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Energy subsidies, energy intensity and management practices

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Abstract
We use unique firm-level data on management practices and energy expenditures in about 2,000 manufacturing firms in central and eastern Europe, Central Asia and Middle East and North Africa to examine how the quality of management practices relates to the energy intensity of firms, taking into account fossil fuel subsidies. We use country- and country-sector-level measures of energy subsidies and distinguish between energy subsidies that take into account externalities and those that do not. Regardless of whether we measure fuel subsidies at the country- or country-sector-level, we find that an improvement in the quality of management practices from the 25th to the 75th percentile of the management practices quality distribution is associated with about a 23 per cent fuel intensity reduction when fuel subsidies are low (negative) and with about a 2 per cent fuel intensity reduction when fuel subsidies are high. The magnitude is stronger in high energy-intensive sectors, where firms are more sensitive to energy prices.

Keywords: Energy efficiency, management practices, energy subsidies, firm behaviour.

JEL Classification: L2, M2, Q48, Q56, Q58, O13, O14 .

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1 Introduction

The reduction of greenhouse gas (GHG) emissions is an increasingly important policy objective for many governments, both in developed and developing economies. This is reflected, among other things, in the number of new climate change-relevant laws passed, which reached a peak of more than 100 per year in 2009-13 (Nachmany et al., 2017), as well as the emergence of energy efficiency as a high-priority topic on the policy agenda. The International Energy Agency (2017) report even names improved energy intensity as the biggest factor behind the recent flattening of global GHG emissions.

In manufacturing – one of the key sectors from the point of view of GHG emissions[1] and energy intensity – improvements in energy efficiency can come about from upgrading or closing existing plants or adding new production capacity that uses more modern technology. Moreover, recent research has found that management practices (either generic or climate-friendly ones) also play a significant role in reducing the energy intensity of firms (see Bloom et al., 2010; Martin et al., 2012), though they are more likely to do so in energy intensive industries (Boyd and Curtis, 2014).

As pointed out by Bloom et al. (2010) and others, it is not possible to determine the sign of the relationship between management practices and energy intensity a priori. On the one hand, better managed firms typically use more efficient production techniques and should thus be able to reduce their energy usage. On the other hand, better managed firms might achieve higher productivity through more intensive capital utilisation which may in turn lead to higher energy usage.

In this paper, we expand the existing research by looking at the relationship between the quality of management practices and energy intensity of firms in the context of not only differences in energy intensity across industries (as in Boyd and Curtis, 2014), but also the availability of energy subsidies for fossil fuels. We are interested in knowing whether the latter affects the relationship between the quality of management practices and energy intensity. Besides the impact on energy intensity and GHG emissions, energy subsidies may also constrain competition by limiting the entry of new firms and job creation as they disincentivise more labour-intensive activities, resulting in misallocation of capital and consequently, lower aggregate productivity growth.

Our contribution to the literature is three-fold. First, we expand the analysis for the United Kingdom (Bloom et al., 2010; Martin et al., 2012), United States (Boyd and Curtis, 2014) and a province in China (Karplus and Zhang, 2017) to almost 40 countries in central and eastern Europe, Central Asia and Middle East and North Africa, using firm-level data on management practices and energy costs from the fifth round of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group (WBG) Business Environment and Enterprise Performance Survey (BEEPS V) and EBRD-European Investment Bank (EIB)-WBG Middle East and North Africa Enterprise Survey (MENA ES). Most of the countries in central and

[1]Together with primary industry, the manufacturing sector accounts for almost 40 per cent of GHG emissions worldwide (Martin et al., 2014).

eastern Europe and Central Asia started the transition from central planning to market economies with an economic structure focused on energy-intensive production. At the beginning of the transition, in 1992, their greenhouse gas intensity of GDP (greenhouse gas emissions per international $ of 2011 GDP) was about twice that in comparable countries elsewhere (EBRD, 2017). It has fallen substantially since then as a result of a shift to less GHG-intensive energy sources, deep energy efficiency improvements within sectors and a shift from energy-intensive activities such as heavy industry to less energy-intensive activities such as services (EBRD, 2011), but is still, with some notable exceptions, above the level in comparable countries. The legacy of energy-intensive production makes these countries particularly interesting and relevant for our analysis.

Second, our analysis goes beyond the relationship between management quality and energy intensity, as we also consider comparative levels of energy prices. Energy-intensive production is only possible when cheap energy resources are available locally or in a neighbouring country under certain conditions. A number of countries in our sample are characterised by the abundance of fossil fuels. Enhanced by the presence of infrastructure, which was predominantly constructed under non-market conditions before the transition period started, this allows for the production of energy at prices well below international prices. If these countries charge less than the international prices for energy in the domestic markets, the domestic energy subsidies are implicit, but have no budgetary implications as long as the price covers the cost of production. For net importers, energy subsidies may be explicit, representing budget expenditures arising from the domestic sale of imported energy at subsidised prices. The variation in the availability of energy subsidies makes it possible to compare the impact of the quality of firms' management practices on energy intensity under different regimes of energy prices. Moreover, recent research indicates that firms in countries with energy subsidies tend to be more capital-intensive (EBRD et al., 2016), strengthening the importance of our research focus.

Third, we propose an alternative way of identifying firms that benefit from energy subsidies, using survey responses. To the best of our knowledge, cross-country estimates of energy subsidies are available at the country level only, which would imply that all firms benefit from them. However, that is typically not the case as energy tariffs for large users (such as those in the smelting industry) often differ from those for regular users. BEEPS V and MENA ES do not include data on the energy tariffs the firms are on, but they do include the information on the main sector of activity and whether or not firms have electricity generators and what percentage of their electricity came from them. In sectors where energy is a higher portion of the firms' costs, firms are likely to be more sensitive to energy prices in general and availability of energy subsidies in particular. We account for differences in energy intensity across sectors by splitting the sample into high or moderate and low energy-intensive sectors (in the spirit of Boyd and Curtis, 2014) and, alternatively, by constructing a novel country- and sector-specific energy subsidy measure. However, recent evidence (see Lyubich et al., 2018) shows that there is enormous heterogeneity in output per dollar of energy input even across firms within narrowly defined industries. In the absence of more detailed information, we utilise information on the use of electricity generators. Firms typically have electricity generators to be able to continue production or provide services when provision of electricity is unreliable. However, having an electricity generator is costly and electricity generated by it is more expensive than electricity from the grid, especially if the price of electricity from the grid is subsidised.[2] Firms that do not use self-generated electricity are thus more likely to be sensitive to energy prices and availability of energy subsidies. In addition, we can distinguish between fuel and electricity subsidies that are measured as a difference between consumer prices and supply costs (so-called pre-tax subsidies) and those that also reflect externalities associated with energy consumption (post-tax subsidies).

We focus on fuel intensity and find that pre-tax fuel subsidies, whether measured at the country- or country-sector level, affect its relationship with management practices quality with the results robust to a large number of additional controls, such as industry, size, ownership, and other firm characteristics. In the best case scenario, availability of fuel subsidies reduces the fuel intensity that would otherwise be associated with an improvement in management practices. In the worst case scenario, it increases fuel intensity. Its magnitude is substantial: in countries where fuel subsidies are absent or near-absent, improving management practices from the 25^{th} to 75^{th} percentile is associated with about a 23 per cent decrease in fuel intensity. In countries with high energy subsidies, the same improvement is associated either with a much lower reduction in fuel intensity (roughly 2 per cent). In high energy-intensive sectors, magnitude is even larger: the same improvement in management practices quality is associated with an almost 25 per cent reduction in fuel intensity in countries with no fuel subsidies, but a 16.7 per cent *increase* in countries with high fuel subsidies. In other words, better managed firms' fuel intensity responds more strongly to the availability of fuel subsidies. Estimates are similar for electricity intensity. The results suggest that these findings are driven by certain types of management practices with the most important one being incentives to employees. Firms where individual performance is the basis for managers' bonuses and non-managers' promotion are more likely to respond to incentives provided by fuel prices. If fuel prices are lower thanks to subsidies, those firms tend to be more fuel intensive.

Our results suggest that distortions in energy prices have an impact on the relationship between management practices and energy intensity, and thus environmental outcomes. Policies aimed at improving management practices might lead to more, rather than fewer, GHG emissions in the absence of incentives to economise on energy use.

The remainder of the paper is organised as follows. Section 2 describes the data sources used. Section 3 discusses the empirical approach used in the paper, while section 4 provides the results. Section 5 discusses sample selection and robustness and section 6 presents concluding remarks and policy implications.

[2]Electricity generators are often powered by diesel. Sakr et al. (2017) note that in Egypt, many off-grid users obtain diesel fuel for electricity generators at above market prices.

2 Data

The data used for the analysis are drawn from a number of sources. The main source of firm-level data are two enterprise surveys conducted in 2011-15: BEEPS V and MENA ES. Energy subsidies data come from the Energy Subsidies Template database provided by the International Monetary Fund (IMF) (as described in Coady et al., 2017).[3] Other sources we use are WorldClim version 1, Version 4 DMSP-OLS Nighttime Lights Time Series from the National Oceanic and Atmospheric Administration (NOAA), sector classification by energy intensity from Upadhyaya (2010), International Energy Agency (IEA) World Energy Balances and World Energy Statistics databases and the United Nations Industrial Development Organisation's (UNIDO) 2016 edition of Industrial Statistics (INDSTAT) database. We describe most of these briefly below.

2.1 BEEPS V and MENA ES

BEEPS V was conducted by the EBRD and WBG in 2011-14 and 2016 (Cyprus and Greece). It covered 16,310 enterprises in 32 countries of central and eastern Europe and Central Asia. MENA ES was implemented by the EBRD, the European Investment Bank (EIB) and WBG in 2013-14 in Djibouti, Egypt, Israel, Jordan, Lebanon, Morocco, Tunisia, West Bank and Gaza, and Yemen. In these nine countries, 6,511 firms were surveyed.[4]

Both surveys are based on face-to-face interviews with managers of registered firms with at least five employees and follow the World Bank Enterprise Surveys methodology. Stratified random sampling is used to select eligible firms to participate in the survey. Strata are defined by sector (typically manufacturing, retail and other services), size (5-19, 20-99 and 100+ employees) and regions within a country. The main purpose is to examine the quality of the business environment; topics covered are infrastructure, competition, sales and supplies, labour, innovation, land and permits, crime, finance, employment and business-government relations. The surveys also include a section on management practices and basic information on firm performance, such as sales, costs (including fuel and electricity costs) and fixed assets (capital).

2.2 IMF Energy Subsidies Template

The country-level estimates of energy subsidies used in this paper come from the IMF Energy Subsidies Template,[5] which provides annual data for gasoline, diesel, kerosene, coal, natural gas

[3] Other attempts to measure energy subsidies worldwide are also available (see a database by the International Energy Agency, Clements et al., 2013; OECD, 2013). We use Coady et al. (2017) because it has the best coverage for the countries in our sample.

