Do Multinationals Use Water and Energy Relatively Efficiently in Malaysian Manufacturing?

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Does Multinational Presence Affect Energy Efficiency in Malaysia's Local Manufacturing Plants?

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Abstract

Using data on medium-large manufacturing plants from the industrial census for 2000 and sample surveys for 2001-2004, this paper asks whether the extent of foreign multinational enterprise (MNE) presence in an industry affects the energy efficiency of local Malaysian plants. At the industry level, correlations between MNE shares of labor or output and local plant energy intensities were negative but rather weak. Plant-level econometric estimates indicate that correlations of MNE shares to local plant energy intensities were more often negative than positive, after accounting for other factor usage and technical characteristics of plants. However, these results vary greatly depending upon on the sample of industries examined, the econometric estimation technique used, whether MNE shares are measured in terms of labor or output, and the level of aggregation used when defining MNE shares. If fixed effects estimators (the most common methodology in the recent literature) are used, most of the spillover coefficients are insignificant, and most of the relatively few significant coefficients are positive. Thus, it is probably best to conclude that evidence of intra-industry, energy intensity spillovers from MNE presence is rather weak.

Keywords: multinational enterprise, energy efficiency, spillover, Malaysia, manufacturing

JEL Categories: F23, L60, O53, Q40

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1. Introduction

This paper asks whether the extent of foreign multinational enterprise (MNE) presence in Malaysia's manufacturing industries is correlated with energy efficiency in medium-large, local plants covered by Malaysia's manufacturing census for 2000 and subsequent manufacturing surveys for 2001-2004. Energy efficiency is defined as the ratio of purchased energy (electricity and fuel) to gross output and does not consider energy produced by plants or pollution abatement efforts. Answering this question is important because energy consumption is usually the largest ultimate source of portion of air pollution generated by manufacturing plants. Greater energy conservation generally implies increased energy efficiency and is an important way to limit or reduce related pollution, especially in middle-income economies like Malaysia, where foreign MNE presence has been relatively large for decades. Much of the more advanced energy saving technology in the world is controlled by MNEs and it is possible that the presence of foreign MNEs can affect how local plants or firms in host economies use energy through so-called intra-industry spillovers.

The paper first reviews related literature analyzing productivity spillovers of MNEs and its implications for analysis of energy efficiency in local plants (Section 2). Second, it describes the database used and simple, industry-level correlations of foreign shares of labor and output to energy intensities (ratios of energy expenditures to output) in local plants (Section 3). It then analyzes whether correlations of MNE shares to local plant energy intensities persist after accounting for other factor use and plant-level technical characteristics that may affect energy intensities (Section 4). Section 5 concludes.

2. MNEs, Energy Efficiency, and Spillovers in Developing Economies

In recent years, theoretical analyses have highlighted the role of what have been called knowledge-based, intangible assets (terminology from Markusen 1991) in MNEs. The key goals of many theoretical analyses are to explain why the MNE chooses to invest abroad when it (at least initially) has several cost disadvantages compared to local firms, and why the MNE chooses to spread out production across countries rather than concentrate it in one location. Most observers agree that MNEs tend to possess relatively large amounts of technological knowledge and networks, marketing expertise and networks, especially international ones, and generally have relatively sophisticated and capable management.[1] The first two characteristics are evidenced by relatively high research and development (R&D) intensities (ratios to total sales), relatively large proportions of patent applications and approvals, relatively high advertising-sales ratios, and relatively high dependence on international trade (generally on both exports and imports). Correspondingly, when asking what makes a firm decide to assume the extra costs of investing in a foreign country (compared to the costs of local firms in the host), Dunning (1988) asserted that a firm must first have "ownership advantages" such as those afforded by possession of relatively large amounts intangible assets, as well as "location advantages" and "internalization advantages" before investing.[2]

The important implication is that, if one accepts the idea that MNEs have relatively large amounts of knowledge-based, intangible assets, MNEs will tend to be relatively efficient producers compared to non-MNEs, at least in some respect. They are also a potentially important source of spillovers that foster higher productivity in local firms. In this context, spillovers refer to the effects that foreign MNE presence has on local plants. These spillovers operate through at least three major channels.

The first channel is direct linkage between MNEs and local plants. Most often these are backward linkages created when MNEs source raw materials, parts, or services from local plants. In many cases, local plants are not able to produce the required materials, parts or

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[1] Caves (2007) and Dunning and Lundan (2008) provide thorough literature reviews. The work of Markusen (2002) has also been influential.

[2] Dunning's OLI (ownership-location-internalization) paradigm has been influential, but others (Buckley and Casson 1992, Casson 1987, Rugman 1980, 1985) emphasize that the concept of internalization alone can explain the existence of the MNE and its characteristics.

services of acceptable quality and/or meet the logistic requirements of the MNE. And in many of these cases, MNEs work closely with local suppliers to help them increase production capacity, improve quality, and meet the logistic requirements involved. The MNE may source inputs from local firms in the same industry or in different industries. In other cases, MNEs may create forward linkages to local firms by supplying intermediate goods (materials, parts, services) or final goods of superior quality. Here again MNEs may find it profitable to help the local firms involved improve their production processes or marketing efforts to better take advantage of the goods or services provided by the MNE. The literature and casual observation suggest that backward linkages are probably more common avenues of spillovers than forward linkages.

The second channel is labor mobility. MNEs often require workers that are relatively skilled and often seek to recruit them from local firms. The relative shortage of skilled labor (particularly middle-level technicians and managers) is one of the most severe constraints affecting Southeast Asian economies, including Malaysia. Thus, not only do MNEs attempt to poach relatively scare, skilled workers from local plants, but local plants often try to hire workers from MNEs. Another group of MNE workers realize their experience has given them the skills to become an entrepreneur and start their own firm. In some instances, the firms created by ex-MNE employees end up supplying parts, materials, and/or services to their old MNE employers. Here again, the spillovers can be either intra- or inter-industry, though they are probably more likely to be intra-industry, to the extent that skills are industry specific.

The third major channel is a demonstration or competition effect. The entry or expansion of foreign MNEs usually increases the competitive pressure on local plants producing goods or services that compete with those produced by the MNE. The increased competitive pressure can motivate local firms to increase their own competitiveness in various ways such as developing or upgrading technology, cutting input costs, or expanding marketing efforts. This effect is predominantly intra-industry in nature, provided that industry definitions are broad enough to include competing firms or plants in the same industry.[3]

Much of the existing research on spillovers focuses on intra-industry productivity spillovers. In other words, these studies examine the effect MNE presence has on the productivity of local firms in the industry where the MNE operates. More recent studies have also examined inter-industry spillovers through forward and backward linkages. Several reviews emphasize that empirical evidence regarding productivity spillovers has been mixed (Görg and Stobl 2001; Fan 2002; Görg and Greenaway 2004; Lipsey and Sjöholm 2005; Pessoa 2007).[4] Previous studies of Asian economies also suggest that estimates of spillovers vary substantially depending on the economies and industry groups studied, the measure of foreign presence used (i.e., whether foreign shares are measured in terms of employment, output, or fixed assets, for example), and estimation methodology. In general, estimates of spillovers are larger when cross sectional methodologies are used, but recent studies generally use fixed effects estimators when panel data are available.[5]

For Malaysia we know of only two studies of spillovers, both of which analyze the 2000-2004 data set used in this study. Khalifah and Adam (2009) analyze a balanced panel using a simplified Cobb-Douglas specification (assuming constant returns to scale) and samples of all manufacturing plants combined. They find that productivity spillovers were positive when MNE presence is

[3] The presence of multi-product firms and plants, including many MNEs, creates substantial divergence between theory, which often assumes single-product, single-plant firms, and statistical compilations, which usually classify multi-product plants and firms by their largest product or service. In Thailand, there are several, large multi-product plants and many multi-plant firms, both local and MNE, which makes this divergence of particular concern. Correspondingly, relatively narrow industry definitions (e.g., 4- or 5-digit level) probably create important outliers among these important, large, multi-product firms or plants.

[4] A recent meta-analysis by Mebratie and van Bergeijk (2013) argues that accounting for firm heterogeneity in terms of R&D and exporting changes many ambiguous results and provides stronger evidence of positive spillovers.

[5] In general, fixed effects panel estimates are preferred because they control for unobserved characteristics among local plants or firms and because they are less vulnerable simultaneity problems that may arise if MNEs are attracted to high productivity industries. However, fixed effects estimates analyze the question of whether changes in foreign shares are related to changes in local firm or plant productivity, which differs from the static question of whether large or small foreign presence affects productivity in local plants or firms.

measured as the share of value added or fixed assets, but insignificant or negative when MNE presence is measured as the share of employment. Spillovers are also found to depend on the foreign ownership shares. Haji Ahmad (2010, Ch. 6) uses the same data set, a translog specification, and both balanced and unbalanced panels. She finds that evidence of significant spillovers was rare. Her results also examined several groups of manufacturing industries, finding that the results varied greatly depending on the industry group examined.

