in most.

3c. Thailand[4]

For Thailand, published compilations of the census for 2006 report that there were 457,968 plants (Thailand, National Statistical Office 2009). However, we use a micro data set that contained only 73,193 plants, including all 26,293 plants which had 16 or more workers. 22,934 were medium-large plants with 20 or more workers. Excluded small plants were thus

[3] The 2006 census covered 29,468 plants with 4.76 million workers, but subsequent surveys covered 27,998 plants with 4.62 million workers in 2007, and 25,694 plants with 4.46 million workers in 2008. Coverage was poorer in previous years with surveys including 20,729 plants with 4.23 million workers in 2005 and 20,685 plants with 4.32 million workers in 2004. See Ramstetter (2012) for compilations of other key variables for 1995-2008. Note that 1996 was also a census year.

[4] Unless otherwise cited, data in this section come from Ramstetter and Kohpaiboon (2012).

69 percent of the database's plants, but they accounted for only 2 percent of both energy expenditures and gross output in all plants. The excluded small plants were 9 percent of MNE plants in the database but accounted for only 0.3 percent of both energy expenditures and gross output in all MNEs. Thus, excluded plants were predominately local and had relatively small energy expenditures and output per plant.

The Thai census data had records for a number of medium-large plants that reported implausibly small values for key variables. For example, 4,169 plants had output per worker of less than US$1,320, value added per worker of less than US$264, or initial fixed assets per worker of less than US$264. These cutoffs are all less than 3.3 percent of corresponding averages for all medium and large plants and comparable nation-wide estimates (including small plants) from either the industrial census or alternative estimates from the national accounts and labor force surveys. They are also substantially below per capita GDP (=per capita value added in all sectors, US$3,158). Plants with extremely low values of these key variables are also predominantly local (98 percent) and are excluded to avoid distorting MNE-local comparisons and reduce the influence of outliers.

Among the remaining 18,765 medium-large plants, there were many apparent duplicates in the data set that need to be eliminated to avoid double counting.[5] Most duplicates had different location information but identical performance information, suggesting that a large number of plants belonging to multiplant firms and operating in different locations reported identical firm-level information.[6] In order to avoid double counting and maximize coverage of large, multiplant firms, which are the focus of this study, 4,828 duplicates (93 percent of which were local plants) were dropped, leaving one record from each set of duplicates in the

[5] Duplicates were defined as records with identical values for the following 11 variables: (a) output, (b) sales of goods produced, (c) intermediate consumption, (d) purchase of materials and parts, (e) electricity and fuel costs, (f) initial fixed assets, (g) ending fixed assets, (h) female workers, (i) male workers, (j) female operatives, (k) male operatives, and (l) foreign ownership shares.

[6] Cross checking with data on large firms compiled from Business On-Line (2008) suggests several cases in which plants recorded firm-level information. Similar problems existed in the 1996 census data (Ramstetter 2004, 2006).

data set. This solution is probably the best feasible and allows for reasonable industry-level calculations, which are the focus of this paper.[7]

3d. Japan and Korea

Data for the two Northeast Asian economies come from published compilations of 2006 data from the Japanese manufacturing census covering plants with 30 or more employees (Japan, Ministry of Economy, Trade and Industry 2009) and the Korean manufacturing survey of plants with 5 or more employees (Korea, National Statistical Office 2007). Korean data include small plants with 5-19 workers that are excluded from Southeast Asian data, and the Japanese estimates of energy cost further exclude plants with 20-29 employees. Although smaller plants account for the majority of plants in both economies and account for relatively large shares of manufacturing employment, their share of shipments (Japan) or gross output (Korea) is relatively low. For example, in Korea, plants with 20 or more employees accounted for 50 percent of all plants with 5 or more employees but 87 percent of the workers and 88 percent of both shipments and output. In Japan, plants with 30 or more employees accounted for only 18 percent of the number of plants with 4 or more employees but 72 percent of workers and 89 percent of shipments. However, published compilations of energy costs are only available for Japanese plants with 30 or more employees and Korean plants with 5 or more employees.

4. Output Structures in Northeast and Southeast Asia

Table 5 first underlines the important fact that manufacturing energy expenditures were much larger in Japan (US$56 billion in 2006) and Korea (US$18 billion) than in Malaysia, Indonesia, and Thailand (US$16 billion combined). Japan and Korea are much larger and

[7] However, this solution is far less satisfactory for plant-level analysis because the resulting database mixes up firm- and plant-level observations and badly distorts location information.

richer economies than those in Southeast Asia and this is a major reason they have relatively large manufacturing sectors and energy expenditures. However, if all manufacturing industries are combined, energy's share of gross output was substantially lower in Japan (2.3 percent), Korea (1.9 percent), and Malaysia (2.0 percent) than in Thailand (4.3 percent) or Indonesia (4.4 percent). In other words, plants in Korea spent by far the largest amounts on energy because the manufacturing industries of these economies were relatively large, not because they used relatively large amounts of energy per unit of output. Moreover, energy shares of output were relatively small in all five economies.

On the other hand, shares of raw materials were by far the largest in all economies, accounting for about one half of output in all manufacturing combined, or a little more, in Japan, Korea, Thailand and Indonesia (Table 5). In Malaysia, the share of materials was even higher, exceeding two-thirds, reflecting the importance of processing trade, much of it in electronics-related machinery, to that economy. Other intermediate consumption (much of which is subcontracting expenses) was particularly large in Thailand and exceeded energy expenditures in all economies. Not surprisingly, wage shares reflected per capita income patterns, being highest in Japan (10 percent) and Korea (8.1 percent), lowest in Indonesia (3.1 percent), and intermediate in Malaysia (6.0 percent) and Thailand (5.4 percent). Interpreting the share of non-wage value added is difficult because a large portion can be defined either as profit or as the return to a plant's stock of capital, including intangible assets such as R&D, marketing networks, and management. However, the precise statistical distinction between these contrasting theoretical concepts is ambiguous. Data for 2006 suggest that non-wage value added was the largest in Indonesia (37 percent), followed by Japan and Korea (27 percent each), and lastly by Malaysia and Thailand (16-17 percent each).

The figures for all manufacturing combined represent weighted averages for all sample plants combined and there is substantial variation of component shares among industries.

With a few exceptions, energy shares tended to be largest in industries such as non-metallic mineral products, textiles, paper products, basic metals, and chemicals. In these cases, there was also a tendency for energy shares to be larger in Indonesia and Thailand than in the other three economies. This pattern was also observed in several smaller industries such as food and beverages, electronics-related machinery, and transport machinery. However, the relatively wide variation of energy shares suggests that the importance of energy costs differs greatly among countries and industries. This variation means that opportunities for cost arbitrage by MNEs also differ greatly depending on the country and industry involved.