[4] BEEPS V and MENA ES data are available at `http://www.ebrd-beeps.com`.

[5] The data are publicly available at:
`http://www.imf.org/external/np/fad/subsidies/index.htm`.

and electricity prices in 188 countries.[6] For each type of fuel, the IMF Energy Subsidies Template includes data on the *real* price (that is, price paid by consumers),[7] supply cost and the cost of environmental externalities from fuel combustion (global warming and local pollution). All data are expressed in US dollars at the market exchange rate. Supply costs alone are considered as the *pre-tax* price. Together, the pre-tax price and the costs of the externalities represent the total efficient price of a fuel, that is, *post-tax* price.

For electricity, which does not produce direct externalities, the total efficient price is equivalent to the supply cost. To ensure comparability across different types of fuels, we express all the prices and costs as per 1 gigajoule (GJ).

Coady et al. (2017) estimated that post-tax energy subsidies amounted to US$ 4.9 trillion worldwide in 2013, equivalent to 6.5 per cent of global GDP. Figure 1 shows the breakdown between the pre-tax subsidies as well as the cost of global warming, local externalities and foregone consumption tax revenues as a share of GDP for the countries in our sample. Several countries do not have pre-tax energy subsidies, but virtually all of them do not take into account the cost of environmental externalities from fuel combustion. The leader among countries with pre-tax energy subsidies is Uzbekistan, where they were equivalent to more than 20 per cent of GDP in 2013. Ukraine, on the other hand, is the leader once externalities are accounted for, with post-tax subsidies equivalent to more than 50 per cent of GDP in 2013.

2.3 Other data sources

We use the WorldClim version 1 database, developed by Hijmans et al. (2005)[8], and the data on nighttime lights from Version 4 DMSP-OLS Nighttime Lights Time Series, National Oceanic and Atmospheric Administration (NOAA),[9] to calculate the average January and July temperatures and intensity of nighttime lights in a firm's vicinity, respectively. We calculate the average intensity of night lights in 2010-12 within a circle with a 10 km radius around a given enterprise. For temperature, the circle radius increases to 25 km due to a lower data resolution. Temperature data are averages over years 1970-2000.

For the calculation of sector-level energy subsidies, we make use of IEA World Energy Balances and World Energy Statistics databases and UNIDO's 2016 edition of INDSTAT-2 database at the level of 2-digit International Standard Industrial Classification (ISIC), Revision 3.1.

We classify manufacturing sectors according to energy input ratio following Upadhyaya (2010). Based on that, manufacture of chemical products, coke and refined petroleum products, paper and paper products are among high energy-intensive sectors, while food products, wood and

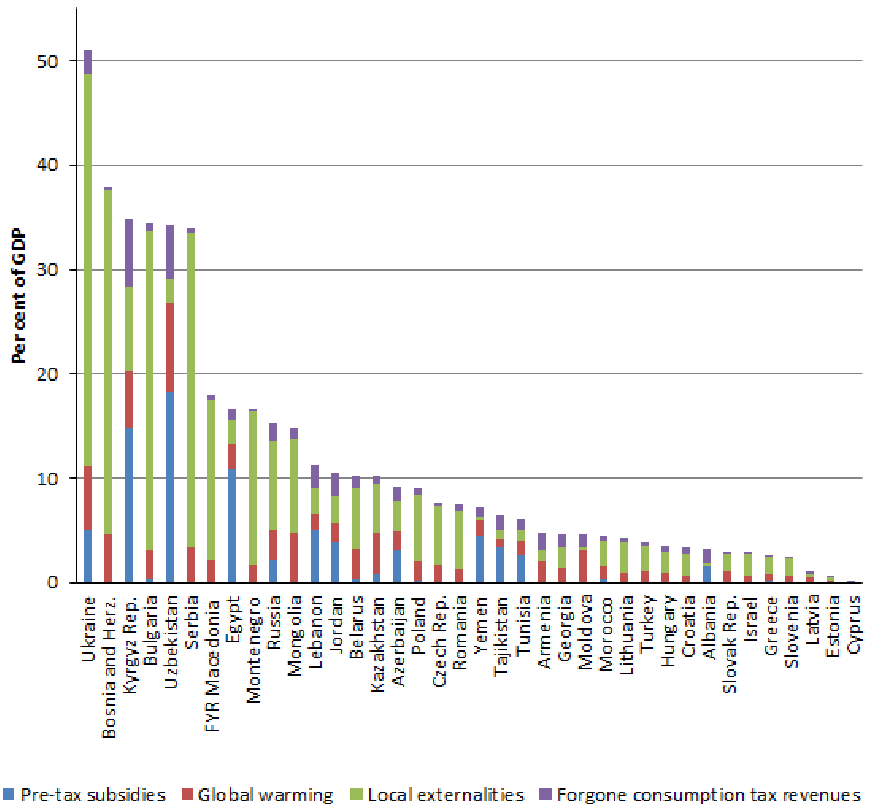
[6] As discussed in Coady et al. (2017), data constraints prevent the inclusion of some broader oil products, such as jet fuels and home heating oil, and as such, energy subsidies in the database are understated.

[7] Consumer prices are compiled from several sources: IEA, IMF, US Energy Information Administration (EIA) and the World Bank. In some cases, they are assumed equal to supply costs. See Coady et al. (2017, p.15) for more details.

[8] Available at `http://www.worldclim.org/version1`.

[9] Available at `http://ngdc.noaa.gov/eog/dmsp/downloadV4composites.html`.

Figure 1: Economic value of fossil-fuel consumption subsidies



Source: IMF Energy Subsidies Template.
Note: These estimates relate to 2013 and include both consumption and production-related subsidies.

wood products, machinery and equipment and recycling are among moderate and low energy-intensive sectors. Table A.1 in Appendix A provides more detailed information.

3 Methodology

In this section, we first explain how we measure management practices and energy subsidies, and then specify estimation models.

3.1 Measuring management practices

BEEPS V and MENA ES include a selection of questions from the US Census Bureau's Management and Organisational Practices Survey (MOPS) (Bloom et al., 2013). The questions concerned four aspects of management – operations, monitoring, targets and incentives – and requested unordered categorical responses. The operations question focused on how the firm handled a process-related problem, such as machinery breaking down. The monitoring question covered the collection of information on production indicators. The questions on targets focused on the timescale for production targets, as well as how difficult it was to achieve them and who was aware of them. Lastly, the incentives questions covered criteria governing promotion, practices for addressing poor performance by employees and the basis on which the achievement of production targets was rewarded. These questions were directed to all manufacturing firms with at least 20 employees (50 in the case of Russia).[10]

On the basis of firms' answers, the quality of their management practices can be assessed and assigned a rating. As the scaling varies across management practices, we first standardise the scores of each management practice (that is, each question) to having a mean of zero and a standard deviation of one (as in Bloom et al., 2012).[11] We then use the z-scores to calculate unweighted averages making use of the z-scores for each individual section of the respective management practice, in order to prevent accentuating the target or incentives sections, which include multiple questions. Lastly, we compute an unweighted average across the scores for the four management areas, and standardise once more this unweighted average.

This means that the average management score across all firms (for which the underlying variables are available) in all countries in the sample is equal to zero. Management practices of individual firms deviate either left or right from zero, with the former denoting bad (below average) practices and the latter indicating good practices, with the higher z-score reflecting a higher quality of management practices.

[10]Russia was the first country in which BEEPS V was implemented. The number of firms with at least 50 employees was not as high as expected, so the threshold was lowered to 20 employees in subsequent countries.

[11]The questions on management practices came at the end of a long face-to-face interview. This resulted in an unusually large number of people responding "don't know" or refusing to answer. Observations with a response rate excluding don't know or refusal below 62.5 per cent prior to recoding described in Appendix C were excluded.

3.2 Measuring energy subsidies

We use two alternative measures of energy subsidies for pre- and post-tax scenarios. The first measure is a gap between the benchmark energy price and the real energy price (paid by consumers); it is calculated at the country level. The second measure consists of energy subsidies received by a sector, normalised by sector output, and is calculated at the country-sector level. In the pre-tax scenario, the benchmark price is the supply cost only. In the post-tax scenario, the benchmark price is the total efficient price, that is, the supply cost plus the foregone revenue of taxes necessary to compensate for the externalities.

3.2.1 Country-level price gap

Country-level price gap calculations are based solely on the data from the IMF Energy Subsidies Template. The subsidy estimation method is based on the price-gap approach, where the price gap is defined as the difference between the benchmark price and the average consumer price for a given product within a country. For net importers of energy, the benchmark price is calculated as the international price at the nearest hub, adjusted for quality differences, plus transportation and distribution costs. For net exporters of energy, the benchmark price is the international price, adjusted for quality differences, minus transportation costs plus distribution costs.[12]

The fuel price gap is calculated as the unweighted average of gasoline, diesel, kerosene, coal, and natural gas price gaps. If any of these fuels is not consumed in a country, it is excluded from the average. For electricity, which is rarely traded across national borders, the benchmark price is calculated based on the make-up of generating capacity, unsubsidised cost of fossil fuels and transmission costs. Electricity supply costs are assumed to be equal to consumer prices in countries where pre-tax subsidy estimates are not available. In our sample, these are available for 14 countries; for the remaining countries, supply costs are assumed to be equal to consumer prices. Thus, the electricity price gap equal to 0 could indicate either that the electricity price was indeed equal to the cost of obtaining it and there were no subsidies, or that the cost of obtaining electricity was not known (and the actual electricity price gap could be either positive or negative). This is why our preferred outcome of interest is fuel, rather than electricity, intensity.

We match fuel and electricity price gaps to the BEEPS V and MENA ES data based on the country and fiscal year to which the data refer. Since different countries were surveyed in different years, we express price gaps in 2011 constant prices.