Some of the earliest research on spillovers from MNEs in Asian hosts examined Indonesia because manufacturing surveys and censuses are rich and easily obtainable. For example, cross section evidence for 1980 and 1991 from Blomström and Sjöholm (1999) and Sjöholm (1997, 1999a, 1999b) indicated that productivity spillovers tended to be positive, and that spillovers tended to be relatively strong in industries where competition among local plants was relatively intense and within regions with diversified industrial structures; there was also some evidence that spillovers were relatively large in industries with large technological gaps between MNEs and local plants, but it was inconsistent, while the degree of foreign ownership, and geographical proximity did not affect the extent of spillovers. Subsequent, more rigorous, panel analysis for 1990-1995 (Takii 2005, 2006) revealed evidence positive intra-industry spillovers that were more prevalent in industries with small technical gaps and where minority foreign MNEs had relatively large shares. Similarly, Blalock and Gertler (2008) found strong evidence of productivity gains, greater competition, and lower prices among local firms in markets that supplied foreign entrants in 1988-2006. Suyanto et al. (2009) analyze spillovers in chemical and pharmaceutical plants in 1998-2000, using a stochastic frontier approach and a generalized Malmquist output-oriented index to decompose productivity growth. Their results show positive productivity spillovers from FDI that are larger with higher competition and in local plants with R&D. Results from Lipsey and Sjöholm (2004, 2006) and Sjöholm and Lipsey (2006) also suggest the existence of positive wage spillovers; i.e., they indicate that local plants tended to pay relatively high wages in industries with large foreign presence. Their results also suggested that foreign takeovers led to higher wages in target plants, but that targeted firms were not necessarily high-wage plants before the takeover.

More recently, a number of studies also indicate positive productivity spillovers in China, but the details are again varied. Using industry level data, Buckley et al. (2007) find a curvilinear relationship with foreign direct investment from HMT (Hong Kong, Macau and Taiwan) firms, but not for other (Western) firms, which is most pronounced for low-technology host industries. In contrast, using a firm-level panel for 1998-2005, Lin et al. (2009) find that HMT firms generated negative horizontal spillovers, while non-HMT firms tended to create positive horizontal spillovers. They also find strong and robust vertical spillover effects on both state-owned firms and non-state firms. Liu's (2008) evidence for 1995-1999 suggests that intra-industry spillovers are negative in the short term but positive in the long term, and that backward linkages seem to be the most important channel through which spillovers occur. Xu and Sheng's (2012) results for 2000-2003 indicate that positive spillovers arise from forward linkages where domestic firms purchase high-quality intermediate goods or equipment from foreign firms in upstream sectors, and that the extent of spillovers varies greatly among domestic firms. Meanwhile, Du et al. (2012) find that non-HMT MNE presence had positive effects on all individual firm level productivity in 1998-2007, while HMT presence did not. They also find weak evidence of positive horizontal externalities and evidence of positive productivity spillovers to domestic firms via backward linkages to local suppliers in downstream as well as forward linkages to their local buyers in the upstream sectors. On the other hand, Galina and Long (2011) use over 6000 specifications that take into account forward and backward linkages, but fail to find evidence of systematic and positive productivity spillovers.

Most studies of spillovers in Thailand analyze the first census year, 1996, because studies using the 2006 census data are yet to appear and because comprehensive data are lacking for other years. This makes reliable estimates of foreign presence difficult to construct (Ramstetter 2012). For 1996, industry level results from Kohpaiboon (2006a, 2006b) and firm-level Ramstetter (2006) and suggested positive productivity spillovers from MNEs. However, the latter study also found very few significant productivity differentials between MNEs and local plants. Kohpaiboon's results suggest that spillovers were relatively strong in industries with relatively low protection. Movshuk and Matusoka-Movshuk (2006) also found evidence of positive wage spillovers in 1996. Using a more limited sample of manufacturing firms in 2001-03, Kohpaiboon (2009) finds positive horizontal spillovers in industries where import protection is relatively low. Sajarattanochote and Poon (2009) examine the geography of technology flows among a sample of MNEs in the Greater Bangkok area, finding evidence of limited regional spillovers to first- and second-order neighbors and large variation in technology transfers depending on nationality, sector, size, and age of the MNEs involved.

For Vietnam, Nguyen, T.T.A. et al. (2006) examine four channels of potential spillovers, labor turnover, technology diffusion and transfer, production linkages, and competition. Their cross section, Cobb-Douglas estimates indicated that "there is little evidence of positive spillover effects at the firm level", though there are also "no signs of negative spillover effect either" (p. 56). In contrast, Pham's (2008) cross section, Cobb-Douglas estimates generally suggested positive spillovers that were largest in Hanoi and Ho Chi Minh City, and from MNEs that were not wholly-foreign. Combining firm-level data for 2000-2005 with the 2000 input-output table, Nguyen, P.L. (2008) estimates cross section Cobb Douglas functions finding that both horizontal and vertical spillovers were generally positive, and largest in more advanced regions and in more sophisticated local firms. In analysis using an unbalanced panel of the same data, Nguyen, N.A. et al. (2008) finds that backward, vertical spillovers were positive in manufacturing, while horizontal spillovers were positive in services. Le and Pomfret (2011) also use a similar approach to estimate spillovers in an unbalanced panel of all industrial firms (including mining and utilities) for 2000-2004, finding positive backward spillovers in manufacturing but negative horizontal spillovers, which were relatively strong on private firms, domestic-oriented firms, firms without R&D, and firms in low technology industries.[6] Translog

[6] The use of the 2000 input-output table in these studies may be unrealistic because of large changes

estimates for 2000, 2002, and 2004 from Ramstetter and Phan (2008) also suggest the existence of positive spillovers from MNEs to private firms in cross sections, but Ramstetter and Phan (2013) find no significant spillovers in unbalanced panels. In sum, these results generally suggest some degree of positive spillovers, especially in cross sections, but results vary depending on specification, sample, and productivity measures, and evidence from panel analysis is relatively weak.[7]

In the same way that MNE presence may affect the productivity of local firms, it is also possible to conjecture that MNE presence may affect energy efficiency in those local firms. Indeed, greater energy efficiency might be one of the more important advantages of MNEs over local firms, as Eskeland and Harrison (2003) demonstrated for Côte d'Ivoire, Mexico, and Venezuela. A related study suggests that similar results are not common in Malaysian industries in 2000-2004 (Ramstetter and Haji Ahmad 2012), but it is still interesting to see if foreign presence is correlated with energy intensities in local plants.

3. The Data, Energy Consumption, Energy Intensities, and Foreign Shares

This study employs the micro data underlying Malaysia's census of manufacturing plant activity for 2000 and smaller surveys of stratified samples for 2001-2004.[8] 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 2001-2004.[9] Most of the difference between the census and survey samples results from the census' inclusion of relatively small plants with limited production. For example, if samples are limited to

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in Vietnam's industrial structure during 2000-2005, for example.

[7] Ramstetter and Phan (2008), Nguyen, N.A. et al. (2008), Nguyen, T.T.A. et al. (2006) use value-added-based estimates of productivity, while Le and Pomfret (2008) and Nguyen, P.L. (2008) use a sales-based measure. Value added data must be compiled from product-level data and omit some portions of sales, but the coverage of the value added samples seems reasonably good for 2000, 2002, and 2004 (Ramstetter and Phan 2008, Table 1, Appendix Tables 1a-1p).

[8] See Ramstetter and Haji Ahmad (2012, pp. 8-12, 23-25, 29-42) for more details on the data.

[9] Unless indicated otherwise, see the Appendix Tables 1a-1j for the details cited in this and the following two paragraphs.

medium-large plants with 20 or more employees and viable basic data, the census contained only 8,540 plants and the surveys 7,406 to 7,581 plants.

Three types of ownership are identified in the Malaysian manufacturing data, majority-local, 50-50 joint ventures, and majority-foreign. In this study, MNEs are thus defined rather narrowly as plants with foreign ownership shares of 50 percent or more.[10] MNEs are predominantly medium-large plants and medium-large plants differ from small, predominantly local plants in important ways. It is also more likely that spillovers from MNEs primarily affect medium-large local plants, rather than smaller ones. And although medium-large plants only comprised 56 percent of all plants meeting the above criteria, they accounted for the 98 percent of their production (measured as gross output) and identical shares of expenditures on energy in 2000-2004. Thus, focusing on the sample of medium-large plants excludes very little production or expenditures on energy. In addition, a focus on medium-large plants has the important advantage of removing most outliers from the samples and making analysis comparable to studies of Indonesia where the data exclude plants with fewer than 20 workers.