Nonetheless, energy shares were usually relatively small compared to shares of other major cost components. Shares of raw materials were largest in most industries for most of the countries. Wage shares also exceeded energy shares in most cases examined, as did shares of other intermediate consumption. In other words, these simple comparisons suggest that energy costs were relatively small and that opportunities for profitable arbitrage of energy price differentials among economies were limited. On the other hand, the scope for arbitrage of raw materials' price differentials was apparently much larger.

5. Output Structures in MNEs and Local Plants in Southeast Asia

This section compares output structures in foreign MNEs and local plants (including local MNEs) in Malaysia, Thailand, and Indonesia. Table 6 first shows that MNEs accounted for 38 percent of energy expenditures in Malaysia, 44 percent in Thailand, and 29 percent in Indonesia (weighted averages of all plants combined). In the same samples of all plants, energy shares of gross output were lower in MNEs, but the differentials were not large -1.4 percentage points in Indonesia, -0.9 percentage points in Malaysia, and -0.3 percentage points in Thailand. However, here again there was wide variation of these differentials among industries and countries. In 30 of the 45 industry-combinations, MNE-local differentials in

energy shares were negative, but most differentials were relatively small. For example, there were only a few cases where differentials exceeded 2 percentage points in absolute value, textiles in Indonesia (-2.9 percentage points), paper in Malaysia (-2.9 percentage points) and Thailand (3.0 percentage points), non-metallic mineral products in Thailand (-2.4 percentage points), electronics-related machinery in Thailand (2.8 percentage points), other transportation machinery in Thailand (6.0 percentage points) and Indonesia (-7.7 percentage points), and other manufacturing in Thailand (-2.9 percentage points). Altogether, there were only 11 cases where negative differentials were less than -1 percent and 7 cases where they were greater than +1 percent. Correspondingly, when the means of differentials in the 15 energy shares are calculated, they were smaller in absolute value than the weighted averages, -1.2 percentage points in Indonesia, -0.3 percentage points in Malaysia, and 0.3 percentage points in Thailand.

Wage shares also tended to be smaller in MNEs than in local plants. MNE-local differentials in wage shares also tended to be larger in absolute value than energy shares (Table 6). Weighted averages were -1.0 percentage points in Malaysia, -1.7 percentage points in Thailand, and -1.6 percentage points in Indonesia. At the industry level, 24 of the 45 differentials were -1.0 percentage points or lower. There is thus evidence of a somewhat more consistent pattern for MNE-local differentials to be negative and relatively large for wage shares than for energy shares. In other words, there is stronger evidence that MNEs find ways to reduce labor costs compared to local plants, than to reduce energy costs.

Partially reflecting their large shares in output, MNE-local differentials tended to be by far the largest for raw materials (Table 6). However, the signs of these differentials and their size tended to vary widely among countries and industries. For example, weighted averages for all plants combined were positive in Malaysia (5.1 percentage points) and Thailand (3.6 percentage points), but negative in Indonesia (-2.5 percentage points). Relatively large, differentials of more than 10 percentage points in absolute value were observed in 16 of the

45 industries, with 9 being positive and 7 being negative. Overall 25 of these differentials were positive while 20 were negative.

6. Conclusions

This paper has documented the importance of energy and other cost components in the gross output of manufacturing plants operating in Japan, Korea, Malaysia, Thailand, and Indonesia. It began with a brief review of the literature on the pollution haven hypothesis and the measurement of energy and other environment-related costs, particularly abatement costs. Energy costs are partially simple input costs because energy is an important input in the production process. However, energy taxes often inflate energy costs with the precise aim of encouraging lower energy consumption and pollution, and increases in energy consumption usually lead to larger pollution emissions by manufacturing plants. Correspondingly, energy consumption by manufacturing plants is a concern for environmental policy makers and economists in these economies. Unfortunately, data on explicit pollution abatement expenditures are not generally available for firms or plants in many East Asian economies.

Two major patterns emerge from this analysis. First, energy is a relatively small cost component in most countries and industries. On average, energy costs were higher in Thailand and Indonesia, than in the other three economies examined. Second, MNE-local plant differentials in energy shares were more often negative than positive, but were generally small. The important implication of these patterns is that the scope for overall cost reductions by relocating energy-intensive activities from Japan or Korea to these Southeast Asian economies, where energy costs tend to be relatively low, is limited by the small size of those costs. However, there was large variation in energy shares among industries. Thus, there are potential gains from relocation for MNEs in industries with relatively large energy shares such as paper products, chemicals, non-metallic mineral products, and basic metals.

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Table 1: Major Air Pollution Emissions by Type and Source in Japan and Korea (thousand tons)

	Japan				Korea	
Type, source	1990	2000	2006	2010	2000	2006
Sulphur Oxides	1,012	922	826	756	491	446
Road Transport	186	97	76	67	6	1
Other mobile sources	40	57	54	43	43	54
Power stations	219	177	198	197	192	152
Industry	460	399	327	327	188	160
Other stationary sources	107	192	170	122	62	79
Nitrogen Oxides	1,715	1,754	1,706	1,479	1,123	1,275
Road Transport	716	634	551	368	365	450
Other mobile sources	65	85	84	71	166	196
Power stations	253	238	278	274	303	364
Industry	555	562	569	568	174	158
Other stationary	126	235	225	199	115	107
Carbon Monoxide	4,433	3,855	2,843	2,535	901	830
Road Transport	2,336	1,830	889	503	728	611
Other mobile sources	27	30	30	25	48	54
Power stations	73	76	76	87	24	39
Industry	1,758	1,713	1,672	1,772	36	36
Other stationary	239	205	176	149	64	90
Non-methane volatile	1,934	1,794	1,661	1,562	680	768
Road Transport	272	165	95	40	120	102
Other mobile sources	4	4	4	4	17	20
Power stations	2	3	3	5	4	6
Other energy	199	238	248	225	-	-
Industry	59	63	73	77	127	139
Other stationary	1,398	1,321	1,238	1,212	412	501
Solvents	1,390	1,309	1,226	1,201	368	463

Source: OECD.Stat (2013).