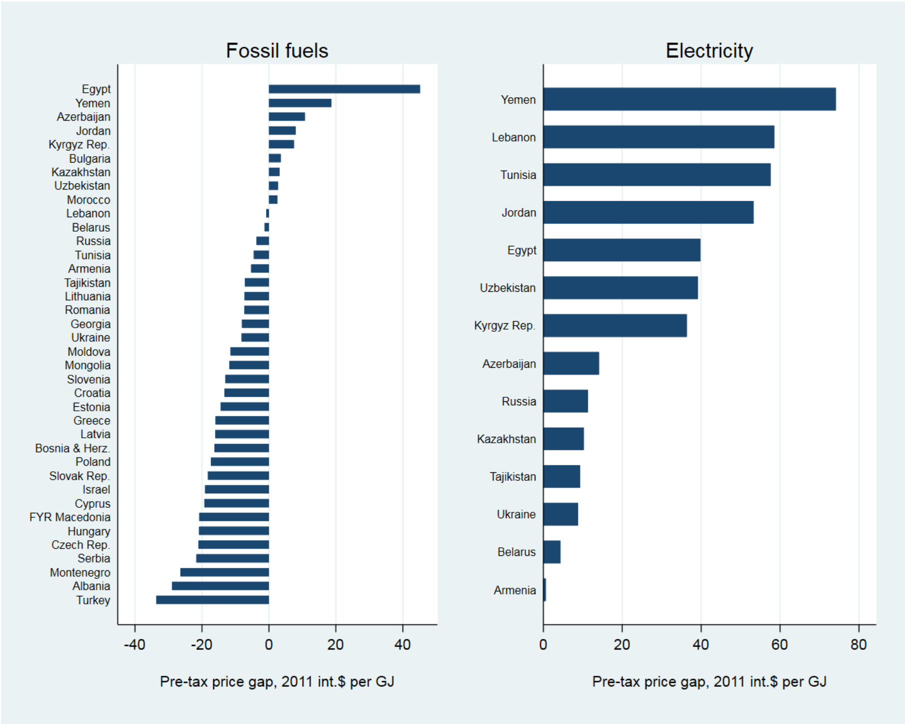
Figure 2 shows fuel and electricity price gaps for the countries in our sample in 2011 international dollars per gigajoule (GJ). In the fiscal year to which the data refer (and which varies by country), the pre-tax fossil fuel price gap was positive (with the price below the supply costs) in 9 countries, with the fuel subsidy reaching 45.9 international dollars per GJ in Egypt, followed by Yemen (14.9 international dollars per GJ) and Azerbaijan (8.6 international dollars

[12]Note that our calculations of the total efficient price do not take into account the value-added tax (VAT) because we analyse only energy used in the production process, which should not be subject to VAT.

per GJ). In the remaining 29 countries, there were no pre-tax fuel subsidies, but the difference between the real price and the supply cost varied between 0.8 international dollars per GJ in Lebanon and more than 33 international dollars per GJ in Turkey. We expect this *negative*subsidy to have a symmetric, but opposite, effect on outcomes as the *positive* subsidy. In other words, the higher the price is above the supply costs (negative subsidy), the less energy intensive we expect the firm to be. The lower the price below the supply cost (positive subsidy), the more energy intensive the firm.

Yemen, Lebanon and Tunisia were the leaders in the electricity pre-tax price gap, with subsidies reaching 71.4, 58.5 and 57.6 international dollars per GJ, respectively.

Figure 2: Pre-tax energy price gaps, international dollars per GJ



Source: IMF Energy Subsidies Template and authors' calculations.
Note: These estimates relate to the fiscal year to which the firm-level data refer and include both consumption and production-related subsidies. The fuel price gap is calculated as the mean of gasoline, diesel, kerosene, coal, and natural gas price gaps. For electricity, which is rarely traded across national borders, the benchmark price is calculated based on the make-up of generating capacity, unsubsidised cost of fossil fuels and transmission costs.

3.2.2 Sector-level energy subsidies

Using the price-gap approach for the estimation of energy subsides has two important implications. First, it assigns the same weight to all the fuels and electricity in the energy mix across all countries and sectors, although there is evidence that they differ. Second, it does not take into account differences in energy intensities across sectors. Furthermore, it does not allow cross-country variation within these groups.

The goal of our alternative measure of energy subsidies is to overcome these obstacles. To address the first one, the price gap is calculated in the following way:

$$g_s = \frac{\sum_f e_{sf} \times (b_f - r_f)}{t_s}, \quad (1)$$

where g_s is the energy price gap faced by a 2-digit sector s, b_f and r_f are the benchmark and the real price of fuel f respectively, e_{sf} and t_s are the amount of fuel f and total amount of energy consumed by sector s. For the purpose of our analysis, two price gaps have to be calculated: fuel and electricity price gaps. The energy price gap calculated in equation (1) is the amount of subsidies per unit of energy consumed by a sector. To make this measure comparable across sectors, it needs to be weighted by the energy intensity of the sector:

$$w_s = \left[\frac{\sum_f e_{fs} \times (b_f - r_f)}{t_s}\right] \times \frac{t_s}{y_s}, \quad (2)$$

where w_s are the weighted energy subsidies received by a 2-digit sector s and y_s is sector value added (or output). Equation (2) could be presented in a simplified way:

$$w_s = \frac{\sum_f e_{fs} \times (b_f - r_f)}{y_s}. \quad (3)$$

This is our preferred formula, when data on energy consumption and value added/output are available at the 2-digit sector level. However, many countries lack detailed data. In this case, equation (2) could be re-written to accommodate information from a broader sector and other countries:

$$w_{cs} = \left[\frac{\sum_f e_{cmf} \times (b_{cf} - r_{cf})}{t_{cm}}\right] \times \frac{1}{N}\sum_{i=1}^{N} \frac{t_{is}}{y_{is}}. \quad (4)$$

The above equation calculates the weighted energy subsidies received by a 2-digit manufacturing sector s from country c based on the energy consumed by the entire manufacturing (or industry) sector of that country, which is denoted as t_{cm}. A rough breakdown of energy consumed by manufacturing, transport, households and so on is available for almost any country in our list. However, the energy intensity of the manufacturing sector is not suitable for the second multiplier in equation (2). Instead, equation (4) uses average energy intensity of sector s, calculated across N countries where detailed sector data are available.

For post-tax electricity subsidies, the benchmark electricity price is calculated as

$$b_e = s_e + \frac{\sum_f e_f \times (w_f + p_f)}{E}, \quad (5)$$

where s_e is the supply cost of electricity, E is the total amount of primary energy used in power generation (including renewables), e_f is the amount of a particular fuel (coal or natural gas) used in power generation, and w_f and p_f are the global warming and local pollution cost of the combustion of this fuel. Thus, if all electricity in a country is produced using coal only, the total efficient price of electricity will include the environmental costs of coal. If a major share of electricity is produced using biofuels or renewables, the benchmark price will be less exposed to the environmental repercussions of coal and natural gas.

The variables used in equations (3) and (4) are extracted from the following sources. The real and benchmark energy prices are available from the IMF Energy Subsidies Template, which is discussed above. Energy consumption data are reported by IEA World Energy Balances and World Energy Statistics databases. Lastly, sector-level value added and output are obtained from the UNIDO INDSTAT database.

Following the discussion above, we calculate both pre- and post-tax energy subsidies using two different benchmark prices. Given the limited availability of sector-level data on production and energy consumption, we calculate weighted energy subsidies as of 2011 only.[13]

Figure 3 shows the resulting pre-tax fuel subsidies by country and by 2-digit manufacturing industry. Among countries, Yemen is now ahead with international \$79.6 of fuel subsidies per international \$ 1000 of output, followed by Egypt with international \$68.4 of fuel subsidies per international \$ 1000 of output. At the other end are Greece and Albania. Among sectors, fossil fuel pre-tax subsidies per international \$ 1000 of output were the highest in metals, non-metallic minerals and chemicals.

3.3 Empirical specifications

The main question of this paper is whether the relationship between the quality of management practices and energy intensity depends on the availability of energy subsidies for fossil fuels. Our methodology is based on Bloom et al. (2010), and the basic specification is as follows:

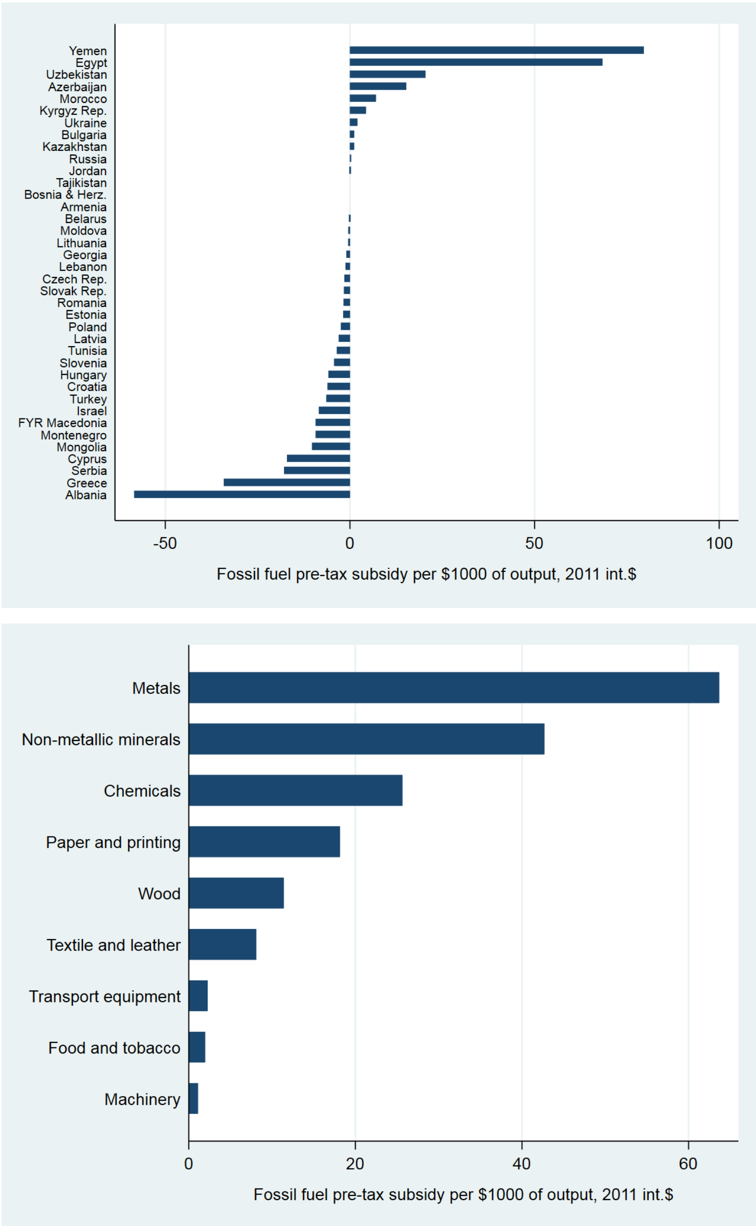
$$(EE/S)_{isc} \times 100 = \beta_0 + \beta_1 M_{isc} + \gamma' \mathbf{Z_{isc}} + \nu' \mathbf{W_{ic}} + \sum_{s=1}^{S} \delta_s D_s + \sum_{c=1}^{C} \delta_c D_c + \epsilon_{isc} \qquad (6)$$

where EE and S denote energy expenditure and total sales, and M is management practices z-score in firm i in sector s and country c. Energy expenditure is measured as fuel expenditure or electricity expenditure. The dependent variables are thus fuel intensity (fuel costs as a percentage of total sales) and electricity intensity (electricity costs as a percentage of total sales). To minimise the impact of outliers, dependent variables are winsorised at 5 per cent. The reference year for them was the survey reference year, which ranged from 2010 in Russia to 2014 in Cyprus and Greece.

Matrix **Z** comprises firm characteristics: total sales, capital (cost of machinery and equipment), labour (number of permanent, full-time employees), latitude and longitude of the firm's location, firm age, ownership structure, exporter status, indicator for credit constrained firms, percentage of employees with a university degree, listed status, indicator if electricity is an obstacle for firm's operations and percentage of self-generated electricity.