Because the Malaysian data span 5 years, it is necessary to control for inflation by deflating nominal values of some variables. 24 industry-level deflators for manufacturing GDP were used to calculate real values of total intermediate consumption and capital.[11] This approach is reasonable for intermediate consumption, but can be misleading for capital (fixed assets) because changes in asset prices are not accounted for. Unfortunately, we know of no deflator or price index for fixed assets in Malaysian manufacturing. Real electricity expenditures were then estimated using the GDP deflator for the electricity and gas industry, and real fuel expenditures calculated using the producer price index for mineral fuels in the domestic economy (Malaysia, Department of Statistics 2011a, 2011b).

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[10] Malaysian data thus differ somewhat from those for other countries (e.g., Indonesia, Thailand, and Vietnam) because minority-foreign plants (e.g., those with foreign ownership shares of 10 percent or more) are usually defined as MNEs.

[11] These deflators are generally defined at the 2-digit level. They were defined at the 3-digit level or for a combination of 3-digit categories in food and miscellaneous manufacturing and a combination of 2-digit categories for textiles and apparel as well as motor vehicles and other transportation machinery (Malaysia Department of Statistics 2011a).

These values were added to obtain real, total energy expenditures, which are used as a proxy for the quantity of energy consumed in the model estimated below.

In this paper, the primary concern is with energy expenditures and energy intensities (ratios of energy expenditures to output) in medium-large, local plants. The left block of Table 1 first shows energy expenditures by these local plants in 2000-2004. These expenditures were concentrated in 12 industries defined at the two- or three-digit level. Plants in another seven two-digit industries (tobacco, leather & footwear, wood, publishing, oil and coal products, miscellaneous manufacturing, and recycling) were not included because of their small size or peculiar characteristics. The 12 large energy using industries accounted for an average 92 percent of energy expenditures by all local manufacturing plants in this sample (minimum of 91 percent in 2002, maximum of 93 percent in 2003, 92 percent in other years). The non-metallic mineral products industry was the largest consumer in 2000-2002 and the second largest in 2003-2004, when it was supplanted by basic metals. Basic metals plants were also the second largest consumer in 2001-2002, but only the fourth largest in 2000. Food and beverages was the third largest category in all years and chemicals the fourth largest in most years (all except 2000). These four large consuming industries accounted for 47 percent of the purchased energy in 2000 and 53-56 percent in subsequent years. Electronics-related machinery was the second a largest in 2000 but energy expenditures fell markedly (68 percent) in 2001 and remained about half (49-54 percent) of 2000 levels in subsequent years. In contrast, energy consumption was unchanged in MNE plants in the same industry in 2001, and somewhat higher in 2002-2004 (Ramstetter and Haji Ahmad, 2012, Appendix Table 1a). This reflects the fact that local plants in this industry were among the most severely affected by the dot-com recession of 2001 and its aftermath, whereas MNEs were able to adjust more easily.

Of the four large energy consuming industries, only non-metallic mineral products had relatively large energy intensities, 10 percent in 2000 and 9 percent in subsequent years (Table 1, right side). Large energy consumption in this industry was thus a result of both large size (measured by output) and high energy intensity. Large energy consumption resulted more from large output than higher energy intensity in basic metals, food and beverages, and chemicals, where energy intensities were always below 4 percent. On the other hand, energy intensities were relatively high, despite relatively small energy purchases in rubber (5.9 percent average), as well as plastics and textiles (4.5-4.6 percent averages). In the 12 large energy consuming industries combined, energy intensity fell from 4.5 percent in 2000 to 4.3 percent in 2001, 4.1 percent in 2002-2003, and 4.0 percent in 2004. Not surprisingly, energy intensities for the 12 largest energy consuming industries were about 0.5 percentage points higher than for all medium-large manufacturing plants.

Table 2 shows two measures of MNE presence, MNE shares of paid workers or output, respectively. If calculated for the 12 large energy using industries, MNE shares of paid workers were consistently about two-fifths (40-41 percent), but shares of output increased some in 2001-2004 (from 47 to 51 percent) after falling in 2001 (from 48 percent in 2000). MNE shares were consistently largest in electronics related machinery, where shares were smaller in 2000 (70 percent of employment and 78 percent of output) than in subsequent survey years (73-77 percent of paid workers and 81-83 percent of output). Put another way, this industry accounted for the majority of MNE activity, accounting for 55-59 percent of all the workers and 60-66 percent of the gross output in all sample MNEs. MNE shares were consistently second highest in textiles, usually third largest in chemicals, and averaged just below fourth largest in rubber products. On the other hand MNE shares were consistently the smallest in food, wood, and paper products. MNE output shares were also tended to be relatively low in basic metals (9^{th} among the 12 large energy consuming industries in 2000-2002, 8^{th} in 2003, and 12^{th} in 2004). In the middle-ranked industries, MNE shares and their industry ranks fluctuated relatively a large amount.

Table 2 also presents simple, industry-level correlations between each measure of MNE presence and the corresponding local plant energy efficiency (right five columns of Table 1). All correlations are negative, suggesting that large MNE presence and relatively low local plant energy intensities tend to be correlated. The strongest correlations were observed in 2001, -0.30 to the MNE worker share and -0.31 to the MNE output share. Correlations for other years were much weaker, however,

-0.17 to -0.21 for correlations to worker shares and -0.16 to -0.24 for correlations to output shares. In other words, these simple calculations suggest that MNE shares are not likely to have been strongly correlated with local plant energy intensities in Malaysia during this period. However, correlations may change greatly after other factors affecting energy demand are accounted for and if correlations are examined using plant-level data.

4. Energy Intensities and Foreign Presence after Accounting for Scale and Factor Usage

This section attempts to examine the relationship between foreign presence and energy intensities in local plants after accounting for the effects of other factor usage and the technical characteristics of plants by estimating a model similar to that in Eskeland and Harrison (2003, 16-18). The models are derived by differentiating "a translog approximation to a production function" (p. 16) with respect to the energy input in question and interpreted as "inverse input demands" (p. 16). As a result, energy intensities are a function of the logs of other factor inputs (other intermediate consumption [mainly materials and parts], fixed assets, and labor), the log of the quantity of electricity (a proxy for the quantity of energy), and factors related to a plant's technological sophistication. Unfortunately, the Malaysian data do not include information on the quantity of energy or electricity consumed so this variable must be proxied by deflating oil and electricity expenditures with appropriate deflators.[12] In the Malaysian data, there are two potentially important indicators of technological sophistication, the ratio of research and development (R&D) expenditures to gross output, or R&D intensity, and the share of highly educated workers in the total workforce. Because correlations among these two indicators are surprisingly low, both are included.[13] The correlation of MNE presence is then captured by adding the foreign share of labor or output in an industry. The resulting model for a cross section of i=1…n plants and t=4 or 5 years (2000-2004 and 2001-2004) years is:

[12] If energy or water prices were equal for all plants, this value variable is equivalent to the quantify variable, but energy prices clearly vary among plants depending on the energy mix, quantities consumed, and the timing of consumption (especially important for electricity and piped gas prices).

[13] In addition, Eskeland and Harrison (2003) also include machinery imports and plant vintage as indicators of plant sophistication, but they are not available in the Malaysian data set.

$$EP_{ijt}=a0+a1(LL_{ijt})+a2(LK_{ijt})+a3(LM_{ijt})+a4(LE_{ijt})+a5(ES_{ijt})+a6(RD_{ijt})+a7(FS_{jt}) \quad (1)$$

where

EP_{ijt}=energy (or water) intensity in plant i, industry j, year t (percent)

ES_{ijt}=share of workers with tertiary education in all workers in plant i, industry j, year t (percent)

FS_{jt}=the share of majority-foreign MNEs in labor or output of industry j, year t

LE_{ijt}= natural log of the quantity of energy purchased by plant i, industry j, year t (real ringgit)

LK_{ijt}= natural log of the fixed assets less depreciation at yearend in plant i, industry j, year t (real ringgit)

LL_{ijt}=natural log of the number of paid workers in plant i, industry j, year t

LM_{ijt}=natural log intermediate expenditures excluding energy in plant i, industry j, year t (real ringgit)

RD_{ijt}=ratio of R&D expenditures to gross output in plant i, industry j, year t (percent)

If the coefficient *a6* is negative, for example, it would mean that local plants tended to have relatively low energy intensities in industries where MNE presence was relatively large, after accounting for the influences of scale and other factor usage, and the two indicators of technological sophistication (the share of highly educated workers and R&D intensities).