Table 2: Greenhouse Gas Emissions by Type in Japan and Korea and Source in Japan (million tons of CO2 equivalent)

Type, source	1990	2000	2006	2010
Total	1,205	1,342	1,334	1,258
Carbon dioxide (CO2)	1,141	1,252	1,263	1,192
Energy sources	1,059	1,167	1,185	1,123
Energy conversion	67.8	70.8	77.0	81.1
Industrial	482.2	467.2	457.0	421.4
Manufacturing	467.1	448.4	437.2	404.3
Paper products	30.0	31.3	26.5	21.3
Chemicals	60.6	61.0	58.0	52.4
Non-metallic mineral products	43.7	38.9	35.8	31.8
Ferrous basic metals	169.9	164.1	167.8	165.4
Machinery	31.3	29.3	36.4	32.4
Other manufacturing	131.6	123.8	112.8	101.0
Non-manufacturing	38.6	32.7	27.3	23.1
Double counting adjustment	-23.5	-14.0	-7.5	-6.0
Transportation	217.4	265.3	250.5	232.0
Motor vehicles	189.2	232.8	219.2	204.3
Air, rail, sea transport	28.2	32.5	31.3	27.7
Other commercial activities	127.5	157.5	165.8	172.0
Residences	164.3	206.1	234.9	217.0
Energy leakages	0.04	0.04	0.04	0.03
Non-energy sources	82.0	84.6	77.9	68.9
Industrial processes	59.9	54.0	50.1	41.2
Waste incineration, etc.	22.1	30.6	27.8	27.7
Methane (CH4)	32.0	25.9	22.5	20.4
Nitrous oxide (N2O)	31.6	29.0	24.1	22.1
Hydroflurocarbons (HFCs)	-	18.8	11.7	18.3
Perflurocarbons (PFCs)	-	9.5	7.3	3.4
Sulphur hexafluoride (SF6)	-	7.2	4.9	1.9
Korea, total	305.5	534.5	602.6	-
Carbon dioxide (CO2)	257.7	466.1	533.6	-
Methane (CH4)	43.8	29.1	23.8	-
Nitrous oxide (N2O)	3.0	16.9	18.7	-
Hydroflurocarbons (HFCs)	1.0	8.4	6.0	-
Perflurocarbons (PFCs)	-	2.3	2.7	-
Sulphur hexafluoride (SF6)	-	11.7	17.8	-

Note: Kyoto=Emissions in the base year under the Kyoto Protocol.
Sources: Japan, Ministry of the Environment (2012); OECD.Stat (2013).

Table 3: Investment in Pollution Abatement Equipment by Japan's Industrial Firms in 2006 (US$ millions, except as noted)

	Total	Total, % of equip-ment invest-ment	Air	Water	Indus-trial waste	Other
All industries	1,446.4	3.98	881.6	230.6	34.3	224.2
Manufacturing	1,008.6	4.22	601.9	196.7	12.8	134.2
Textiles	39.1	6.43	7.6	7.5	0.3	22.6
Paper products	58.8	4.89	10.0	20.8	1.2	14.9
Chemicals	147.3	3.49	76.0	39.7	1.4	17.6
Oil refining	224.2	20.95	197.0	11.9	0.0	0.4
Non-metallic mineral products	91.5	8.02	24.9	2.6	1.9	60.5
Ferrous basic metals	129.1	6.69	109.4	11.5	0.3	0.9
Non-ferrous basic metals	78.4	4.31	41.4	27.6	0.8	5.0
General machinery	48.5	3.84	37.6	6.1	1.8	2.3
Electronics-related machinery	58.5	1.05	33.5	29.7	1.2	3.4
Motor vehicles	86.1	2.59	53.7	22.0	3.4	3.3
Other manufacturing	34.6	6.22	10.8	17.3	0.5	3.3
Non-manufacturing	437.8	3.50	279.7	33.9	21.5	90.0
Electricity	433.9	4.02	277.4	33.2	21.1	90.0
Gas	0.4	0.03	0.0	0.4	0.0	0.0
Mining	3.6	1.55	2.3	0.3	0.4	0.0

Source: Japan, Ministry of Economy, Trade and Industry (2009b)

Table 4a: Capital Expenditure on Pollution Abatement by U.S. Manufacturing Plants by Purpose in 2005 (US$ millions, except as noted)

Industry	Abate-ment, total	Abate-ment, % of all expendi-tures	Air	Water	Solid waste
Manufacturing	5,907.8	4.60	3,877	1,355	676.7
Food products	448.0	3.71	152	247	49.2
Paper products	573.3	10.24	380	146	47.5
Oil and coal products	1,743.0	15.78	1,531	182	30.1
Chemicals	1,271.6	7.53	727	351	193.3
Non-metallic mineral products	217.4	4.22	160	23	34.7
Basic metals	511.9	11.44	311	100	101.7
Electronics-related manufacturing	188.9	1.07	69	82	38.6
Transportation machinery	260.1	1.70	148	75	36.8
Other manufacturing	693.6	1.73	400	148	144.8

Source: United States Census Bureau (2008).

Table 4b: Current Expenditures on Pollution Abatement by U.S. Manufacturing Plants by Purpose in 2005 (US$ millions, except as noted)

Industry	Abate-ment, total	Abate-ment, % of ship-ments	Air	Water	Solid waste
Manufacturing	20,677.6	0.44	8,629	6,725	5,323
Food products	1,572.8	0.29	314	933	326
Paper products	1,796.2	1.10	572	758	467
Oil and coal products	3,746.1	0.79	2,522	755	469
Chemicals	5,217.2	0.86	1,698	1,986	1,533
Non-metallic mineral products	696.0	0.61	483	76	137
Basic metals	2,291.1	1.14	990	638	663
Electronics-related manufacturing	814.6	0.17	227	330	257
Transportation machinery	1,319.1	0.19	485	395	440
Other manufacturing	3,224.5	0.22	1,340	853	1,032

Source: United States Census Bureau (2008).

Table 4c: Current Expenditures on Pollution Abatement Less Depreciation for U.S. Manufacturing Plants by Expense in 2005

Industry	Total	Energy	Labor	Mater-ials	Con-tracted
Amounts in US$ millions					
Manufacturing	17,829	5,712	4,096	2,811	5,210
Food products	1,374	281	257	246	591
Paper products	1,451	358	290	328	476
Oil and coal products	3,267	1,423	616	512	716
Chemicals	4,409	1,307	1,112	765	1,226
Non-metallic mineral products	583	226	135	93	128
Basic metals	1,986	599	407	314	666
Electronics-related manufacturing	731	185	244	105	196
Transportation machinery	1,179	377	339	103	361
Other manufacturing	2,850	956	698	346	850
Shares of Expenses by Category (percent)					
Manufacturing	0.60	5.73	0.71	0.12	10.51
Food products	0.42	3.08	0.54	0.09	45.94
Paper products	1.39	4.05	1.40	0.45	41.36
Oil and coal products	0.93	11.62	7.77	0.16	46.94
Chemicals	1.46	6.16	2.43	0.33	37.12
Non-metallic mineral products	0.89	3.32	0.70	0.24	11.84
Basic metals	1.37	4.83	1.91	0.29	20.49
Electronics-related manufacturing	0.27	4.96	0.32	0.06	2.75
Transportation machinery	0.23	8.35	0.40	0.02	5.23
Other manufacturing	0.31	4.58	0.27	0.06	3.56

Source: United States Census Bureau (2006, 2008).