[13] The reference period of BEEPS V and MENA ES data is between 2010 and 2012, with most countries using 2011.

Figure 3: Pre-tax fuel subsidies, international dollars per 1000 international dollars of output



Source: IMF Energy Subsidies Template and authors' calculations.
Note: These estimates relate to the fiscal year to which the firm-level data refer and include both consumption and production-related subsidies.

Matrix **W** includes the average January and July temperatures in the 25 km radius around the firm over 1970-2000, and average intensity of night lights in years 2010-12 with a 10 km radius around the firm. We include these variables to control for the general climate and economic conditions around the firm, which could have an impact on its energy intensity. D_s and D_c denote 2-digit sector[14] and country fixed effects.

[14] We group together sectors 15-16, 18-19, 21-22, 23-24, 26-27, 30-35 and 36-37.

As discussed in section 2.2, there are two types of energy subsidies: pre-tax and post-tax energy subsidies, with the former equal to the difference between the real price and supply cost, and the latter explicitly taking into account externalities. Because firms do not typically consider the cost of any externalities their activities may generate, we first focus on pre-tax energy subsidies and adjust equation (6) to produce the following specification:

$$(EE/S)_{isc}\times 100 = \beta_0 + \beta_1 M_{isc} * P + \beta_2 M_{isc} + \beta_3 P + \gamma^{'}\mathbf{Z_{isc}} + \nu^{'}\mathbf{W_{ic}} + \sum_{s=1}^{S}\delta_s D_s + \sum_{c=1}^{C}\delta_c D_c + \epsilon_{isc}, \tag{7}$$

where P is a measure of pre-tax energy subsidies at the country level (P_c) and at the country-sector (P_{sc}) level. Note that when P is measured at the country level, equation (7) does not explicitly control for P_c; rather, it is absorbed in the country fixed effects.

To formally test whether the firms' energy intensity indeed responds only to pre-tax energy subsidies but not to the cost of externalities associated with energy, we augment specification in equation (7) by adding the difference between the post- and pre-tax energy price gap and its interaction with the quality of management practices, as follows:

$$(EE/S)_{isc}\times 100 = \beta_0 + \beta_1 M_{isc} * P + \beta_2 M_{isc} + \beta_3 P + \beta_4 M_{isc} * \Delta P + \beta_5 \Delta P + \gamma^{'}\mathbf{Z_{isc}} + \nu^{'}\mathbf{W_{ic}} + \sum_{s=1}^{S}\delta_s D_s + \sum_{c=1}^{C}\delta_c D_c + \epsilon_{isc}, \tag{8}$$

where ΔP is the difference between the post- and pre-tax energy price gap, measured either at the country or country-sector level. When P is measured at the country level, P_c and ΔP_c are absorbed in country fixed effects and not explicitly included in equation (8). If, as hypothesised, firms do not consider externalities when deciding on energy intensity of their production, we would expect coefficients β_4 and β_5 (in case of ΔP_{sc}) not to be statistically significantly different from 0.

Models (6), (7) and (8) are estimated using the *svy* command in Stata, using Taylor-linearised standard errors that account for survey stratification. To ensure that each economy is given equal consideration in averages, sampling weights within each economy are re-scaled to sum to one, as is common practice. To account for the possibility that management practices will matter more for energy usage in sectors where energy is a higher portion of their costs when using energy subsidies measured at the country level, we estimate these models separately for the high energy-intensive and low and moderate energy-intensive sectors using the classification in Upadhyaya (2010). This is in the spirit of Boyd and Curtis (2014), who find that the relationship between management and energy use is the strongest for firms in energy-intensive sectors.

An alternative way of taking into account differences across sectors – which doesn't require splitting the sample – is to measure energy subsidies at the country-sector level. However, Lyubich et al. (2018) show that there is enormous heterogeneity in output per dollar of energy input even across firms within narrowly defined industries. To further account for these differences even when using energy subsidies measured at the country-sector level, we split the sample into firms that use self-generated electricity and those that do not. Firms typically have electricity generators to be able to continue production or provide services when the electricity supply is unreliable. However, having an electricity generator is costly and electricity generated by it is more expensive than electricity from the grid, especially if the price of electricity from the grid is subsidised. Firms that do not use self-generated electricity are thus more likely to be sensitive to energy prices and availability of energy subsidies.

3.4 Sample size and descriptive statistics

We focus on manufacturing firms with at least 20 employees (50 in Russia), for which measures of management practices are available. Table B.1 in Appendix B provides a breakdown of our sample by country. The number of observations ranges from 15 in Montenegro to 439 in Russia, 656 in Turkey, and 1,133 in Egypt.

Table 1: Firm-level descriptive statistics, sample

	Obs.	Mean	Std. Error
Fuel costs, % total sales	2,247	3.158	0.236
Electricity costs, % total sales	2,207	3.736	0.224
Management (z-score)	2,247	0.029	0.047
Total sales, '000 USD	2,247	5489.612	353.608
Number of PFT employees	2,247	105.715	6.384
Net book value of equipment, '000 USD	2,247	1462.409	114.356
Credit-constrained firm, dummy	2,247	0.180	0.016
Exporting firm, dummy	2,247	0.431	0.021
Firm age	2,247	19.342	0.554
25+% foreign ownership, dummy	2,247	0.162	0.015
25+% state ownership, dummy	2,247	0.017	0.005
% employees with a university degree	2,247	17.429	0.691
Listed firm, dummy	2,247	0.043	0.008
% of firms owning/sharing a generator	2,237	0.197	0.016
% self-generated electricity	2,247	4.432	0.555
Electricity is major or severe obstacle	2,247	0.240	0.019

Source: BEEPS V, MENA ES and authors' calculations.
Note: Means and standard errors are calculated using survey-weighted observations (using Stata's svy prefix). Standard errors are Taylor-linearised standard errors.

Once the sample is restricted to firms with available data for variables used in the analysis (see section 3.3), the total number of observations drops from 4,977 to 2,247. Most of this drop is due to the availability of data for capital and fuel expenditures – only 4,545 firms have non-missing data on both.[15] Out of these, 2,271 firms have non-missing data on sales, management practices and percentage of employees with a university degree. The sample is further reduced to 2,247 due to missing data for age, exporter status, ownership and severity of electricity as an obstacle. We discuss possible sample selection issues in section 5.[16]

[15] Data are classified as missing if the response is don't know or refusal.

[16] BEEPS V and MENA ES also cover Djibouti, Kosovo and West Bank and Gaza. They are excluded from the

Table 1 presents descriptive statistics for all firm-level variables used in the analysis (with the exception of GPS coordinates). Fuel and electricity expenditure constitute 3.2 and 3.7 per cent of total sales, respectively. Firms had on average 106 permanent, full-time employees, generated just over US$ 5.49 million in sales during the last complete fiscal year, and have been operating for around 19 years. Of these firms, 16.2 per cent had at least 25 per cent foreign ownership, 43.1 per cent of them were exporters and 18 per cent of them were credit-constrained.

While 19.7 per cent of firms owned or shared an electricity generator, self-generated electricity on average accounted for around 4.4 per cent of total electricity usage. However, there were also firms that relied exclusively on self-generated electricity for their production needs. Overall, 24 per cent of firms stated that electricity was a very severe or major obstacle to their current operations.

analysis because all eligible observations in Djibouti have missing data on capital and the IMF Energy Subsidies Template does not have data on energy subsidies for Kosovo and West Bank and Gaza.

4 Results

In this section we discuss the results obtained by estimating equations (6), (7) and (8). For reasons discussed in section 2.2, we focus on results using fuel intensity as the outcome of interest, but we show that results are in general robust to using electricity intensity. We also look into which component(s) of management practices are driving the results. Lastly, we discuss the robustness of our findings to changes in the sample as well as sample selection bias.

4.1 Baseline specification

The baseline specification in equation (6) looks at the relationship between the quality of management practices and fuel intensity, not taking into account possible fuel subsidies. We find a negative and significant (at the 10 per cent level) correlation in the full sample and the sample of firms in moderate and low energy-intensive sectors (see Table 2). In the sample of firms in high energy-intensive sectors, the correlation is positive, but not statistically significant. The lack of more statistically significant results could be attributed to a number of different factors. As discussed above, better managed firms may either decrease their energy intensity while using more efficient production techniques or increase it because of higher capital utilisation. The absence of a significant relationship, either positive or negative, suggests that our sample includes firms of both types, with the estimates somewhat in favour of the first hypothesis.

Table 2 includes a number of firm characteristics that are statistically significantly associated with fuel intensity. On the one hand, the correlation between the volume of total sales and fuel intensity is negative. This suggests that larger firms need less fuel to produce a unit of output, which is consistent with economies of scale.[17] Capital, on the other hand, is strongly and positively associated with fuel intensity. Intuitively, a higher amount of capital deployed in production should lead to higher energy expenditures, *ceteris paribus*.

Among other firm characteristics not reported in the table, there are a few that should be mentioned. First, there is a negative and significant correlation between fuel intensity and an indicator for credit constrained firms overall and in the moderate and low energy-intensity sectors. This could be because firms that do not have access to credit need to be less fuel intensive (more efficient) to operate than firms that do, in order to compete. Alternatively, it may signal the reluctance of banks to provide loans to firms for energy-saving technologies. Second, there is also a negative and significant correlation between fuel intensity and the percentage of employees with a completed university degree in the high energy-intensity sectors. This may indicate that employees with more education are more aware of the measures that could be taken to reduce fuel intensity and/or are more willing to adopt them.

[17]To some extent, this is an artefact of the specification, because total sales are in the denominator of the dependent variable. Using log sales three fiscal years ago instead of log sales last complete fiscal year, the coefficient estimate on log sales three fiscal years ago is positive, but not significant. Results are available on request.

Table 2: Management practices and fuel intensity

	Sectors according to energy intensity		
Dep. var.: Fuel intensity	All (1)	High (2)	Moderate & low (3)
Management (z-score)	-0.302*	0.060	-0.394*
	(0.180)	(0.284)	(0.203)
Sales, log	-1.381***	-1.166***	-1.415***
	(0.250)	(0.261)	(0.319)
Labour, log	0.692**	0.481	0.539
	(0.341)	(0.377)	(0.404)
Capital, log	0.518***	0.318*	0.543***
	(0.123)	(0.173)	(0.137)
R^2	0.291	0.465	0.336
Observations	2,247	696	1,551

Source: BEEPS V, MENA ES and authors' calculations.
Note: Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, fuel intensity, is calculated as fuel expenditure over total sales and winsorised at 5 per cent. Sectors are split into high, moderate and low energy-intensive sectors according to Upadhyaya (2010). All regressions include country and sector fixed effects and control for other firm characteristics (log of firm age, percentage of employees with a college degree, percentage of self-generated electricity, longitude and latitude of the firm's location, January and July mean temperatures and night-lights around the firm, as well as indicators for listed firms, credit constrainedness, 25 per cent foreign and state ownership, exporter status and electricity as a major or very severe obstacle).