All estimates use robust standard errors to account for potential heteroscedasticity. Pooled estimates covering two periods 2001-2004 and 2000-2004 are performed in order to see if the results are affected by the inclusion of the census year, by lagging independent variables in 2001-2004, and/or the choice between pooled OLS, random effects, or a fixed choice estimator. The lagged specification is important because it provides a rough robustness check of how sensitive the results are to simultaneity issues.[14] We also check whether results are sensitive to the level of disaggregation for MNE shares (3- or 4-digit) or to the MNE share measure used. Year dummies are included to partially account for the effects of annual economic fluctuations at the plant level.

Regional and industry dummies are omitted in order to allow meaningful comparisons of fixed

[14] The use of lagged independent variables does not remove simultaneity bias, but good instruments could not be found and the lagged specification is likely to be less affected by this bias than cross sections or contemporaneous pooled estimates. Fixed effects panel estimates can also provide a rough check of simultaneity bias, but are not meaningful when investigating MNE-local differentials because ownership is a time-invariant, individual effect for most plants. Thus, estimates including individual effects reveal the effects of ownership changes on energy intensities, not the extent of MNE-local differentials.

effects estimators with the other two estimators. The use of time invariant (e.g., industry and location) dummies with a fixed effects estimator only picks up effects for plants changing their (industry or location) status. The interpretation of the coefficient *a6* differs among estimators. As mentioned above, if fixed effects are used, it reveals the effects of changes in MNE ownership shares on changes in local plant energy intensity. In contrast, the pooled OLS estimator measures the pure cross sectional effects of the level of MNE shares on the level of local plant energy intensities. The interpretation of the random effects estimator is essentially a combination of these two effects. Econometrically the fixed effects estimator is generally thought to be desirable because it is interpreted as controlling for so-called unobservable plant-specific characteristics and reduces the potential for simultaneity problems compared to other estimators. It is thus the most common estimator in most of the recent spillover literature. We examine results for all three estimators because they provide alternative perspectives on the nature of spillovers that may exist.

Table 3 first reports the results of estimating equation (1) in a sample of 11 large energy consuming industries combined; oil and coal products was omitted from the econometric analysis because there were very few local plants in the industry and because plants in this industry often tend to be outliers with exceptionally high labor productivity or capital intensity compared to other plants in the sample. The remaining sample of 21,910 observations formed an unbalanced panel covering the five years 2000-2004 with an average of 3 observations per plant during the 5 year period. Pooled OLS, random effects, and fixed effects estimates are first compared for estimates in this sample. In order to partially check for influences of simultaneity, a lagged model is also specified by lagging all independent variables one period and estimated for plants with observations in two or more consecutive years are available. These restrictions are quite binding, however, and the resulting sample is substantially smaller, 13,412 local plants.

In Table 3's large sample of 11 industries, coefficients on materials and the proxy for energy quantities tended to be positive and statistically significant at the standard 5 percent level, while the coefficient on capital was usually significantly negative and the coefficient on labor was usually insignificant. Thus, these results suggest that, on average, energy was a complement to capital, a substitute for materials, and not strongly related to labor use in the production process. Energy intensity was also weakly correlated with R&D intensity and the share of highly educated workers in local plants. The equations explained the variation in the dependent variable reasonably well with R^2 varying in the 0.45-0.50 range, except when the lagged specification is estimated by fixed effects. This poor fit in the fixed effects estimates of the lagged specification is not surprising, because the lags and fixed effects combine to remove much of the variation in the independent variables and their correlations to variation in the dependent variable. This makes fixed effects estimates of the lagged specification of limited interest here and these estimates are not discussed in detail below.

In this large sample, results for the key coefficient on the MNE ownership share varied starkly among estimation methods and specification (Table 3). For example, in the contemporaneous specification estimated by pooled OLS or the lagged specification estimated by pooled OLS or random effects, the coefficient on the foreign ownership share was usually negative and significant at standard levels. On the other hand, if estimated with fixed effects using labor shares (either 3- or 4-digit) and a contemporaneous specification, this spillover coefficient was positive and significant, indicating that energy intensity in local plants tended to be higher in industries with large MNE presence. In other words, the contemporaneous, fixed estimates using labor shares suggest the opposite result of all other significant results for this coefficient in the table. However, this result is clearly sensitive to the use of lags (as are all fixed effects estimates) and the choice of the MNE share variable (i.e., the same result does not obtain when MNE shares of labor are used). Several other results are also sensitive to choice of specification, estimation technique, and/or MNE share measure. Thus, it seems best to interpret these results with some caution.

As indicated above, it is common to estimate spillovers in subgroups of industries that are defined relatively homogeneously in one regard or another. For example, in this context, there is obvious concern with industries that consume a lot of energy and thus pollute a lot. Thus, we first divide the industries into the four smallest (textiles, paper, plastics, metal products) and four largest (non-metallic mineral products, basic metals, food and beverages, chemicals) energy users among of the 11 large energy using industries. The three industries with intermediate or inconsistent rankings are omitted from this analysis. Table 4a first presents results for the four smaller industries. If pooled OLS and random effects are used with this sample, spillover coefficients were positively significant for all estimates of the contemporaneous specification and most estimates of the lagged specification (exceptions were observed when MNE presence was defined as 3-digit output shares). However, the spillover coefficient was insignificant in fixed effects of the contemporaneous specification.[15]

In the four largest energy consuming industries, correlations of local plant energy intensities to foreign MNE shares were never statistically significant at the standard level when MNE presence was narrowly defined at the 4-digit level (Table 4b). In other words, in the largest energy using (and polluting) industries, intra-industry spillovers are not observed if industries are narrowly defined. However, if MNE shares of output are used and industries are defined more broadly at the 3-digit level, spillover coefficients were always negatively significant if estimated by pooled OLS or random effects. The same qualitative result was obtained using these estimators and corresponding 3-digit labor shares with the lagged specification. However, if 3-digit labor shares and the contemporaneous specification are used, pooled OLS estimates reveal negative and statistically significant spillovers, random effects results suggest negligible (insignificant) spillovers, and fixed effects estimates indicated positive spillovers that are weakly significant at the 10 percent level or better (the 6 percent level in this case).[16] Corresponding estimates using the 3-digit share of output show insignificant spillovers, however. Thus, in these large energy using industries, large MNE presence had no effect on energy intensities in local plants when industries are narrowly defined, but there is some weak indication that suggests that MNE presence may have led to lower local plant intensities if industries are defined more broadly and the assumptions underlying pooled OLS or

[15] If a lagged specification is used, fixed effects estimates also reveal negative coefficients that are significant coefficient if 4-digit labor shares are used or nearly significant at the 6 percent level if 3- or 4-digit output shares are used. However, the lagged fixed effect estimates describe the variation in the dependent variable much more poorly than other estimates.

[16] Fixed effects estimates of the lagged specification also indicate the coefficient was negative and significant, but the explanatory power of these estimates is much lower than the other estimates.

random effects estimates are warranted.

We then divide the sample into industries with low energy intensities (metal products, electronics-related machinery, basic metals and chemicals) and those with high energy intensities (non-metallic mineral products, rubber, plastics, and textiles). The three industries with intermediate or inconsistent rankings are again omitted from the analysis. In the low energy intensity group, the spillover coefficient was never negative and significant (Table 5a). It was also statistically insignificant in all pooled OLS and random effects of the lagged specification, but positively significant in all but one of the corresponding estimates of the contemporaneous specification (pooled OLS estimates using the 3-digit labor share being the major exception). The coefficient was also positive in fixed effects estimates of the contemporaneous specification using the 3-digit share of output, but insignificant if other definitions of MNE presence are used.[17] Correspondingly, in low energy intensity industries, local energy intensities appear to have been higher in industries where MNE presence was relatively high if pooled OLS or random effects and a contemporaneous specification are used, but results from the lagged specification and fixed effects are not consistent.

The sample of high energy intensity industries reveals perhaps the most consistent results in the samples examined here. All but one of the pooled OLS and random effects estimates of both lagged and contemporaneous specifications yield negative and significant spillover coefficients (Table 5b). And even in the one case when the coefficient was insignificant (random effects of the contemporaneous specification using 4-digit labor shares), it was negative and almost weakly significant (at the 13 percent level). However, here again, fixed effects estimates differed markedly, suggesting no statistically significant spillovers. The tendency for these and most other fixed effects estimates to yield insignificant spillover coefficients is noteworthy, because as explained previously, fixed effects estimates of the contemporaneous specification are generally preferred when examining intra-industry spillovers. Moreover, the substantial variation of pooled OLS and random effects

[17] The coefficient is also positive and significant in fixed effects estimates of the lagged specification when MNE presence is defined as the 4-digit labor share but here again the explanatory power of the fixed effects estimates of the lagged specification is very low.

results depending on the sample of industries, specification (contemporaneous or lagged), or definition of MNE presence (3- vs. 4-digit, labor vs. output), suggests that evidence of intra-industry energy intensity spillovers is rather weak during this period in Malaysian manufacturing.