Table 5: Expenditures on Fuels & Electricity and Shares of Major Costs Components in Total Shipments (Japan) or Gross Output (other countries) in 2006 (except 2004 for Malaysia; plants with 20 or more workers and viable data)

Industry	Fuels & elec-tricity, US$m.	Ratios to shipments or output, %				
		Intermediate consumption			Value added	
		Fuels & elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Manufacturng	89,880					
Japan, 30+ workers	55,679	2.32	53.70	5.94	10.31	27.73
Korea, 5+ workers	18,112	1.89	56.50	5.60	8.23	27.77
Malaysia, 20+ workers	3,217	2.05	67.89	7.13	6.00	16.93
Thailand, 20+ workers	6,666	4.31	56.65	15.49	5.35	18.20
Indonesia, 20+ workers	6,206	4.43	49.80	5.86	3.05	36.86
Food & beverages	7,818					
Japan, 30+ workers	4,860	2.28	50.31	1.00	10.46	35.94
Korea, 5+ workers	1,075	2.10	57.38	1.39	7.46	31.67
Malaysia, 20+ workers	307	1.57	72.87	10.12	3.61	11.83
Thailand, 20+ workers	741	3.16	56.96	16.95	5.30	17.63
Indonesia, 20+ workers	835	2.93	61.06	4.82	2.35	28.84
Textiles	3,236					
Japan, 30+ workers	746	5.83	42.73	7.07	18.67	25.70
Korea, 5+ workers	934	4.19	45.39	12.22	12.43	25.78
Malaysia, 20+ workers	122	7.28	56.46	9.13	10.90	16.23
Thailand, 20+ workers	580	9.91	47.53	18.87	9.13	14.56
Indonesia, 20+ workers	853	7.62	50.74	5.20	4.74	31.71
Paper products	5,516					
Japan, 30+ workers	3,540	6.63	50.01	3.95	10.99	28.41
Korea, 5+ workers	993	6.43	53.58	3.85	9.62	26.52
Malaysia, 20+ workers	96	4.80	58.07	7.51	9.97	19.65
Thailand, 20+ workers	320	8.05	50.03	22.81	5.26	13.86
Indonesia, 20+ workers	567	7.23	40.38	9.69	1.59	41.11
Chemicals	13,934					
Japan, 30+ workers	8,816	4.15	47.62	1.51	7.45	39.28
Korea, 5+ workers	3,357	3.90	62.77	1.59	5.16	26.58
Malaysia, 20+ workers	468	3.18	55.88	11.04	3.96	25.94
Thailand, 20+ workers	494	4.34	54.13	20.87	3.60	17.07
Indonesia, 20+ workers	799	4.96	47.55	8.00	1.24	38.25

Table 5 (continued)

Industry	Fuels & elec-tricity, US$m.	Ratios to shipments or output, %				
		Intermediate consumption			Value added	
		Fuels & elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Rubber & plastics	4,854					
Japan, 30+ workers	2,848	2.72	47.02	6.86	13.99	29.40
Korea, 5+ workers	936	2.24	51.98	7.39	11.19	27.20
Malaysia, 20+ workers	303	3.61	58.87	9.71	10.82	16.99
Thailand, 20+ workers	426	4.14	57.21	15.39	6.18	17.09
Indonesia, 20+ workers	341	3.16	63.23	3.59	2.97	27.05
Non-metallic mineral products	7,027					
Japan, 30+ workers	3,565	8.22	30.06	4.40	15.29	42.03
Korea, 5+ workers	1,709	6.81	44.41	4.09	9.04	35.65
Malaysia, 20+ workers	399	10.27	38.99	11.64	9.72	29.38
Thailand, 20+ workers	549	11.34	33.79	29.25	7.11	18.52
Indonesia, 20+ workers	806	18.74	23.46	10.05	3.75	43.99
Basic metals	13,894					
Japan, 30+ workers	10,022	4.64	56.95	3.51	7.31	27.59
Korea, 5+ workers	2,754	2.93	65.34	3.50	4.29	23.95
Malaysia, 20+ workers	323	4.28	70.41	6.17	4.59	14.55
Thailand, 20+ workers	323	5.03	64.87	13.20	2.76	14.15
Indonesia, 20+ workers	471	5.28	66.87	3.26	0.73	23.86
Electronics-related machinery	9,200					
Japan, 30+ workers	5,618	1.24	52.52	8.37	11.83	26.05
Korea, 5+ workers	1,865	0.90	49.46	6.40	8.54	34.70
Malaysia, 20+ workers	532	0.93	74.89	5.25	5.40	13.53
Thailand, 20+ workers	1,008	3.68	58.66	13.68	5.39	18.58
Indonesia, 20+ workers	176	1.94	56.27	3.92	2.57	35.30
Transportation machinery	7,130					
Japan, 30+ workers	4,247	0.85	65.35	4.25	9.00	20.56
Korea, 5+ workers	1,444	0.92	59.72	5.48	9.42	24.46
Malaysia, 20+ workers	81	0.91	70.59	7.21	6.66	14.63
Thailand, 20+ workers	838	3.72	56.48	11.48	2.78	25.54
Indonesia, 20+ workers	521	4.11	34.25	5.67	1.23	54.74

Notes and sources: Data for Indonesia, Malaysia, and Thailand refer to samples of plants with viable data (see text for details); see Appendix Tables 1a, 1b, 1c, 1d, 1e for data for on additional industries and sources.