4.2 Country-level subsidies

To estimate the effect of relative pre-tax price of fuel on a firm's fuel intensity, we estimate the model in specification (7) for the full sample, as well as separately for the high versus moderate and low energy-intensive sectors, to check whether fuel subsidies (and their interaction with management practices) matter more for sectors where energy is a higher portion of the firms' costs.

In Table 3, the estimated coefficients on management practices quality are negative in all sectors, though statistically significant (at the 10 per cent level) only in the sample of firms in moderate and low energy-intensive sectors. In contrast, the estimated coefficient on management practices quality interacted with fuel price gap is positive throughout, but statistically significant only in the full sample (at the 10 per cent level) and the high energy-intensive sector (at the 5 per cent level).

To understand the magnitude of the total impact of management practices on fuel intensity, we look at what happens when the quality of a firm's management practices improves from the 25$^{\text{th}}$

Table 3: Management practices and fuel intensity: pre-tax price gap

	Sectors according to energy intensity		
Dep. var.:	All	High	Moderate & low
Fuel intensity	(1)	(2)	(3)
Management (z-score)	-0.236	-0.045	-0.329*
	(0.166)	(0.284)	(0.188)
Management (z-score)	0.013*	0.024**	0.009
* Fuel price gap	(0.007)	(0.011)	(0.010)
Sales, log	-1.386***	-1.193***	-1.418***
	(0.250)	(0.268)	(0.319)
Labour, log	0.684**	0.529	0.533
	(0.341)	(0.379)	(0.404)
Capital, log	0.522***	0.340**	0.544***
	(0.123)	(0.172)	(0.137)
R^2	0.292	0.471	0.337
Observations	2,247	696	1,551

Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, fuel intensity, is calculated as fuel expenditure over total sales and winsorised at 5 per cent. Sectors are split into high, moderate and low energy-intensive sectors according to Upadhyaya (2010). Other control variables are the same as those listed under Table 2.

to the 75th percentile of the management practices quality distribution.[18] Estimates in column (1) indicate that in a country where the fuel price gap is in the bottom quartile of the fuel price distribution, such improvement is associated with a 21.9 per cent decrease in firms' fuel intensity (statistically significant at the 5 per cent level). In a country where the fuel price gap is in the top quartile (that is, fuel subsidies are high), the same improvement is associated with only a 1.1 per cent decrease in firms' fuel intensity (not statistically significant).

Firms in high energy-intensive sectors are more sensitive to fuel prices and subsidies. In a country where the fuel price gap is in the bottom quartile of the fuel price distribution, such improvement is associated with an 24.4 per cent *decrease* in their fuel intensity. Conversely, in a country where the fuel price gap is in the top quartile, the same improvement is associated with a 16.7 per cent *increase* in fuel intensity (not statistically significant).

The implications of these results are twofold. First, they confirm that firms respond to incentives provided by fuel subsidies: higher fuel subsidies are associated with a lower reduction in fuel intensity. Second, in high energy-intensive sectors, firms are more sensitive to fuel prices: higher fuel subsidies are associated with higher fuel intensity.

[18]The magnitude of these effects is calculated by estimating the average marginal effects of management practices by quartiles of pre-tax fuel price (using the margins command in Stata), multiplying them by the interquartile range of the distribution of management practices quality and normalising the amount by the average fuel intensity in the estimation sample.

4.3 Sector-level subsidies

The benefits of fuel (and more generally, energy) subsidies are not equally distributed among all firms within a country. Firms in high energy-intensive sectors are more likely to benefit from them than firms in sectors with moderate and low energy intensity, and their management is more likely to respond to the incentives provided by fuel subsidies. But sectors use a different mix of fuels and electricity in each country, and energy intensity differs even within high energy-intensive sectors. The results in Table 4 use a country-sector-level measure of fuel subsidies, which accounts for these differences, and also allows us to explicitly control for the level of fuel subsidy per output. Because we expect firms that do not use self-generated electricity to be more sensitive to fuel prices, we split the sample into those that use self-generated electricity and those that do not in columns (2) and (3).[19]

Table 4: Management practices and fuel intensity: pre-tax fuel subsidy per output

		Use self-generated electricity	
Dep. var.:	All	Yes	No
Fuel intensity	(1)	(2)	(3)
Management (z-score)	-0.332*	-0.941*	-0.338
	(0.191)	(0.531)	(0.209)
Management (z-score)	0.010**	0.010	0.012**
* (Fuel subsidy / output)	(0.005)	(0.011)	(0.005)
Fuel subsidy / output	-0.008	0.030	-0.011
	(0.007)	(0.025)	(0.007)
Sales, log	-1.471***	-2.220***	-1.512***
	(0.276)	(0.535)	(0.305)
Labour, log	0.666*	0.437	0.762*
	(0.382)	(0.468)	(0.428)
Capital, log	0.560***	1.276***	0.527***
	(0.133)	(0.299)	(0.139)
R^2	0.286	0.377	0.310
Observations	2,037	361	1,676

Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, fuel intensity, is calculated as fuel expenditure over total sales and winsorised at 5 per cent. Other control variables are the same as those listed under Table 2.

The estimated coefficients on fuel subsidy per output are not statistically significantly different from zero in any of the columns, indicating that fuel subsidy per output is not correlated with fuel intensity, after we control for country and industry fixed effects and other firm

[19]The number of observations in Table 4 is lower than in Table 3, because we exclude sectors with ISIC Rev. 3.1 codes 25 "Rubber and plastic products", 36 "Furniture and other manufacturing n.e.c." and 37 "Recycling". These sectors are aggregated under the "Non-specified" category in the IEA energy consumption data, which can also include other energy consumption that cannot be attributed to any particular industrial sector. Consequently, the "Non-specified" category cannot be used as a proxy for aggregated sectors 25, 36 and 37 because it is likely to overestimate their energy consumption.

characteristics. The estimated coefficient on management practices quality is negative and statistically significant at the 10 per cent level in the full sample and the sample of firms that use self-generated electricity, indicating that having better management practices quality is associated with lower fuel intensity. The estimated coefficient on management practices quality interacted with fuel price gap is positive and statistically significant at the 5 per cent level in the full sample and in the sample of firms that do not use self-generated electricity and are thus more sensitive to energy prices.

To understand the magnitude of the total impact of management practices on fuel intensity, we again look at what happens when a firm's management practices quality improves from the 25th to the 75th percentile of the management practices quality distribution.[20] In country-sector pairs where the fuel subsidy per output is in the bottom quartile of the fuel price distribution, such improvement is associated with a 24.2 per cent decrease in fuel intensity of firms (statistically significant at the 5 per cent level). Conversely, in country-sector pairs where the fuel subsidy per output is in the top quartile (that is, fuel subsidies per output are high), the same improvement is associated with a 2.9 per cent decrease in fuel intensity (though not statistically significantly different from zero) – less than an eighth of the impact associated with fuel subsidy per output in the bottom quartile.

In the sample of firms that do not use self-generated electricity (column (3) in Table 4), the described improvement in management practices quality is associated with a 26.6 per cent decrease in fuel intensity in country-sector pairs where the fuel price gap is in the bottom quartile (statistically significant at the 5 per cent level). In country-sector pairs where the fuel price gap is in the upper quartile, the corresponding decrease in fuel intensity is only 2.1 per cent (again not statistically significantly different from zero). Thus, higher fuel subsidies per output result in a lower decrease in fuel intensity. As seen from column (2) in Table 4, the sample of firms that use self-generated electricity is limited. It is thus not surprising that most of the estimated coefficients of interest are not statistically significantly different from zero. However, the results indicate that such firms are, as expected, less sensitive to fuel prices/availability of fuel subsidies.

Comparing estimates in Table 4 with estimates in Table 3, it is clear that the change in the identification strategy does not substantially affect the relationship between fuel subsidies on the one hand, and capital and sales on the other hand. While the relevant coefficient estimates differ, the magnitude of the estimated total impact of management practices on fuel intensity is quite similar in the full sample regardless of the fuel subsidy measure used. An improvement of management practices quality from the 25th to the 75th percentile of the management practices quality distribution is associated with about 20 per cent fuel intensity reduction when fuel subsidies are low (negative) and with about 3 per cent fuel intensity reduction when fuel subsidies are high.

[20] As in section 4.2, the magnitude of these effects is calculated by estimating the average marginal effects of management practices by quartiles of pre-tax fuel subsidy per output (using the margins command in Stata), multiplying them by the interquartile range of the distribution of management practices quality and normalising the amount by the average fuel intensity in the estimation sample.

4.4 Management practices components

So far, we used an overall index of the quality of management practices, obtained by averaging across all the management survey scores. In Table 5, we look at whether certain management practices are more strongly correlated with fuel savings than others. The coefficients come from separate regressions of fuel intensity on the various management scores, fuel subsidy measures (in the case of country-sector level measures) and their interactions. All regressions control for the same set of variables as those shown in Tables 3 and 4.

Table 5: Management practices components and fuel intensity

	Fuel subsidy measure			
Dep. var.: Fuel intensity	Price gap			Subsidy/output
Sectors according to energy intensity	All (1)	High (2)	Moderate & low (3)	All (4)
Dealing with problems in the production process	-0.513**	-0.302	-0.594**	-0.569**
	(0.210)	(0.321)	(0.259)	(0.249)
Dealing with problems in the production process * Fuel subsidy	0.002	-0.005	0.002	-0.004
	(0.008)	(0.012)	(0.010)	(0.008)
Number of production performance indicators	0.038	0.497**	-0.128	-0.022
	(0.153)	(0.246)	(0.170)	(0.167)
Number of production performance indicators * Fuel subsidy	0.011	0.027**	0.007	0.001
	(0.007)	(0.012)	(0.009)	(0.005)
Time frame of production targets	0.274	0.018	0.248	0.330
	(0.241)	(0.252)	(0.322)	(0.273)
Time frame of production targets * Fuel subsidy	0.003	0.012	0.007	0.001
	(0.007)	(0.009)	(0.010)	(0.006)
Achievement of production targets	-0.172	-0.276	-0.098	-0.226
	(0.176)	(0.296)	(0.189)	(0.208)
Achievement of production targets * Fuel subsidy	0.008	0.013	0.011	0.007
	(0.007)	(0.012)	(0.008)	(0.005)
Awareness of production targets	-0.263	-0.705**	-0.205	-0.281
	(0.198)	(0.341)	(0.235)	(0.246)
Awareness of production targets * Fuel subsidy	0.006	0.033*	0.008	0.009**
	(0.009)	(0.019)	(0.011)	(0.004)
Basis for managers' performance bonuses	0.128	-0.031	0.230	0.047
	(0.200)	(0.239)	(0.244)	(0.221)
Basis for managers' performance bonuses * Fuel subsidy	0.015**	0.026***	0.007	0.013***
	(0.007)	(0.009)	(0.009)	(0.004)
Primary way of promoting non-managers	0.039	0.415	0.022	-0.042
	(0.207)	(0.262)	(0.233)	(0.232)
Primary way of promoting non-managers * Fuel subsidy	0.016**	0.021**	0.011	0.014***
	(0.007)	(0.010)	(0.008)	(0.004)

Table 5 – continued from previous page

Dep. var.: Fuel intensity	Fuel subsidy measure			
	Price gap			Subsidy/output
Sectors according to energy intensity	All	High	Moderate & low	All
	(1)	(2)	(3)	(4)
Dismissal of under-performing	-0.023	0.040	-0.087	-0.056
non-manager	(0.194)	(0.376)	(0.221)	(0.236)
Dismissal of under-performing	-0.002	-0.009	0.002	0.003
non-manager * Fuel subsidy	(0.008)	(0.011)	(0.009)	(0.004)

Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Every section represents a regression of fuel intensity on a different management survey z-score. Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, fuel intensity, is calculated as fuel expenditure over total sales and winsorised at 5 per cent. Fuel subsidy is measured at the country level (price gap) in columns (1)-(3) and at the country-sector level (subsidy/output) in column (4). Sectors are split into high, moderate and low energy-intensive sectors according to Upadhyaya (2010). Model in column (4) includes fuel subsidy/output. Other control variables are the same as those listed under Table 2.