5. Conclusions

This paper has examined whether foreign MNE presence affected energy intensities in local, medium-large plants in Malaysian manufacturing during 2000-2004. It began with a review of the related literature on productivity spillovers, which emphasized that results of previous studies of Malaysia and many other economies fail to provide convincing evidence of significant productivity spillovers. At the industry level, descriptive statistics then indicated that correlations between MNE shares of labor or output and local plant energy intensities were negative but rather weak. Similarly, plant-level econometric estimates indicate that correlations of MNE shares to local plant energy intensities were more often negative than positive after accounting for other factor usage and technical characteristics of plants. In other words, there is some evidence that MNE presence is correlated with local plant energy intensity. However, these results vary greatly depending upon on the sample of industries examined, the econometric estimation technique used, whether MNE shares are measured in terms of labor or output, and the level of aggregation used when defining MNE shares. Notably, if fixed effects estimators (the most common methodology in the recent literature) are used, most of the spillover coefficients are insignificant, and most of the relatively few significant coefficients are positive. Thus, it is probably best to conclude that evidence of intra-industry, energy intensity spillovers from MNE presence, like corresponding evidence for productivity spillovers, is rather weak.

It should not be surprising that results regarding productivity and energy intensity spillovers are similar because their determinants are similar and estimation methodologies are derived from the same underlying production function. Several extensions of both types of analyses are potentially interesting, however. Although the data are somewhat less detailed, it would also be possible to analyses for several pre-Asian financial crisis years (e.g., 1994-1997) and it would be interesting to see if these spillovers differed in the pre-crisis period. It may also be possible to do analyses for more recent years, though there have been no large economic changes to suggest that spillovers have changed much from the 2000-2004 period. More rigorous econometric tests comparing various estimators (e.g., Hausman tests of fixed effects vs. random effects or the Breusch and Pagan Lagrangian multiplier test for random effects) are also of potential interest to some researchers and worthy of closer examination. In this paper, we have purposely avoided analyses of such tests because, rather than focusing on a technical econometric argument over which estimator is preferable, we prefer to emphasize that each estimator attempts to answer subtly different economic questions. The important point we take from this exercise is that there is some evidence of spillovers with MNE presence usually leading to lower energy intensity in local plants (from pooled OLS and random effects estimates), but evidence that changes in MNE presence affect changes in local plant energy intensities is much weaker.

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Table 1: Energy Expenditures and Energy Intensities in Local Plants

	Energy Expenditures (RM millions)					Energy Intensities				
Industry	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Manufacturing	6,341	5,205	5,991	7,137	7,605	3.97	3.72	3.62	3.60	3.50
Large Energy Users (12 industries)	5,832	4,763	5,461	6,615	6,996	4.45	4.26	4.13	4.14	3.98
Food, beverages	754	684	725	858	920	3.74	3.93	3.50	3.86	3.80
Textiles	148	124	134	119	113	5.01	4.56	4.46	4.93	4.11
Wood products	368	340	349	410	432	3.73	4.08	3.96	4.00	4.05
Paper products	356	254	285	300	328	3.78	3.73	3.72	3.69	3.14
Petroleum products	215	83	151	641	691	5.47	2.81	2.60	4.19	3.83
Chemicals	484	437	599	827	887	3.81	3.33	3.52	3.11	3.04
Rubber products	394	375	380	432	444	6.03	6.09	5.84	6.21	5.37
Plastics	344	268	349	330	337	4.73	4.58	4.54	4.39	4.20
Non-metallic mineral products	1,010	1,030	1,040	989	1,080	10.90	9.86	10.27	9.87	9.74
Basic metals	717	769	877	1,120	1,110	3.87	3.42	3.38	3.11	2.90
Metal products	199	126	157	159	195	2.73	2.11	2.13	2.12	2.01
Electronics-related machinery	843	273	415	430	459	2.87	2.14	2.41	2.08	2.13

Note: This table includes plants with 20 or more paid workers and positive output, employee compensation, and fixed assets.
Source: Author's compilations from micro data underlying Department of Statistics (2002, various years)

Table 2: Majority-Foreign MNE Shares of Paid Workers and Output, and Correlations to Energy Intensities in Local Plants

	MNE Shares of Paid Workers					MNE Shares of Output				
Industry	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Manufacturing	39.99	40.79	39.63	39.51	40.46	48.26	47.43	49.11	50.47	51.09
Large Energy Users (12 industries)	43.36	44.99	43.92	44.45	44.43	54.70	56.63	55.53	52.50	51.91
Food, beverages	13.55	14.21	12.71	11.59	12.73	22.27	22.00	19.35	17.60	19.34
Textiles	48.48	46.79	50.27	43.41	45.05	64.51	62.94	58.74	59.37	61.96
Wood products	14.42	14.60	15.40	16.83	17.42	15.33	15.94	16.27	15.70	18.11
Paper products	16.41	21.26	16.57	15.04	16.19	16.10	24.02	18.81	16.89	19.05
Petroleum products	12.71	38.39	34.05	17.52	18.26	32.43	44.24	50.49	24.16	24.80
Chemicals	37.73	41.50	40.97	38.19	39.16	53.97	55.79	55.60	54.66	59.20
Rubber products	35.59	36.68	39.42	40.65	39.39	34.40	34.79	35.15	37.64	36.88
Plastics	23.30	23.53	27.90	30.19	31.12	27.00	29.07	42.83	42.92	38.89
Non-metallic mineral products	22.15	22.90	23.99	23.00	24.06	29.08	27.72	28.54	30.65	28.93
Basic metals	23.83	23.81	25.29	26.75	21.97	26.77	24.26	23.89	27.12	15.81
Metal products	27.94	25.92	24.26	26.71	23.77	36.29	34.02	30.80	34.82	32.61
Electronics-related machinery	69.64	77.17	73.42	74.36	75.03	77.97	82.39	82.88	80.93	81.05
Correlations to energy intensities in local plants (12 industries)	-0.19	-0.30	-0.17	-0.21	-0.19	-0.16	-0.31	-0.24	-0.20	-0.20

Note: This table includes plants with 20 or more paid workers and positive output, employee compensation, and fixed assets.
Source: Author's compilations from micro data underlying Department of Statistics (2002, various years)

Table 3: Correlations of MNE Presence to Energy Intensities in Private Plants and Other Slope Coefficients from Equation (1), 11 Large Energy Using Industries