Table 6: Foreign MNE share of Expenditures on Fuels & Electricity and MNE-Local Percentage Differences in Shares of Major Cost Components in Gross Output in 2006 (except 2004 for Malaysia; plants with 20 or more workers and viable data)

Industry	Fuels & electricity, MNE share,%	MNE-Local differences in ratios to output, %				
		Intermediate consumption			Value added	
		Fuels & electricity	Raw materials	Other	Wage	Non-wage
MANUFACTURING, WEIGHTED AVERAGES						
Malaysia, majority-foreign MNEs	37.83	-0.91	5.06	-0.27	-0.96	-2.92
Thailand, all MNEs	44.17	-0.34	3.57	-0.88	-1.74	-0.60
Indonesia, all MNEs	28.54	-1.40	-2.49	-0.61	-1.59	6.08
MANUFACTURING, 15 INDUSTRY MEANS						
Malaysia, majority-foreign MNEs	34.42	-0.19	0.16	1.22	-1.11	-0.07
Thailand, all MNEs	40.64	0.27	2.41	0.46	-1.41	-1.73
Indonesia, all MNEs	32.27	-1.19	0.79	-1.13	-1.45	2.97
FOOD & BEVERAGES						
Malaysia, majority-foreign MNEs	21.19	0.19	-10.26	2.41	0.05	7.61
Thailand, all MNEs	17.47	0.32	-5.05	2.90	1.14	0.69
Indonesia, all MNEs	21.80	-0.98	-11.09	-0.93	-1.51	14.52
TEXTILES						
Malaysia, majority-foreign MNEs	75.75	4.26	4.07	2.05	-5.67	-4.72
Thailand, all MNEs	21.39	-0.71	3.35	-5.96	-1.85	5.16
Indonesia, all MNEs	23.65	-2.94	4.73	3.14	-2.91	-2.02
APPAREL						
Malaysia, majority-foreign MNEs	43.16	-0.16	8.75	-9.85	6.20	-4.93
Thailand, all MNEs	28.46	0.03	-0.41	3.08	-2.27	-0.43
Indonesia, all MNEs	25.36	-1.99	-1.53	3.35	-2.14	2.31
WOOD PRODUCTS						
Malaysia, majority-foreign MNEs	19.70	0.39	-4.07	2.06	-0.75	2.36
Thailand, all MNEs	8.98	-0.79	2.72	2.06	-3.74	-0.25
Indonesia, all MNEs	16.58	-0.33	10.40	1.01	-2.50	-8.58
PAPER PRODUCTS						
Malaysia, majority-foreign MNEs	9.61	-2.94	6.46	2.23	-0.95	-4.81
Thailand, all MNEs	51.15	3.00	-9.79	14.70	-3.32	-4.59
Indonesia, all MNEs	29.93	-0.14	12.70	-7.13	-2.52	-2.92
CHEMICALS						
Malaysia, majority-foreign MNEs	50.15	-1.19	15.79	2.33	-1.88	-15.05
Thailand, all MNEs	28.80	-1.22	1.03	1.45	-1.25	-0.02
Indonesia, all MNEs	25.69	-1.73	9.73	-1.21	-1.25	-5.54

Table 6 (continued)

Industry	Fuels & electricity, MNE share,%	Ratios to shipments or output, %				
		Intermediate consumption			Value added	
		Fuels & electricity	Raw materials	Other	Wage	Non-wage
RUBBER & PLASTICS						
Malaysia, majority-foreign MNEs	32.24	-0.87	-7.84	4.08	0.13	4.51
Thailand, all MNEs	38.64	-0.05	-6.62	1.34	-0.07	5.40
Indonesia, all MNEs	22.84	-0.79	5.83	0.80	-0.60	-5.24
NON-METALLIC MINERAL PRODUCTS						
Malaysia, majority-foreign MNEs	28.75	-0.09	-10.68	2.65	0.17	7.94
Thailand, all MNEs	7.86	-2.37	6.60	-2.82	2.94	-4.35
Indonesia, all MNEs	30.34	0.88	-4.01	-5.48	1.89	6.73
BASIC METALS						
Malaysia, majority-foreign MNEs	10.06	-1.85	-7.37	6.78	2.11	0.32
Thailand, all MNEs	42.69	0.06	11.84	-7.03	-0.43	-4.45
Indonesia, all MNEs	11.29	-1.67	-18.12	1.25	0.73	17.82
METAL PRODUCTS						
Malaysia, majority-foreign MNEs	35.47	0.25	-3.66	1.26	-3.51	5.66
Thailand, all MNEs	38.91	-0.34	-7.39	10.23	0.07	-2.56
Indonesia, all MNEs	41.76	0.27	2.03	0.46	-1.71	-1.05
GENERAL MACHINERY						
Malaysia, majority-foreign MNEs	60.42	0.23	1.37	-1.09	-4.05	3.53
Thailand, all MNEs	63.00	0.51	10.34	-3.38	-0.95	-6.51
Indonesia, all MNEs	48.08	-0.88	-2.83	-5.08	1.43	7.36
ELECTRONICS-RELATED MACHINERY						
Malaysia, majority-foreign MNEs	77.31	-0.23	4.53	-1.93	-1.94	-0.44
Thailand, all MNEs	85.96	2.79	-13.73	5.30	0.27	5.37
Indonesia, all MNEs	66.34	-0.54	4.83	-0.35	-1.62	-2.31
MOTOR VEHICLES						
Malaysia, majority-foreign MNEs	12.45	-0.10	3.50	-2.35	0.28	-1.32
Thailand, all MNEs	60.85	-0.25	-4.15	4.85	-1.24	0.79
Indonesia, all MNEs	87.23	1.58	-24.23	-1.19	-4.34	28.19
OTHER TRANSPORTATION MACHINERY						
Malaysia, majority-foreign MNEs	22.69	-0.18	-10.22	4.90	-6.53	12.02
Thailand, all MNEs	88.08	5.99	14.17	-16.91	-3.90	0.65
Indonesia, all MNEs	18.81	-7.66	17.22	-7.61	-3.97	2.03
OTHER MANUFACTURING						
Malaysia, majority-foreign MNEs	17.32	-0.53	11.97	2.70	-0.38	-13.75
Thailand, all MNEs	27.39	-2.93	33.21	-2.90	-6.49	-20.89
Indonesia, all MNEs	14.37	-0.89	6.22	2.04	-0.68	-6.69

Notes and sources: Data refer to samples of plants with viable data (see text for details); see Appendix Tables 2a, 2b, 2c, for details and sources.