Out of eight management practices, half are negatively and half positively correlated with fuel intensity, though only the correlation with the management practice on dealing with problems in the production process is statistically significant in column (1). This is not surprising, since we also did not find any statistically significant correlations of the overall management practices quality with fuel intensity. Some of the interactions of management practices with fuel price gap are positive and statistically significant, though. In particular, the basis for managers' performance bonuses and primary way of promoting non-managers.

Among the firms in high energy-intensive sectors (column (2)), four out of eight management practices are negatively correlated with fuel intensity, with awareness of production targets the only correlation that is statistically significant at the 5 per cent level. The coefficients on the interactions of fuel price gap with the number of production performance indicators, awareness of production targets, basis for managers' performance bonuses and primary way of promoting non-managers are all positive and statistically significant at at least the 10 per cent level. This indicates that firms in high energy-intensive sectors respond to incentives more than those in moderate and low energy-intensive sectors.

Estimates in column (4), which use fuel subsidy per output rather than fuel price gap as a measure of fuel subsidy, are similar. It is again the coefficients on the interactions of fuel price gap with awareness of production targets, basis for managers' performance bonuses and primary way of promoting non-managers that are positive and statistically significant at at least the 5 per cent level of significance (with the latter two statistically significant at the 1 per cent level).

Overall, it appears that practices related to people management are more strongly linked with fuel intensity once fuel subsidies are taken into account than practices related to operations, monitoring or targets. This is similar in spirit to the findings of Bloom et al. (2010), though rather than indicating that the "use and analysis of performance indicators accompanied by some form of consequence management leads firms" to be less fuel intensive, it indicates that firms where individual performance is the basis for managers' bonuses and non-managers' promotion are more likely to respond to incentives provided by fuel prices. If fuel prices are lower thanks to fuel subsidies, those firms tend to be more fuel intensive.

4.5 Post-tax subsidies

To formally test whether the firms' fuel intensity indeed responds only to pre-tax fuel subsidies and not also to the cost of externalities associated with fuel, we estimate equation (8). Table 6 has the results for the sector-level measures of fuel subsidies, which are likely to be somewhat closer to the actual impact.

The pre-tax fuel subsidy per output coefficient estimates are similar to those in Table 4; only the estimated coefficient on the management quality interacted with pre-tax subsidy per output is positive and statistically significant at the 5 per cent level. The management quality coefficient estimate by itself is still negative, but no longer statistically significant once we control for the difference in post- and pre-tax subsidy per output. Looking at the total effect of the post-tax fuel subsidy per output on energy intensity reveals that, as in the case of pre-tax fuel subsidy per output, the level of post-tax fuel subsidy per output has no effect on the firm's energy intensity. Moreover, even the coefficient on post-tax fuel subsidy per output interacted with management quality on fuel intensity is not statistically significantly different from zero.

The magnitude of the total impact of management practices on fuel intensity illustrates this point. Improving the firm's management practices quality from the 25^{th} to the 75^{th} percentile of the management practices quality distribution is associated with a 17.7 per cent decrease (statistically significant at the 10 per cent level) in fuel intensity in country-sector pairs where the fuel subsidy per output is in the bottom quartile of the post-tax fuel subsidy per output distribution, and with around a 12 per cent decrease in fuel intensity in country-sector pairs where the fuel subsidy per output is either in the second, third, or fourth quartile of the post-tax fuel subsidy per output distribtion. In other words, unless there are no fuel subsidies per output, improvement in management practices quality is not associated with additional reductions in fuel intensity. This confirms our hypothesis that firms' fuel intensity responds only to pre-tax fuel subsidies and not to the cost of externalities associated with fossil fuels.

4.6 Electricity intensity

As discussed in section 2.2, it is very difficult to obtain the cost of electricity generation. Electricity price gap measure is only available for 14 countries in our sample, which further reduces the sample available for estimation. Because of this, our focus so far has been on fuel intensity and fuel price gap.

Table 6: Management practices and fuel intensity: post-tax subsidy

Dep. var.: Fuel intensity	All
Management (z-score)	-0.281
	(0.197)
Management (z-score) * Pre-tax fuel subsidy/output	0.009**
	(0.004)
Management (z-score) * Post- and pre-tax fuel subsidy/output difference	-0.004
	(0.003)
Pre-tax fuel subsidy/output	-0.009
	(0.007)
Post- and pre-tax fuel subsidy/output difference	0.001
	(0.003)
Sales, log	-1.473***
	(0.277)
Labour, log	0.671*
	(0.386)
Capital, log	0.561***
	(0.133)
Combined post-tax effect	
Management (z-score) * Post-tax fuel subsidy/output	0.005
	(0.006)
Post-tax fuel subsidy/output	-0.008
	(0.007)
R^2	0.287
Observations	2,037

Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, fuel intensity, is calculated as fuel expenditure over total sales and winsorised at 5 per cent. Other control variables are the same as those listed under Table 2. Combined post-tax coefficients are calculated as the sum of the coefficients on pre-tax subsidy and post- and pre-tax fuel subsidy/output difference.

Nevertheless, with the above caveats regarding the electricity price gap estimates, the results are qualitatively similar for electricity intensity. While the correlation between management practices quality and electricity intensity is positive in the overall sample and in moderate and low-energy intensive sectors, it is negative in high energy-intensive sectors, but never statistically significant (panel A of Table 7).

Once we take into account pre-tax electricity price gaps (panel B), the sample size decreases because of the availability of electricity subsidy measures. Neither the coefficient on the quality of management practices nor the coefficent on the management practices quality interacted with electricity price gap are statistically significant. Improving a firm's management practices quality from the 25^{th} to the 75^{th} percentile of the management practices quality distribution in a high energy-intensive sector in a country where the electricity price gap is in the top quartile of the electricity price gap distribution is associated with an 27.5 per cent *increase* in fuel intensity

Table 7: Management practices and electricity intensity: pre-tax price gap

	Electricity subsidy measure			
Dep. var.: Electricity intensity	Price gap			Subsidy/output
Sectors according to energy intensity	All (1)	High (2)	Moderate & low (3)	All (4)
Panel A: Basic specification				
Management (z-score)	0.161	-0.054	0.306	
	(0.235)	(0.279)	(0.261)	
Sales, log	-1.469***	-1.469***	-1.451***	
	(0.214)	(0.269)	(0.261)	
Labour, log	0.861***	0.928**	0.827**	
	(0.308)	(0.390)	(0.349)	
Capital, log	0.405***	0.207	0.423***	
	(0.095)	(0.149)	(0.114)	
R^2	0.435	0.649	0.430	
Subpop observations	2,299	701	1,598	
Panel B: Accounting for electricity price gap				
Management (z-score)	-0.398	-0.144	0.585	0.701
	(1.154)	(0.784)	(1.112)	(0.656)
Management (z-score)	0.020	0.016	-0.005	-0.009
* Electricity subsidy	(0.025)	(0.017)	(0.025)	(0.011)
Sales, log	-1.117***	-1.612***	-1.030***	-1.166***
	(0.327)	(0.347)	(0.383)	(0.343)
Labour, log	0.359	1.353**	0.051	0.423
	(0.451)	(0.538)	(0.452)	(0.484)
Capital, log	0.327**	-0.153	0.531***	0.382**
	(0.157)	(0.203)	(0.191)	(0.167)
R^2	0.485	0.739	0.467	0.490
Observations	1,605	551	1,054	1,444

Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Simple OLS using survey-weighted observations (using Stata's svy prefix). *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. The dependent variable, electricity intensity, is calculated as electricity expenditure over total sales and winsorised at 5 per cent. Electricity subsidy is measured at the country level (price gap) in columns (1)-(3) and at the country-sector level (subsidy/output) in column (4). Sectors are split into high, moderate and low energy-intensive sectors according to Upadhyaya (2010). Model in column (4) includes fuel subsidy/output. Other control variables are the same as those listed under Table 2.

(statistically significant at 10 per cent). Conversely, in a high energy-intensive sector in a country where the electricity price gap is in the bottom quartile, the same improvement in the quality of management practices is associated with a 1.9 per cent *decrease* in electricity intensity (not statistically significant).

5 Sensitivity analysis

In the empirical analysis, we control for country and industry fixed effects, as well as for firm characteristics. We winsorise the outcome variables at 5 per cent, to exclude outliers and we use survey weights that sum up to 1 within each country, so that each country has the same weight in the regressions, regardless of the number of observations.

However, given that the availability of variables included in the regressions varies by country and firms within countries, we run the risk that the results are driven by a specific country. Moreover, as shown in section 2.1, we lose observations due to missing values for both dependent and independent variables and the results are potentially affected by the selection bias. We address these two concerns below.

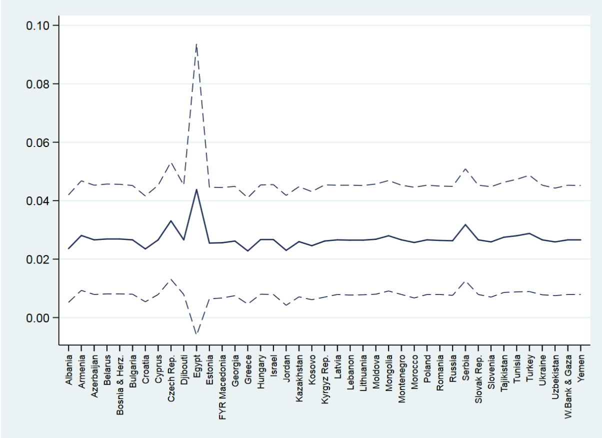
5.1 Changes in the sample

To test for the robustness of our results to changes in the sample, we re-estimate specifications in column (2) in Table 3 and columns (1) and (3) in Table 4, removing one country at a time from the sample.