Indepen-dent variable, statistic	Contemporaneous Specification, 2000-2004						Lagged Specification, 2001-2004					
	Pooled OLS		Rand. Effects		Fixed Effects		Pooled OLS		Rand. Effects		Fixed Effects	
	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.
MNE SHARES OF PAID WORKERS IN 3-DIGIT INDUSTRIES												
LL	-0.0101	0.87	0.1259	0.18	0.0536	0.67	0.0622	0.45	0.3230	0.00	0.0234	0.84
LK	0.1720	0.00	0.1337	0.00	0.0371	0.17	0.1939	0.00	0.1742	0.00	0.0051	0.83
LM	-2.7155	0.00	-2.1985	0.00	-1.8125	0.00	-2.6868	0.00	-1.6020	0.00	-0.1861	0.09
LE	2.5651	0.00	1.9073	0.00	1.4233	0.00	2.4638	0.00	1.1204	0.00	-0.0680	0.26
ES	-0.0049	0.05	-0.0046	0.10	-0.0049	0.18	-0.0041	0.25	-0.0029	0.46	0.0054	0.24
RD	0.0422	0.10	-0.0213	0.62	-0.0442	0.46	0.0996	0.09	0.0619	0.33	0.0535	0.43
FS	-0.0041	0.00	0.0008	0.64	0.0106	0.00	-0.0074	0.00	-0.0089	0.00	-0.0025	0.62
Obs./R^2	21,910	0.50	21,910	0.50	21,910	0.47	13,412	0.47	13,412	0.45	13,412	0.01
MNE SHARES OF PAID WORKERS IN 4-DIGIT INDUSTRIES												
LL	-0.0227	0.72	0.1206	0.20	0.0559	0.66	0.0490	0.55	0.3141	0.00	0.0275	0.82
LK	0.1717	0.00	0.1331	0.00	0.0374	0.17	0.1929	0.00	0.1730	0.00	0.0049	0.84
LM	-2.7129	0.00	-2.1990	0.00	-1.8126	0.00	-2.6830	0.00	-1.6011	0.00	-0.1880	0.08
LE	2.5675	0.00	1.9079	0.00	1.4232	0.00	2.4669	0.00	1.1225	0.00	-0.0677	0.26
ES	-0.0060	0.02	-0.0051	0.07	-0.0048	0.18	-0.0054	0.13	-0.0037	0.36	0.0054	0.24
RD	0.0397	0.12	-0.0220	0.61	-0.0434	0.47	0.0945	0.11	0.0585	0.36	0.0524	0.43
FS	-0.0014	0.36	0.0036	0.08	0.0093	0.01	-0.0044	0.03	-0.0048	0.07	0.0021	0.62
Obs./R^2	21,910	0.50	21,910	0.50	21,910	0.47	13,412	0.47	13,412	0.45	13,412	0.01
MNE SHARES OF OUTPUT IN 3-DIGIT INDUSTRIES												
LL	0.0055	0.93	0.1368	0.14	0.0483	0.70	0.0684	0.41	0.3252	0.00	0.0217	0.85
LK	0.1736	0.00	0.1352	0.00	0.0375	0.17	0.1964	0.00	0.1765	0.00	0.0057	0.82
LM	-2.7179	0.00	-2.1977	0.00	-1.8091	0.00	-2.6864	0.00	-1.5996	0.00	-0.1846	0.09
LE	2.5580	0.00	1.9050	0.00	1.4225	0.00	2.4569	0.00	1.1167	0.00	-0.0685	0.25
ES	-0.0024	0.34	-0.0034	0.23	-0.0049	0.18	-0.0020	0.57	-0.0019	0.64	0.0054	0.23
RD	0.0461	0.07	-0.0192	0.66	-0.0435	0.47	0.1050	0.08	0.0653	0.31	0.0541	0.42
FS	-0.0089	0.00	-0.0051	0.00	0.0032	0.25	-0.0111	0.00	-0.0130	0.00	-0.0044	0.23
Obs./R^2	21,910	0.50	21,910	0.50	21,910	0.47	13,412	0.47	13,412	0.45	13,412	0.01
MNE SHARES OF OUTPUT IN 4-DIGIT INDUSTRIES												
LL	-0.0191	0.76	0.1262	0.18	0.0480	0.70	0.0516	0.53	0.3157	0.00	0.0237	0.84
LK	0.1719	0.00	0.1338	0.00	0.0378	0.16	0.1931	0.00	0.1730	0.00	0.0049	0.84
LM	-2.7150	0.00	-2.1982	0.00	-1.8085	0.00	-2.6864	0.00	-1.6031	0.00	-0.1861	0.09
LE	2.5665	0.00	1.9072	0.00	1.4223	0.00	2.4656	0.00	1.1218	0.00	-0.0678	0.26
ES	-0.0056	0.03	-0.0046	0.11	-0.0048	0.18	-0.0050	0.16	-0.0035	0.38	0.0054	0.24
RD	0.0404	0.11	-0.0212	0.63	-0.0433	0.47	0.0962	0.10	0.0594	0.35	0.0532	0.43
FS	-0.0023	0.12	0.0007	0.71	0.0019	0.42	-0.0052	0.01	-0.0056	0.02	-0.0018	0.62
Obs./R^2	21,910	0.50	21,910	0.50	21,910	0.47	13,412	0.47	13,412	0.45	13,412	0.01

Notes: in the Obs./R2 rows, the coefficient column contains the number of observations and the P-value column contains the R-squared; all p-values based on robust standard errors; estimated equations also include year dummies; detailed estimates including all dummies and the constant available from authors.

Table 4a: Correlations of MNE Presence to Energy Intensities in Private Plants and Other Slope Coefficients from Equation (1), 4 Smallest of 11 Large Energy Using Industries

Independent variable, statistic	Contemporaneous Specification, 2000-2004						Lagged Specification, 2001-2004					
	Pooled OLS		Rand. Effects		Fixed Effects		Pooled OLS		Rand. Effects		Fixed Effects	
	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.
MNE SHARES OF PAID WORKERS IN 3-DIGIT INDUSTRIES												
LL	-0.3572	0.00	-0.1462	0.17	-0.1201	0.35	-0.2048	0.09	0.0899	0.47	-0.0222	0.86
LK	0.0840	0.01	0.0888	0.01	0.0558	0.13	0.1444	0.00	0.1436	0.00	0.0348	0.32
LM	-1.6399	0.00	-1.3712	0.00	-1.1823	0.00	-1.6191	0.00	-0.8908	0.00	-0.0822	0.49
LE	1.8550	0.00	1.3860	0.00	1.0692	0.00	1.7111	0.00	0.7161	0.00	-0.0930	0.23
ES	-0.0073	0.03	0.0006	0.88	0.0009	0.82	-0.0156	0.00	-0.0110	0.01	-0.0055	0.21
RD	0.0851	0.21	-0.0314	0.58	-0.0539	0.50	0.2277	0.01	0.0769	0.31	0.0027	0.90
FS	0.0151	0.00	0.0204	0.00	0.0066	0.39	0.0098	0.09	0.0196	0.02	-0.0111	0.29
Obs./R^2	6,739	0.45	6,739	0.45	6,739	0.43	3,873	0.39	3,873	0.37	3,873	0.05
MNE SHARES OF PAID WORKERS IN 4-DIGIT INDUSTRIES												
LL	-0.3405	0.00	-0.1356	0.21	-0.1173	0.36	-0.1893	0.12	0.0980	0.44	-0.0283	0.82
LK	0.0817	0.01	0.0880	0.01	0.0562	0.13	0.1441	0.00	0.1440	0.00	0.0338	0.33
LM	-1.6437	0.00	-1.3739	0.00	-1.1826	0.00	-1.6238	0.00	-0.8951	0.00	-0.0806	0.50
LE	1.8516	0.00	1.3858	0.00	1.0693	0.00	1.7073	0.00	0.7194	0.00	-0.0929	0.23
ES	-0.0073	0.03	0.0006	0.87	0.0010	0.81	-0.0155	0.00	-0.0107	0.01	-0.0057	0.19
RD	0.1010	0.18	-0.0217	0.69	-0.0511	0.52	0.2434	0.01	0.0872	0.26	-0.0005	0.98
FS	0.0167	0.00	0.0188	0.00	0.0061	0.38	0.0129	0.01	0.0139	0.02	-0.0125	0.05
Obs./R^2	6,739	0.45	6,739	0.45	6,739	0.44	3,873	0.39	3,873	0.38	3,873	0.05
MNE SHARES OF OUTPUT IN 3-DIGIT INDUSTRIES												
LL	-0.3593	0.00	-0.1495	0.16	-0.1213	0.34	-0.2059	0.09	0.0898	0.48	-0.0326	0.80
LK	0.0851	0.00	0.0907	0.01	0.0560	0.13	0.1441	0.00	0.1439	0.00	0.0360	0.31
LM	-1.6386	0.00	-1.3652	0.00	-1.1809	0.00	-1.6201	0.00	-0.8902	0.00	-0.0734	0.54
LE	1.8605	0.00	1.3897	0.00	1.0690	0.00	1.7146	0.00	0.7212	0.00	-0.0938	0.23
ES	-0.0072	0.04	0.0008	0.82	0.0009	0.81	-0.0156	0.00	-0.0108	0.01	-0.0054	0.21
RD	0.0932	0.19	-0.0288	0.60	-0.0536	0.50	0.2353	0.01	0.0818	0.30	0.0040	0.86
FS	0.0089	0.02	0.0098	0.01	0.0033	0.40	0.0057	0.25	0.0073	0.15	-0.0102	0.06
Obs./R^2	6,739	0.45	6,739	0.45	6,739	0.43	3,873	0.39	3,873	0.38	3,873	0.05
MNE SHARES OF OUTPUT IN 4-DIGIT INDUSTRIES												
LL	-0.3487	0.00	-0.1441	0.18	-0.1215	0.34	-0.1975	0.10	0.0966	0.44	-0.0305	0.81
LK	0.0834	0.01	0.0901	0.01	0.0563	0.13	0.1451	0.00	0.1448	0.00	0.0340	0.33
LM	-1.6348	0.00	-1.3663	0.00	-1.1798	0.00	-1.6157	0.00	-0.8924	0.00	-0.0774	0.52
LE	1.8539	0.00	1.3890	0.00	1.0691	0.00	1.7076	0.00	0.7210	0.00	-0.0934	0.23
ES	-0.0070	0.04	0.0006	0.86	0.0009	0.82	-0.0152	0.00	-0.0109	0.01	-0.0053	0.23
RD	0.0957	0.19	-0.0275	0.62	-0.0531	0.51	0.2351	0.01	0.0826	0.29	0.0032	0.89
FS	0.0119	0.00	0.0108	0.00	0.0020	0.54	0.0096	0.01	0.0091	0.02	-0.0076	0.06
Obs./R^2	6,739	0.45	6,739	0.45	6,739	0.43	3,873	0.39	3,873	0.38	3,873	0.05

Notes: in the Obs./R2 rows, the coefficient column contains the number of observations and the P-value column contains the R-squared; all p-values based on robust standard errors; estimated equations also include year dummies; detailed estimates including all dummies and the constant available from authors.