Appendix Table 1a: Expenditures on Fuels & Electricity and Shares of Major Costs Components in Total Shipments in Japan's Medium-Large Manufacturing Plants 2006 (30 or more employees)

Industry	Fuels & elec-tricity, US$m.	Ratios to shipments, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Manufacturng	55,679	1.17	1.15	53.70	5.94	10.31	27.73
Food & beverages	4,860	1.19	1.09	50.31	1.00	10.46	35.94
Textiles	746	3.02	2.81	42.73	7.07	18.67	25.70
Apparel, etc.	151	0.55	1.00	37.52	13.22	22.49	25.22
Wood products	235	0.45	1.47	61.20	2.28	12.50	22.09
Paper products	3,540	4.62	2.01	50.01	3.95	10.99	28.41
Chemicals	8,816	2.61	1.55	47.62	1.51	7.45	39.28
Rubber & plastics	2,848	0.77	1.95	47.02	6.86	13.99	29.40
Rubber products	664	0.94	1.68	45.68	4.66	15.34	31.69
Plastics	2,184	0.72	2.04	47.45	7.56	13.56	28.67
Nonmetallic mineral products	3,565	5.24	2.98	30.06	4.40	15.29	42.03
Basic metals	10,022	2.05	2.59	56.95	3.51	7.31	27.59
Ferrous basic metals	7,907	2.49	2.99	55.44	3.05	7.20	28.83
Nonferrous basic metals	2,114	1.17	1.79	60.00	4.44	7.52	25.07
Metal products	1,890	0.77	1.52	43.21	11.96	16.38	26.16
General machinery	2,325	0.23	0.72	46.81	13.71	13.67	24.86
Electronics-related machinery	5,618	0.29	0.95	52.52	8.37	11.83	26.05
Transportation machinery	4,247	0.28	0.56	65.35	4.25	9.00	20.56
Other manufacturing	6,817	2.30	0.53	56.49	5.56	6.11	29.01
Oil & coal products	5,519	3.94	0.27	74.64	0.10	0.84	20.21

Notes: Value added is estimated as the difference between shipments and intermediate consumption; raw materials include parts; other manufacturing includes tobacco, leather & footwear, printing & publishing, oil & coal products, miscellaneous manufacturing, and recycling; the motor vehicles category is omitted because most variables are not disclosed to protect anonymity of reporting plants.
Source: Japan, Ministry of Economy, Trade and Industry (2009a)

Appendix Table 1b: Expenditures on Fuels & Electricity and the Structure of Output in Korea's Manufacturing Plants 2006 (5 or more employees)

Industry	Fuels & elec-tricity, US$m.	Ratios to Output, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Manufacturng	18,112	0.88	1.01	56.50	5.60	8.23	27.77
Food & beverages	1,075	1.17	0.92	57.38	1.39	7.46	31.67
Textiles	934	1.93	2.26	45.39	12.22	12.43	25.78
Apparel	51	0.10	0.28	28.03	21.39	13.42	36.79
Wood products	97	0.63	1.40	59.39	4.36	11.37	22.86
Paper products	993	3.34	3.09	53.58	3.85	9.62	26.52
Chemicals	3,357	2.31	1.59	62.77	1.59	5.16	26.58
Rubber & plastics	936	0.69	1.55	51.98	7.39	11.19	27.20
Nonmetallic mineral products	1,709	4.28	2.53	44.41	4.09	9.04	35.65
Basic metals	2,754	1.11	1.82	65.34	3.50	4.29	23.95
Metal products	667	0.39	1.07	48.86	10.67	13.04	25.97
General machinery	570	0.13	0.56	53.42	8.49	10.75	26.65
Electronics-related machinery	1,865	0.17	0.73	49.46	6.40	8.54	34.70
Transportation machinery	1,444	0.42	0.50	59.72	5.48	9.42	24.46
Motor vehicles	914	0.25	0.56	62.30	3.54	8.57	24.78
Other transportation machiner	530	0.87	0.35	52.99	10.52	11.64	23.62
Other manufactuirng	1,660	1.08	0.44	68.47	3.55	5.05	21.40
Oil & coal products	1,368	1.51	0.36	80.98	0.42	0.96	15.77

Notes: Raw materials include parts; other manufacturing includes tobacco, leather & footwear, printing & publishing, oil & coal products, miscellaneous manufacturing, and
Source: Korea, National Statistical Office (2007)

Appendix Table 1c: Expenditures on Fuels & Electricity and the Structure of Output in Malaysia's Medium-Large Manufacturing Plants 2004 (20 or more employees)

Industry	Fuels & elec-tricity, US$m.	Ratios to Output, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Manufacturng	3,217	0.90	1.15	67.89	7.13	6.00	16.93
Food & beverages	307.34	0.88	0.69	72.87	10.12	3.61	11.83
Textiles	122.48	1.91	5.37	56.46	9.13	10.90	16.23
Apparel	15.16	0.18	0.82	54.51	11.90	20.82	11.77
Wood products	141.62	1.44	2.20	56.37	7.89	10.97	21.14
Paper products	95.54	2.62	2.18	58.07	7.51	9.97	19.65
Chemicals	467.99	1.60	1.59	55.88	11.04	3.96	25.94
Rubber & plastics	303.15	1.36	2.25	58.87	9.71	10.82	16.99
Nonmetallic mineral products	398.96	6.01	4.25	38.99	11.64	9.72	29.38
Basic metals	323.34	1.99	2.29	70.41	6.17	4.59	14.55
Metal products	79.69	0.59	1.34	59.84	8.74	10.36	19.13
General machinery	54.29	0.40	1.04	60.22	7.19	10.68	20.48
Electronics-related machinery	532.06	0.20	0.73	74.89	5.25	5.40	13.53
Transportation machinery	80.71	0.27	0.64	70.59	7.21	6.66	14.63
Motor vehicles	60.37	0.24	0.60	72.34	5.75	5.22	15.84
Other transportation machiner	20.35	0.37	0.81	63.30	13.29	12.63	9.60
Other manufactuirng	3.69	0.28	1.54	56.05	5.80	18.35	17.97

Notes: Raw materials include parts; other manufacturing includes tobacco, leather & footwear, printing & publishing, oil & coal products, miscellaneous manufacturing, and
Source: Malaysia, Department of Statistics (various years).