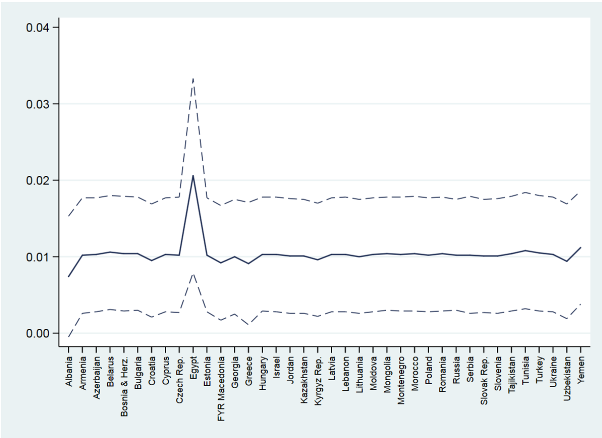
The results in Figure 4 show stability of the estimated coefficient for the quality of management interacted with fuel subsidy using price gap and subsidy per output measures. Although the coefficients are broadly robust, Egypt – which has the largest number of firms in our sample – has important influence on the overall coefficient. Excluding it from the sample results in a coefficient estimate that is larger in magnitude, but less precise. However, in the case of fuel subsidies per output, the estimated coefficients are statistically significant at the 5 per cent level in panel 4b and at the 1 per cent level in panel 4c, rather than the 10 per cent level, as in the respective columns in Table 4. This could be because the quality of management in Egyptian firms is on average lower than in firms in most of the other countries, and they do not adapt their fuel intensity behaviour to the fuel subsidy availability to the same extent as better managed firms would under the same circumstances.

Figure 4: Estimated coefficient on the quality of management interacted with fuel subsidy and 90 per cent confidence intervals, excluding one country at a time

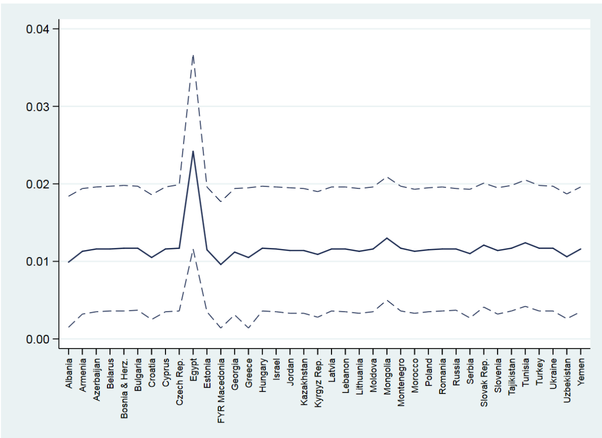
(a) Fuel price gap, Table 3, column (1)



(b) Fuel subsidy/output, Table 4, column (1)



(c) Fuel subsidy/output, Table 4, column (3)



Source: BEEPS V, MENA ES, IMF Energy Subsidies Template and authors' calculations.
Note: Dashed lines represent the 90 per cent confidence interval.

5.2 Selection bias

How do the firms in the final sample differ from the full sample? Tables 8 and B.2 (in Appendix B) address this from two angles, since the number of observations drops because of missing values for the dependent as well as independent variables. Table 8 shows the differences in the means of fuel intensity by the availability of right-hand-side variables which cause the number of observations to drop. The results indicate that: (i) firms with missing exporter status are less fuel-intensive than firms that provide this information; (ii) firms with a missing assessment of electricity as an obstacle are less fuel-intensive than firms that provide this information; and (iii) firms with missing data on the percentage of employees with a completed university degree are less fuel-intensive than firms that provide this information.

However, the difference in the average fuel intensity of firms with non-missing data for all independent variables and firms for which at least one of the control variables has missing values is not statistically significant.

Table 8: Differences in fuel intensity by data availability

Has data on	No Mean	Std. error	Yes Mean	Std. error	p-value
Has data on	**Fuel intensity**				
Management (z-score)	2.769	0.668	3.337	0.247	0.426
Capital, log	3.927	0.642	3.083	0.222	0.214
% with a completed university degree	2.222	0.322	3.360	0.249	0.005
Age	4.302	0.708	3.312	0.239	0.185
25+% foreign ownership	5.582	2.445	3.308	0.239	0.355
25+% state ownership	6.215	2.622	3.308	0.239	0.269
Exporter status	1.254	0.313	3.324	0.240	0.000
Electricity as an obstacle	1.127	0.415	3.319	0.239	0.000
All control variables	3.629	0.535	3.157	0.239	0.420

Source: BEEPS V, MENA ES and authors' calculations.
Note: Means using survey-weighted observations (using Stata's svy prefix). Taylor-linearised standard errors account for survey stratification.

Table B.2 in Appendix B looks at whether any of the independent variables is statistically significantly associated with the likelihood that data on fuel intensity are missing; the dependent variable is an indicator equal to 1 if data are missing and 0 otherwise. Column (1) uses the sample with all control variables; it indicates that firms with more capital and a higher share of employees with a university degree are more likely to have missing data on fuel intensity, while firms with better management, exporters, firms with at least 25 per cent foreign ownership and firms with a higher percentage of self-generated electricity are less likely to have missing data on fuel intensity.

Because availability of some of the control variables is limited, the specification does not include a measure of capital in columns (2) and (3). In columns (4) and (5), sales are no longer included as a control variable, in addition to capital, while management is excluded on top of sales and capital in columns (6) and (7). Samples in columns (3), (5) and (7) use the same sample as specification in column (1). Management coefficient estimate and the coefficient estimates on percentage of employees with a university degree and percentage of self-generated electricity preserve their significance and magnitude throughout.

In the sample used in our analysis, only the percentage of employees with a completed university degree is statistically significantly associated with fuel intensity; the estimated coefficient is negative. Firms with non-missing data on the percentage of employees with a completed university degree have on average statistically significantly higher fuel intensity than those with missing data on this variable (Table 8). This could result in upward bias of the estimated magnitudes of this coefficient in our analysis: the actual coefficient may be lower and not statistically significant. However, this coefficient is rather small compared with the others.

Taken together, Tables 8 and B.2 suggest that selection bias due to missing values for outcome and control variables is unlikely to significantly bias our findings.

6 Conclusion

In this paper, we combine information on firm-level quality of management practices and firm-level energy intensity with the information on energy subsidies for fossil fuels, measured at the country and country-sector level. We focus on fuel intensity, but the results are robust to using electricity intensity instead. We find that pre-tax fuel subsidies, whether measured at the country level or country-sector level, have an impact on the relationship between fuel intensity and management practices quality with the results robust to a large number of additional controls, such as industry, size, ownership and other firm characteristics.

An improvement of management practices quality from the 25^{th} to the 75^{th} percentile of the management practices quality distribution is associated with about 23 per cent fuel intensity reduction when fuel subsidies are low (or negative) and with about 2 per cent fuel intensity reduction when fuel subsidies are high. The relationship is stronger in high energy-intensive sectors and its magnitude is substantial: the same improvement in management practices quality is associated with a 16.7 per cent *increase* in fuel intensity in a country where the fuel price gap is in the top quartile, and a 24.4 per cent *decrease* in fuel intensity in a country where the fuel price gap is in the bottom quartile. In other words, better managed firms are less fuel intensive when fuel prices are not distorted by subsidies, and more fuel intensive when fuel prices are distorted by subsidies.

The relationship is also stronger for firms that do not use self-generated electricity and are thus much more sensitive to fuel prices. The results suggest that these findings are driven by certain types of management practices with the most important one being incentives to employees. Firms where individual performance is the basis for managers' bonuses and non-managers' promotion are more likely to respond to incentives provided by fuel prices. If fuel prices are lower thanks to subsidies, those firms tend to be more fuel intensive.

As expected, post-tax fuel subsidies, which reflect externalities associated with energy generation and consumption, do not influence the relationship between fuel intensity and management practices quality. Firms care about the costs of their operations, but not also about the externalities these operations may generate.

These results suggest that management practices that are associated with improved productivity (see Bloom et al., 2012, for a similar group of countries) may be linked to worse environmental performance in the absence of incentives to economise on energy use. Well-run firms use energy inputs more efficiently and thereby increase their productivity while at the same time reducing GHG emissions only when energy prices are not distorted by subsidies. Governments wishing to reduce GHG emissions should carefully consider the impact energy prices have on firm behaviour.

References

N. Bloom, E. Brynjolfsson, L. Foster, R. Jarmin, I. Saporta-Eksten, and J. Van Reenen (2013), “Management in America”, CES Working Paper CES-WP-13-01, US Census Bureau Center for Economic Studies.

N. Bloom, C. Genakos, R. Martin, and R. Sadun (2010), “Modern management: Good for the environment or just hot air?”, *The Economic Journal*, *120*(544), 551–572.

N. Bloom, H. Schweiger, and J. Van Reenen (2012), “The land that lean manufacturing forgot? Management practices in transition countries”, *Economics of Transition*, *20*(4), 593–635.

G. A. Boyd and E. M. Curtis (2014), “Evidence of an “energy-management gap” in U.S. manufacturing: Spillovers from firm management practices to energy efficiency”, *Journal of Environmental Economics and Management*, *68*(3), 463–479.

B. Clements, D. Coady, S. Fabrizio, S. Gupta, T. Alleyne, and C. Sdralevich (2013), *Energy subsidy reform: Lessons and implications*, Washington, D.C.: International Monetary Fund.

D. Coady, I. Parry, L. Sears, and B. Shang (2017), “How large are global fossil fuel subsidies?”, *World Development*, *91*, 11–27.

EBRD (2011), *The Low Carbon Transition. Special Report on Climate Change*, London: EBRD.

EBRD (2017), *EBRD Transition Report 2017-18: Sustaining Growth*, EBRD.

EBRD, EIB, and WB (2016), *What’s Holding Back the Private Sector in MENA? Lessons from the Enterprise Survey*, Washington, DC: The World Bank, license: Creative Commons Attribution CC BY 3.0 IGO.

R. J. Hijmans, S. E. Cameron, J. L. Parra, P. G. Jones, and A. Jarvis (2005), “Very high resolution interpolated climate surfaces for global land areas”, *International Journal of Climatology*, *25*(15), 1965–1978.

International Energy Agency (2017), *Energy Efficiency 2017*, Paris: IEA.

V. J. Karplus and D. Zhang (2017), “Management and energy efficiency in a Chinese manufacturing cluster”, draft, Submission to the 9th Annual ARCS Research Conference.

E. Lyubich, J. S. Shapiro, and R. Walker (2018), “Regulating mismeasured pollution: Implications of firm heterogeneity for environmental policy”, NBER Working Paper 24228, National Bureau of Economic Research.

R. Martin, L. de Preux, and U. J. Wagner (2014), “The impact of a carbon tax on manufacturing: Evidence from microdata”, *Journal of Public Economics*, *117*, 1–14.