Table 4b: Correlations of MNE Presence to Energy Intensities in Private Plants and Other Slope Coefficients from Equation (1), 4 Largest of 11 Large Energy Using Industries

Indepen-dent variable, statistic	Contemporaneous Specification, 2000-2004						Lagged Specification, 2001-2004					
	Pooled OLS		Rand. Effects		Fixed Effects		Pooled OLS		Rand. Effects		Fixed Effects	
	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.
MNE SHARES OF PAID WORKERS IN 3-DIGIT INDUSTRIES												
LL	0.0290	0.78	0.2383	0.19	0.0214	0.93	-0.0878	0.50	0.4184	0.02	-0.0124	0.96
LK	0.3493	0.00	0.2035	0.00	0.0177	0.69	0.3157	0.00	0.2689	0.00	-0.0060	0.89
LM	-3.4160	0.00	-2.7472	0.00	-2.0039	0.00	-3.3451	0.00	-2.3945	0.00	-0.0375	0.85
LE	3.1787	0.00	2.3371	0.00	1.8105	0.00	3.1985	0.00	1.6942	0.00	-0.1137	0.33
ES	-0.0124	0.00	-0.0097	0.08	-0.0116	0.11	-0.0041	0.51	0.0120	0.15	0.0200	0.04
RD	0.0021	0.95	-0.0498	0.45	-0.0623	0.48	0.1026	0.35	0.1075	0.43	0.1562	0.31
FS	-0.0080	0.03	0.0033	0.46	0.0223	0.06	-0.0133	0.00	-0.0156	0.02	-0.0297	0.02
Obs./R^2	9,627	0.58	9,627	0.58	9,627	0.56	6,034	0.58	6,034	0.56	6,034	0.02
MNE SHARES OF PAID WORKERS IN 4-DIGIT INDUSTRIES												
LL	0.0186	0.86	0.2385	0.19	0.0177	0.94	-0.0992	0.44	0.4103	0.02	0.0036	0.99
LK	0.3436	0.00	0.2016	0.00	0.0194	0.66	0.3065	0.00	0.2610	0.00	-0.0101	0.82
LM	-3.4066	0.00	-2.7468	0.00	-2.0031	0.00	-3.3330	0.00	-2.3868	0.00	-0.0465	0.82
LE	3.1829	0.00	2.3389	0.00	1.8091	0.00	3.2048	0.00	1.6990	0.00	-0.1101	0.35
ES	-0.0153	0.00	-0.0104	0.06	-0.0116	0.11	-0.0077	0.22	0.0094	0.26	0.0202	0.04
RD	0.0003	0.99	-0.0501	0.45	-0.0620	0.48	0.0982	0.37	0.1038	0.45	0.1524	0.32
FS	0.0007	0.85	0.0089	0.10	0.0087	0.19	-0.0028	0.55	-0.0005	0.94	0.0024	0.79
Obs./R^2	9,627	0.58	9,627	0.58	9,627	0.57	6,034	0.58	6,034	0.56	6,034	0.02
MNE SHARES OF OUTPUT IN 3-DIGIT INDUSTRIES												
LL	0.0287	0.79	0.2379	0.19	0.0106	0.96	-0.0954	0.46	0.4128	0.02	-0.0013	1.00
LK	0.3555	0.00	0.2103	0.00	0.0198	0.66	0.3205	0.00	0.2753	0.00	-0.0078	0.86
LM	-3.4140	0.00	-2.7485	0.00	-1.9983	0.00	-3.3362	0.00	-2.3870	0.00	-0.0439	0.83
LE	3.1631	0.00	2.3303	0.00	1.8078	0.00	3.1836	0.00	1.6805	0.00	-0.1136	0.33
ES	-0.0090	0.04	-0.0075	0.18	-0.0118	0.11	-0.0020	0.74	0.0144	0.08	0.0202	0.04
RD	0.0025	0.94	-0.0488	0.46	-0.0621	0.48	0.1046	0.34	0.1114	0.42	0.1553	0.32
FS	-0.0155	0.00	-0.0124	0.00	0.0027	0.67	-0.0169	0.00	-0.0256	0.00	-0.0142	0.08
Obs./R^2	9,627	0.58	9,627	0.58	9,627	0.57	6,034	0.58	6,034	0.56	6,034	0.01
MNE SHARES OF OUTPUT IN 4-DIGIT INDUSTRIES												
LL	0.0243	0.82	0.2391	0.19	0.0078	0.97	-0.0894	0.49	0.4206	0.02	0.0015	1.00
LK	0.3448	0.00	0.2049	0.00	0.0206	0.64	0.3064	0.00	0.2621	0.00	-0.0100	0.82
LM	-3.4108	0.00	-2.7482	0.00	-1.9985	0.00	-3.3383	0.00	-2.3936	0.00	-0.0447	0.82
LE	3.1806	0.00	2.3361	0.00	1.8064	0.00	3.2006	0.00	1.6953	0.00	-0.1101	0.35
ES	-0.0144	0.00	-0.0093	0.09	-0.0118	0.11	-0.0070	0.25	0.0104	0.21	0.0201	0.04
RD	0.0003	0.99	-0.0494	0.46	-0.0621	0.48	0.0984	0.37	0.1053	0.44	0.1529	0.32
FS	-0.0022	0.51	-0.0003	0.94	-0.0035	0.44	-0.0054	0.16	-0.0069	0.19	-0.0031	0.69
Obs./R^2	9,627	0.58	9,627	0.58	9,627	0.57	6,034	0.58	6,034	0.56	6,034	0.03

Notes: in the Obs./R2 rows, the coefficient column contains the number of observations and the P-value column contains the R-squared; all p-values based on robust standard errors; estimated equations also include year dummies; detailed estimates including all dummies and the constant available from authors.

Table 5a: Correlations of MNE Presence to Energy Intensities in Private Plants and Other Slope Coefficients from Equation (1), 4 Least Energy-Intensive of 11 Large Energy Using Industries