Appendix Table 1d: Expenditures on Fuels & Electricity and the Structure of Output in Thailand's Medium-Large Manufacturing Plants 2006 (20 or more employees)

		Ratios to Output, %				
		Intermediate consumption			Value added	
Industry	Fuels & elec-tricity, US$m.	Fuels & elec-tricity	Raw mater-ials	Other	Wage	Non-wage
Manufacturng	6,666	4.31	56.65	15.49	5.35	18.20
Food & beverages	741.20	3.16	56.96	16.95	5.30	17.63
Textiles	580.50	9.91	47.53	18.87	9.13	14.56
Apparel	158.39	4.35	53.25	16.55	14.23	11.62
Wood products	73.66	5.37	53.05	18.58	9.28	13.72
Paper products	319.51	8.05	50.03	22.81	5.26	13.86
Chemicals	493.60	4.34	54.13	20.87	3.60	17.07
Rubber & plastics	426.40	4.14	57.21	15.39	6.18	17.09
Nonmetallic mineral products	548.97	11.34	33.79	29.25	7.11	18.52
Basic metals	323.40	5.03	64.87	13.20	2.76	14.15
Metal products	269.58	4.09	53.74	17.07	6.72	18.37
General machinery	436.23	4.93	51.50	20.33	4.98	18.27
Electronics-related machinery	1,008	3.68	58.66	13.68	5.39	18.58
Transportation machinery	838.29	3.72	56.48	11.48	2.78	25.54
Motor vehicles	438.68	2.35	56.10	12.00	2.50	27.06
Other transportation machiner	399.60	10.42	58.33	8.99	4.16	18.11
Other manufactuirng	448.63	2.51	66.92	8.95	6.07	15.54

Notes: Raw materials include parts; other manufacturing includes tobacco, leather & footwear, printing & publishing, oil & coal products, miscellaneous manufacturing, and
Source: Thailand, National Statistical Office (2009).

Appendix Table 1e: Expenditures on Fuels & Electricity and the Structure of Output in Indonesia's Medium-Large Manufacturing Plants 2006 (20 or more employees)

Industry	Fuels & elec-tricity, US$m.	Ratios to Output, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw materia	Other	Wage	Non-wage
Manufacturng	6,206	2.35	2.08	49.80	5.86	3.05	36.86
Food & beverages	835.40	2.07	0.86	61.06	4.82	2.35	28.84
Textiles	852.68	3.37	4.25	50.74	5.20	4.74	31.71
Apparel	211.58	1.41	2.93	43.93	9.22	10.33	32.18
Wood products	166.26	2.79	1.22	53.14	4.49	6.75	31.61
Paper products	567.41	5.14	2.08	40.38	9.69	1.59	41.11
Chemicals	798.80	2.28	2.68	47.55	8.00	1.24	38.25
Rubber & plastics	341.19	1.45	1.71	63.23	3.59	2.97	27.05
Nonmetallic mineral products	805.65	12.59	6.15	23.46	10.05	3.75	43.99
Basic metals	471.17	2.72	2.55	66.87	3.26	0.73	23.86
Metal products	111.35	1.46	1.71	52.32	5.61	3.11	35.79
General machinery	99.40	1.36	2.37	50.98	8.45	3.95	32.89
Electronics-related machinery	175.77	0.48	1.46	56.27	3.92	2.57	35.30
Transportation machinery	520.73	1.33	2.78	34.25	5.67	1.23	54.74
Motor vehicles	308.64	1.02	3.03	23.89	5.62	1.11	65.32
Other transportation machiner	212.08	1.79	2.41	49.88	5.75	1.41	38.76
Other manufactuirng	248.45	0.82	0.78	32.79	6.23	5.25	54.13

Notes: Raw materials include parts; other manufacturing includes tobacco, leather & footwear, printing & publishing, oil & coal products, miscellaneous manufacturing, and
Source: Indonesia, BPS-Statistics (2008).

Appendix Table 2a: Expenditures on Fuels & Electricity and Shares of Major Cost Components in Gross Output for Majority-Foreign MNEs (foreign share=50%+) and Local Plants in Malaysia, 2004

Industry	Fuels & elec-tricity, US$m.	Ratios to output, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw mater-ials	Other	Wage	Non-wage
LOCAL PLANTS							
Manufacturng, weighted average	2,000	1.26	1.23	65.41	7.26	6.47	18.36
Manufacturng, 15 industry mean	-	1.63	1.49	60.61	8.46	9.49	18.32
Food & beverages	242.22	0.66	0.88	74.85	9.66	3.60	10.35
Textiles	29.70	2.80	1.84	53.94	7.86	14.41	19.15
Apparel	8.62	0.87	0.21	50.38	16.56	17.89	14.09
Wood products	113.73	2.08	1.49	57.10	7.51	11.10	20.71
Paper products	86.36	2.29	3.07	56.84	7.09	10.15	20.55
Chemicals	233.30	1.92	1.97	46.54	9.66	5.07	34.85
Rubber & plastics	205.43	2.34	1.60	61.84	8.16	10.77	15.29
Nonmetallic mineral products	284.26	4.06	6.23	42.08	10.90	9.67	27.06
Basic metals	290.80	2.33	2.24	71.57	5.08	4.26	14.51
Metal products	51.42	1.25	0.60	61.04	8.33	11.50	17.28
General machinery	21.49	0.92	0.38	59.44	7.80	12.96	18.49
Electronics-related machinery	120.72	0.97	0.15	71.22	6.81	6.97	13.88
Motor vehicles	52.85	0.61	0.25	71.86	6.09	5.18	16.01
Other transportation machinery	15.73	0.81	0.42	65.92	12.03	14.30	6.52
Other manufactuirng	243.30	0.54	1.06	64.56	3.35	4.46	26.02
MAJORTIY-FOREIGN MNES							
Manufacturng, weighted average	1,217	1.03	0.56	70.47	6.99	5.51	15.44
Manufacturng, 15 industry mean	-	1.90	1.03	60.77	9.67	8.37	18.25
Food & beverages	65.12	0.83	0.89	64.60	12.07	3.65	17.96
Textiles	92.78	6.95	1.95	58.01	9.91	8.74	14.44
Apparel	6.54	0.77	0.15	59.13	6.70	24.09	9.16
Wood products	27.90	2.71	1.25	53.03	9.58	10.36	23.07
Paper products	9.18	1.70	0.72	63.30	9.32	9.21	15.75
Chemicals	234.69	1.36	1.34	62.33	11.99	3.19	19.80
Rubber & plastics	97.72	2.11	0.96	54.00	12.24	10.90	19.80
Nonmetallic mineral products	114.70	4.73	5.48	31.40	13.55	9.84	35.00
Basic metals	32.54	2.07	0.66	64.21	11.86	6.37	14.83
Metal products	28.26	1.53	0.57	57.38	9.59	7.99	22.94
General machinery	32.80	1.13	0.41	60.82	6.71	8.92	22.02
Electronics-related machinery	411.35	0.67	0.22	75.75	4.88	5.04	13.44
Motor vehicles	7.52	0.56	0.19	75.36	3.74	5.46	14.69
Other transportation machinery	4.62	0.84	0.21	55.70	16.94	7.77	18.55
Other manufactuirng	50.96	0.52	0.55	76.53	6.05	4.07	12.27

Notes and Source: See Appendix Table 1c.