R. Martin, M. Muûls, L. de Preux, and U. J. Wagner (2012), “Anatomy of a paradox: Management practices, organizational structure and energy efficiency”, *Journal of Environmental Economics and Management*, *63*, 208–223.

M. Nachmany, S. Fankhauser, J. Setzer, and A. Averchenkova (2017), *Global Trends in Climate Change Legislation and Litigation: 2017 Update*, Grantham Research Institute on Climate Change and the Environment.

OECD (2013), *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels*, Paris: OECD.

D. Sakr, J. Huenteler, T. Matsuo, and A. Khanna (2017), "Scaling up distributed solar in emerging markets: The case of the Arab Republic of Egypt", The World Bank Policy Research Working Paper 8103.

S. Upadhyaya (2010), "Compilation of energy statistics for economic analysis", Working Paper 01/2010, UNIDO, Vienna.

Appendices

A Classification of manufacturing sectors by energy input ratio

Table A.1: Classification of manufacturing sectors by energy input ratio

Intensity of energy consumption	ISIC	Description of activities
High energy-intensive	17	Textiles
	21	Paper and paper products
	23	Coke and refined petroleum products
	24	Chemical products
	26	Non-metallic mineral products
	27	Basic metals
Moderate energy-intensive	15	Food products and beverages
	18	Wearing apparel; dressing and dyeing
	19	Leather products
	20	Wood and wood products
	22	Printing and publishing
	24	Rubber and plastic products
	28	Fabricated metal products
Low energy-intensive	16	Tobacco products
	29	Machinery and equipment n.e.c.
	30	Office, accounting and computing machinery
	31	Electrical machinery and apparatus n.e.c.
	32	Radio, TV and communication equipment
	33	Medical, precision and optical instruments
	34	Motor vehicles, trailers and semi-trailers
	35	Other transport equipment
	36	Furniture and other manufacturing n.e.c.
	37	Recycling

Source: Upadhyaya (2010).

B Sample selection characteristics

Table B.1: Sample breakdown

	No. of obs.				No. of obs.		
Country	All	With fuel exp. and sales	With fuel exp., sales, and all control variables	Country	All	With fuel exp. and sales	With fuel exp., sales, and all control variables
Albania	42	23	12	Latvia	50	14	9
Armenia	61	33	19	Lebanon	116	97	57
Azerbaijan	68	35	2	Lithuania	52	30	20
Belarus	74	47	33	Moldova	52	33	16
Bosnia and Herz.	59	42	33	Mongolia	58	42	25
Bulgaria	51	41	34	Montenegro	15	5	4
Croatia	52	45	38	Morocco	116	84	27
Cyprus	24	9	5	Poland	98	19	13
Czech Rep.	51	30	25	Romania	101	81	70
Egypt	1,133	922	790	Russia	439	222	135
Estonia	39	29	19	Serbia	43	34	28
FYR Macedonia	50	47	42	Slovak Rep.	51	22	16
Georgia	45	32	21	Slovenia	35	28	21
Greece	42	32	18	Tajikistan	50	27	17
Hungary	43	14	12	Tunisia	230	213	195
Israel	113	88	54	Turkey	656	172	128
Jordan	199	167	107	Ukraine	366	169	73
Kazakhstan	120	49	24	Uzbekistan	88	75	65
Kyrgyz Rep.	63	30	19	Yemen	32	25	21
Total					**4,977**	**3,107**	**2,247**

Source: BEEPS V and MENA ES.
Note: Control variables used are management practices, number of permanent, full-time employees, net book value of equipment, firm age, % of employees with a university degree, % of firms owning/sharing a generator, % of self-generated electricity, exporter status, indicators for listed firms and firms where electricity is major or severe obstacle. Exp. - expenditures.

Table B.2: Sample selection characteristics

Dep. var.: Has data on fuel intensity	(1) Restricted	(2) No K	(3) No K, restricted	(4) No K or S	(5) No K or S, restricted	(6) No K, S or M	(7) No K, S or M, restricted
Management (z-score)	-0.161**	-0.094*	-0.152**	-0.095*	-0.148**		
	(0.072)	(0.053)	(0.074)	(0.049)	(0.074)		
Sales, log	-0.006	-0.047	0.031				
	(0.066)	(0.038)	(0.065)				
Labour, log	0.103	0.119*	0.141	0.067	0.164*	0.048	0.137
	(0.105)	(0.064)	(0.102)	(0.047)	(0.087)	(0.045)	(0.086)
Capital, log	0.085*						
	(0.046)						
Firm age	0.014	-0.035	0.027	-0.033	0.026	-0.028	0.009
	(0.143)	(0.081)	(0.143)	(0.072)	(0.142)	(0.070)	(0.143)
25+% foreign ownership, dummy	-0.482*	0.044	-0.438*	0.043	-0.419*	0.026	-0.455*
	(0.254)	(0.140)	(0.252)	(0.129)	(0.251)	(0.124)	(0.249)
25+% state ownership, dummy	0.150	0.093	0.004	0.160	0.034	0.176	0.153
	(0.493)	(0.309)	(0.463)	(0.278)	(0.463)	(0.277)	(0.476)
Exporting firm, dummy	-0.313*	-0.107	-0.266	-0.147	-0.259	-0.138	-0.268
	(0.172)	(0.109)	(0.178)	(0.098)	(0.177)	(0.095)	(0.178)
% employees with a university degree	0.009**	0.009***	0.009**	0.009***	0.009**	0.007***	0.009**
	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
Credit-constrained firm, dummy	0.334*	0.110	0.339*	0.113	0.329*	0.127	0.341*
	(0.181)	(0.114)	(0.181)	(0.105)	(0.181)	(0.103)	(0.182)
Listed firm, dummy	-0.235	0.006	-0.241	-0.092	-0.242	0.025	-0.190
	(0.366)	(0.224)	(0.362)	(0.207)	(0.364)	(0.194)	(0.349)
% self-generated electricity	-0.013**	0.001	-0.013**	0.002	-0.013**	0.002	-0.012**
	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)
Electricity is a major or severe obstacle	-0.188	0.144	-0.177	0.095	-0.173	0.096	-0.181
	(0.193)	(0.109)	(0.190)	(0.100)	(0.190)	(0.096)	(0.190)
Latitude	0.004	0.031	0.033	0.013	0.030	0.007	0.019
	(0.072)	(0.040)	(0.068)	(0.035)	(0.067)	(0.034)	(0.069)
Longitude	0.030**	0.017*	0.031**	0.008	0.031**	0.008	0.030**
	(0.014)	(0.010)	(0.013)	(0.009)	(0.013)	(0.008)	(0.014)
Average January temperatures in the firm's vicinity	0.057	0.066*	0.062	0.020	0.062	0.025	0.064
	(0.059)	(0.036)	(0.057)	(0.033)	(0.057)	(0.032)	(0.058)

Table B.2 – continued from previous page

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var.: Has data on fuel intensity	Restricted	No K	No K, restricted	No K or S	No K or S, restricted	No K, S or M	No K, S or M, restricted
Average July temperatures	0.067	-0.005	0.070	0.018	0.069	0.010	0.073
in the firm's vicinity	(0.071)	(0.032)	(0.069)	(0.031)	(0.069)	(0.030)	(0.069)
Average intensity of nighttime	-0.005	0.002	-0.005	-0.001	-0.005	-0.001	-0.004
lights in the firm's vicinity	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
F-test	4.31	4.93	4.46	6.69	4.56	6.81	4.35
Observations	2,315	3,632	2,315	4,247	2,315	4,495	2,315

Source: BEEPS V, MENA ES and authors' calculations.

Note: *, ** and *** denote significance at the 10, 5, and 1 per cent level, respectively. Taylor-linearised standard errors that account for survey stratification are reported in parentheses. Average marginal effects based on probit using survey-weighted observations (using Stata's svy prefix). K - capital, S - sales, M - management (z-score).

C Construction of the management practice variable

We distinguish four management areas:

1. Operations
   Practice 1 (question R.1): Over the last complete fiscal year, what best describes what happened at this establishment when a problem in the production process arose?
   Answers (score in parentheses): "No action was taken" or "Don't know' (1), "We fixed it but did not take further action" (2), "We fixed it and took action to make sure it did not happen again" (3), "We fixed it and took action to make sure that it did not happen again, and had a continuous improvement process to anticipate problems like these in advance" or "Does not apply" (4).

2. Monitoring
   Practice 2 (question R.2): Over the last complete fiscal year, how many production performance indicators were monitored at this establishment?
   Answers (score in parentheses): "No production performance indicators" or "Don't know" (1), "1-2 production performance indicators" (2), "3-9 production performance indicators" (3), "10 or more production performance indicators" (4).

3. Targets
   Practice 3 (question R.6): Over the last complete fiscal year, what best describes the time frame of production targets at this establishment? Examples of production targets are: production, quality, efficiency, waste, on-time delivery.
   Answers (score in parentheses): "No production targets" or "Don't know" (1), "Main focus was on short-term (less than one year) production targets" (2), "Combination of short-term and long-term production targets" (3), and "Main focus was on long-term (more than one year) production targets" (4).

   Practice 4 (question R.7): Over the last complete fiscal year, how easy or difficult was it for this establishment to achieve its production targets?
   Answers (score in parentheses): "Possible to achieve without much effort" or "Only possible to achieve with extraordinary effort" or "Don't know" or "Does not apply" (1), "Possible to achieve with some effort" (2), "Possible to achieve with normal amount of effort" (3), "Possible to achieve with more than normal effort" (4).

   Practice 5 (question R.8): Over the last complete fiscal year, who was aware of the production targets at this establishment?
   Answers (score in parentheses): "Only senior managers" or "Don't know" or "Does not apply" (1), "Most managers and some production workers" (2), "Most managers and most production workers" (3), "All managers and most production workers" (4).

4. Incentives
   Practice 6 (question R.11): Over the last complete fiscal year, what were managers' performance bonuses usually based on?
   Answers (score in parentheses): "No performance bonuses" or "Don't know" (1), "Their company's performance as measured by production targets" (2), "Their establishment's

performance as measured by production targets" (3), "Their team or shift performance as measured by production targets" (4), "Their own performance as measured by production targets" (5).

Practice 7 (question R.13): Over the last complete fiscal year, what was the primary way non-managers were promoted at this establishment?
Answers (score in parentheses): "Non-managers are normally not promoted" or "Don't know" or "Does not apply" (1), "Promotions were based mainly on factors other than performance and ability (for example, tenure or family connections)" (2), "Promotions were based partly on performance and ability, and partly on other factors (for example, tenure or family connections)" (3), "Promotions were based solely on performance and ability" (4).

Practice 8 (question R.15): Over the last complete fiscal year, when was an under-performing non-manager reassigned or dismissed?
Answers (score in parentheses): "Rarely or never" or "Don't know" or "Does not apply" (1), "After 6 months of identifying non-manager under-performance" (2), "Within 6 months of identifying non-manager under-performance" (3).