Indepen-dent variable, statistic	Contemporaneous Specification, 2000-2004						Lagged Specification, 2001-2004					
	Pooled OLS		Rand. Effects		Fixed Effects		Pooled OLS		Rand. Effects		Fixed Effects	
	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.
MNE SHARES OF PAID WORKERS IN 3-DIGIT INDUSTRIES												
LL	-0.3474	0.00	-0.2826	0.00	-0.1208	0.43	-0.2331	0.02	-0.0517	0.60	-0.0731	0.58
LK	0.0544	0.08	0.0492	0.11	0.0398	0.34	0.0871	0.07	0.1318	0.00	0.0071	0.83
LM	-1.3346	0.00	-1.1529	0.00	-1.0894	0.00	-1.3237	0.00	-0.7093	0.00	-0.1453	0.09
LE	1.6566	0.00	1.4153	0.00	1.1439	0.00	1.5682	0.00	0.7168	0.00	-0.1092	0.15
ES	0.0034	0.23	0.0000	1.00	-0.0082	0.11	0.0070	0.12	0.0051	0.33	0.0081	0.28
RD	0.0298	0.28	-0.0082	0.87	-0.1033	0.41	-0.0004	0.99	-0.0174	0.17	-0.0241	0.47
FS	0.0029	0.11	0.0054	0.01	0.0045	0.22	0.0006	0.84	-0.0005	0.88	0.0030	0.49
Obs./R^2	6,368	0.43	6,368	0.43	6,368	0.41	3,649	0.38	3,649	0.37	3,649	0.04
MNE SHARES OF PAID WORKERS IN 4-DIGIT INDUSTRIES												
LL	-0.3536	0.00	-0.2786	0.00	-0.1257	0.41	-0.2500	0.01	-0.0692	0.47	-0.0623	0.64
LK	0.0546	0.07	0.0489	0.11	0.0403	0.34	0.0886	0.06	0.1322	0.00	0.0070	0.83
LM	-1.3363	0.00	-1.1538	0.00	-1.0871	0.00	-1.3262	0.00	-0.7141	0.00	-0.1492	0.08
LE	1.6572	0.00	1.4147	0.00	1.1431	0.00	1.5713	0.00	0.7198	0.00	-0.1080	0.15
ES	0.0032	0.26	0.0001	0.98	-0.0082	0.11	0.0065	0.14	0.0046	0.38	0.0082	0.28
RD	0.0295	0.28	-0.0077	0.87	-0.1027	0.41	-0.0023	0.95	-0.0202	0.12	-0.0262	0.43
FS	0.0041	0.01	0.0052	0.01	0.0000	1.00	0.0031	0.22	0.0038	0.20	0.0098	0.03
Obs./R^2	6,368	0.43	6,368	0.43	6,368	0.41	3,649	0.38	3,649	0.37	3,649	0.04
MNE SHARES OF OUTPUT IN 3-DIGIT INDUSTRIES												
LL	-0.3546	0.00	-0.2833	0.00	-0.1208	0.44	-0.2497	0.01	-0.0581	0.55	-0.0724	0.59
LK	0.0545	0.08	0.0491	0.11	0.0395	0.35	0.0882	0.06	0.1319	0.00	0.0068	0.84
LM	-1.3352	0.00	-1.1524	0.00	-1.0886	0.00	-1.3257	0.00	-0.7111	0.00	-0.1463	0.08
LE	1.6585	0.00	1.4159	0.00	1.1440	0.00	1.5720	0.00	0.7185	0.00	-0.1094	0.15
ES	0.0029	0.31	-0.0002	0.96	-0.0082	0.11	0.0063	0.15	0.0049	0.35	0.0081	0.28
RD	0.0290	0.30	-0.0078	0.87	-0.1040	0.40	-0.0032	0.93	-0.0185	0.15	-0.0248	0.46
FS	0.0044	0.02	0.0059	0.01	0.0065	0.04	0.0031	0.28	0.0010	0.77	0.0045	0.28
Obs./R^2	6,368	0.43	6,368	0.43	6,368	0.41	3,649	0.38	3,649	0.37	3,649	0.04
MNE SHARES OF OUTPUT IN 4-DIGIT INDUSTRIES												
LL	-0.3519	0.00	-0.2753	0.00	-0.1268	0.41	-0.2505	0.01	-0.0661	0.50	-0.0717	0.59
LK	0.0549	0.07	0.0495	0.11	0.0404	0.34	0.0891	0.06	0.1325	0.00	0.0075	0.82
LM	-1.3350	0.00	-1.1512	0.00	-1.0864	0.00	-1.3254	0.00	-0.7130	0.00	-0.1486	0.08
LE	1.6564	0.00	1.4141	0.00	1.1429	0.00	1.5706	0.00	0.7192	0.00	-0.1094	0.15
ES	0.0032	0.25	0.0002	0.94	-0.0082	0.11	0.0066	0.13	0.0047	0.37	0.0081	0.29
RD	0.0302	0.27	-0.0066	0.89	-0.1024	0.41	-0.0024	0.94	-0.0196	0.13	-0.0253	0.45
FS	0.0039	0.01	0.0042	0.02	-0.0011	0.73	0.0031	0.17	0.0028	0.34	0.0064	0.19
Obs./R^2	6,368	0.43	6,368	0.43	6,368	0.41	3,649	0.38	3,649	0.37	3,649	0.04

Notes: in the Obs./R2 rows, the coefficient column contains the number of observations and the P-value column contains the R-squared; all p-values based on robust standard errors; estimated equations also include year dummies; detailed estimates including all dummies and the constant available from authors.

Table 5b: Correlations of MNE Presence to Energy Intensities in Private Plants and Other Slope Coefficients from Equation (1), 4 Most Energy-Intensive of 11 Large Energy Using Industries

Indepen-dent variable, statistic	Contemporaneous Specification, 2000-2004						Lagged Specification, 2001-2004					
	Pooled OLS		Rand. Effects		Fixed Effects		Pooled OLS		Rand. Effects		Fixed Effects	
	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.	Value	P-val.
MNE SHARES OF PAID WORKERS IN 3-DIGIT INDUSTRIES												
LL	0.1645	0.32	0.3313	0.15	0.0925	0.73	0.1190	0.58	0.4538	0.08	0.1111	0.68
LK	0.2006	0.00	0.1798	0.00	0.0740	0.17	0.1696	0.04	0.2572	0.00	0.0177	0.71
LM	-3.7585	0.00	-2.9695	0.00	-2.3104	0.00	-3.6376	0.00	-2.4910	0.00	-0.2096	0.43
LE	3.3717	0.00	2.3966	0.00	1.8598	0.00	3.3885	0.00	1.8673	0.00	-0.0652	0.61
ES	-0.0121	0.09	-0.0088	0.22	-0.0043	0.63	-0.0111	0.21	-0.0168	0.10	0.0024	0.83
RD	0.1581	0.25	0.0167	0.94	-0.0122	0.96	0.4520	0.09	0.3650	0.26	0.2962	0.38
FS	-0.0318	0.00	-0.0279	0.00	-0.0043	0.79	-0.0337	0.00	-0.0388	0.00	-0.0336	0.07
Obs./R^2	6,155	0.54	6,155	0.53	6,155	0.53	3,752	0.53	3,752	0.52	3,752	0.03
MNE SHARES OF PAID WORKERS IN 4-DIGIT INDUSTRIES												
LL	0.1668	0.31	0.3322	0.15	0.0942	0.73	0.1241	0.56	0.4615	0.07	0.1232	0.64
LK	0.2072	0.00	0.1819	0.00	0.0736	0.17	0.1787	0.03	0.2603	0.00	0.0134	0.78
LM	-3.7768	0.00	-2.9835	0.00	-2.3115	0.00	-3.6582	0.00	-2.5080	0.00	-0.2201	0.41
LE	3.3753	0.00	2.3972	0.00	1.8595	0.00	3.3903	0.00	1.8637	0.00	-0.0672	0.60
ES	-0.0116	0.10	-0.0087	0.22	-0.0043	0.63	-0.0108	0.22	-0.0168	0.10	0.0025	0.82
RD	0.1296	0.34	0.0078	0.97	-0.0125	0.96	0.4128	0.13	0.3410	0.29	0.2838	0.40
FS	-0.0182	0.00	-0.0118	0.13	0.0015	0.89	-0.0177	0.00	-0.0204	0.01	-0.0098	0.41
Obs./R^2	6,155	0.54	6,155	0.53	6,155	0.53	3,752	0.53	3,752	0.52	3,752	0.02
MNE SHARES OF OUTPUT IN 3-DIGIT INDUSTRIES												
LL	0.1842	0.26	0.3392	0.14	0.0944	0.73	0.1498	0.48	0.4596	0.07	0.1182	0.66
LK	0.2014	0.00	0.1822	0.00	0.0743	0.16	0.1707	0.04	0.2633	0.00	0.0198	0.68
LM	-3.7412	0.00	-2.9686	0.00	-2.3097	0.00	-3.6220	0.00	-2.4915	0.00	-0.2110	0.43
LE	3.3478	0.00	2.3921	0.00	1.8594	0.00	3.3619	0.00	1.8638	0.00	-0.0668	0.60
ES	-0.0102	0.15	-0.0084	0.24	-0.0043	0.63	-0.0088	0.31	-0.0158	0.12	0.0026	0.82
RD	0.1661	0.21	0.0171	0.94	-0.0122	0.96	0.4630	0.07	0.3726	0.24	0.2921	0.39
FS	-0.0406	0.00	-0.0274	0.00	-0.0043	0.64	-0.0435	0.00	-0.0427	0.00	-0.0165	0.11
Obs./R^2	6,155	0.54	6,155	0.54	6,155	0.53	3,752	0.54	3,752	0.53	3,752	0.04
MNE SHARES OF OUTPUT IN 4-DIGIT INDUSTRIES												
LL	0.1881	0.26	0.3387	0.14	0.0940	0.73	0.1550	0.47	0.4694	0.07	0.1253	0.64
LK	0.2073	0.00	0.1825	0.00	0.0737	0.17	0.1747	0.04	0.2616	0.00	0.0142	0.77
LM	-3.7795	0.00	-2.9862	0.00	-2.3115	0.00	-3.6543	0.00	-2.5133	0.00	-0.2173	0.41
LE	3.3606	0.00	2.3939	0.00	1.8593	0.00	3.3720	0.00	1.8597	0.00	-0.0676	0.59
ES	-0.0109	0.12	-0.0086	0.23	-0.0043	0.62	-0.0102	0.24	-0.0165	0.11	0.0026	0.82
RD	0.1405	0.30	0.0101	0.96	-0.0131	0.96	0.4302	0.11	0.3503	0.27	0.2854	0.40
FS	-0.0240	0.00	-0.0124	0.05	-0.0023	0.75	-0.0263	0.00	-0.0238	0.00	-0.0064	0.57
Obs./R^2	6,155	0.54	6,155	0.53	6,155	0.53	3,752	0.53	3,752	0.52	3,752	0.02

Notes: in the Obs./R2 rows, the coefficient column contains the number of observations and the P-value column contains the R-squared; all p-values based on robust standard errors; estimated equations also include year dummies; detailed estimates including all dummies and the constant available from authors.