Appendix Table 2b: Expenditures on Fuels & Electricity and Shares of Major Cost Components in Gross Output for Foreign MNEs (foreign share=10%+) and Local Plants in Thailand, 2006

Industry	Fuels & elec-tricity, US$m.	Ratios to output, %				
		Intermediate consumption			Value added	
		Fuels & elec-tricity	Raw mater-ials	Other	Wage	Non-wage
LOCAL PLANTS						
Manufacturng, totals, weighted av	3,722	4.47	55.00	15.90	6.16	18.47
Manufacturng, 15 industry mean	-	5.21	53.06	17.02	6.90	17.81
Food & beverages	611.70	3.10	57.78	16.47	5.12	17.53
Textiles	456.31	10.07	46.77	20.23	9.53	13.39
Apparel	113.31	4.34	53.36	15.68	14.86	11.76
Wood products	67.05	5.45	52.77	18.37	9.66	13.74
Paper products	156.08	6.79	54.15	16.60	6.65	15.82
Chemicals	351.46	4.76	53.77	20.36	4.03	17.08
Rubber & plastics	261.63	4.15	59.78	14.87	6.22	14.97
Nonmetallic mineral products	505.83	11.57	33.15	29.53	6.85	18.91
Basic metals	185.35	5.00	59.85	16.18	2.95	16.02
Metal products	164.69	4.23	56.76	12.86	6.70	19.45
General machinery	161.40	4.62	45.24	22.39	5.55	22.20
Electronics-related machinery	141.56	1.72	68.28	10.00	5.20	14.79
Motor vehicles	171.76	2.50	58.72	8.92	3.28	26.57
Other transportation machinery	47.65	5.73	47.23	22.23	7.21	17.61
Other manufactuirng	325.77	4.16	48.29	10.58	9.72	27.26
FOREIGN MNES						
Manufacturng, totals, weighted av	2,945	4.13	58.57	15.02	4.42	17.87
Manufacturng, 15 industry mean	-	5.48	55.47	17.48	5.50	16.07
Food & beverages	129.50	3.42	52.72	19.37	6.26	18.22
Textiles	124.19	9.36	50.13	14.28	7.69	18.55
Apparel	45.08	4.38	52.96	18.75	12.59	11.33
Wood products	6.61	4.66	55.49	20.43	5.92	13.50
Paper products	163.43	9.79	44.35	31.30	3.33	11.23
Chemicals	142.14	3.54	54.80	21.81	2.78	17.06
Rubber & plastics	164.77	4.11	53.16	16.21	6.14	20.37
Nonmetallic mineral products	43.14	9.20	39.75	26.71	9.79	14.55
Basic metals	138.04	5.07	71.69	9.16	2.52	11.57
Metal products	104.88	3.89	49.37	23.09	6.76	16.89
General machinery	274.83	5.13	55.58	19.00	4.60	15.69
Electronics-related machinery	866.48	4.51	54.55	15.30	5.48	20.16
Motor vehicles	266.92	2.25	54.58	13.78	2.04	27.35
Other transportation machinery	351.95	11.71	61.40	5.32	3.31	18.25
Other manufactuirng	122.86	1.23	81.50	7.68	3.22	6.37

Notes and Source: See Appendix Table 1d.

Appendix Table 2c: Expenditures on Fuels & Electricity and Shares of Major Cost Components in Gross Output for Foreign MNEs (foreign share=10%+) and Local Plants in Indonesia, 2006

Industry	Fuels & elec-tricity, US$m.	Ratios to output, %					
		Intermediate consumption				Value added	
		Fuels	Elec-tricity	Raw mater-ials	Other	Wage	Non-wage
LOCAL PLANTS							
Manufacturng, weighted average	4,435	2.73	2.20	50.69	6.08	6.08	32.22
Manufacturng, 15 industry mean	-	2.94	2.67	47.79	6.90	7.16	32.53
Food & beverages	653.29	2.35	0.86	64.24	5.09	4.17	23.30
Textiles	651.04	3.68	4.87	49.23	4.19	7.34	30.69
Apparel	157.93	1.45	3.60	44.48	8.02	15.26	27.19
Wood products	138.70	2.83	1.24	51.28	4.31	12.32	28.02
Paper products	397.59	5.29	1.98	36.53	11.85	5.66	38.69
Chemicals	593.59	2.73	2.81	44.29	8.40	4.24	37.53
Rubber & plastics	263.26	1.60	1.78	61.61	3.37	5.20	26.45
Nonmetallic mineral products	561.18	12.40	6.08	24.64	11.66	7.46	37.75
Basic metals	417.96	2.71	2.82	69.67	3.07	3.17	18.55
Metal products	64.86	1.51	1.56	51.51	5.43	7.03	32.96
General machinery	51.61	1.12	3.08	52.51	11.19	8.65	23.45
Electronics-related machinery	59.17	0.96	1.37	52.80	4.17	7.11	33.59
Motor vehicles	39.41	0.91	1.86	43.59	6.59	6.46	40.59
Other transportation machinery	172.19	3.59	5.35	39.23	10.45	5.71	35.66
Other manufactuirng	212.74	0.98	0.83	31.26	5.72	7.64	53.56
FOREIGN MNES							
Manufacturng, weighted average	1,771	1.66	1.87	48.21	5.47	4.49	38.30
Manufacturng, 15 industry mean	-	2.42	2.00	48.58	5.77	5.71	35.50
Food & beverages	182.10	1.38	0.85	53.14	4.16	2.66	37.81
Textiles	201.64	2.69	2.93	53.96	7.33	4.42	28.67
Apparel	53.65	1.33	1.74	42.95	11.36	13.13	29.50
Wood products	27.56	2.60	1.14	61.69	5.33	9.81	19.43
Paper products	169.82	4.80	2.33	49.23	4.73	3.14	35.77
Chemicals	205.21	1.39	2.42	54.02	7.19	2.98	31.99
Rubber & plastics	77.93	1.06	1.53	67.44	4.17	4.60	21.21
Nonmetallic mineral products	244.47	13.05	6.32	20.62	6.18	9.35	44.48
Basic metals	53.22	2.79	1.07	51.54	4.32	3.90	36.37
Metal products	46.50	1.38	1.95	53.54	5.89	5.32	31.91
General machinery	47.79	1.56	1.76	49.68	6.11	10.07	30.81
Electronics-related machinery	116.60	0.29	1.50	57.63	3.82	5.48	31.28
Motor vehicles	269.23	1.05	3.30	19.36	5.40	2.12	68.77
Other transportation machinery	39.89	0.68	0.59	56.45	2.85	1.74	37.68
Other manufactuirng	35.71	0.31	0.62	37.48	7.76	6.96	46.87

Notes and Source: See Appendix Table 1e.