5 Foreign direct investment and energy prices

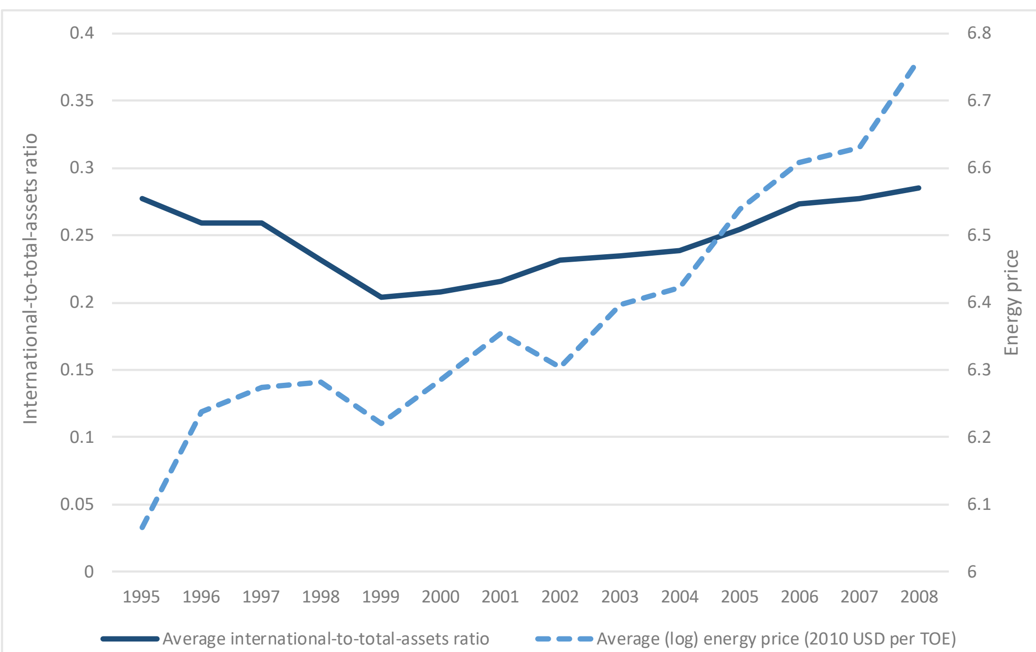
Outward foreign direct investment (FDI) is the focus of this chapter.[1] Globally, foreign direct investment increased substantially over the past four decades, particularly in the manufacturing sector. This sector heavily depends on energy as a production input and could experience a loss in competitiveness when energy prices rise because of more stringent environmental regulation. This chapter investigates whether firms have redirected investment towards foreign countries with lower energy prices and laxer environmental policies, thereby shifting polluting emissions – a potential consequence of asymmetric environmental policies, known as the pollution haven effect. Empirical studies on this topic have so far mostly focused on outward FDI from a single country. This study sheds light on the relation between industrial energy prices and FDI flows in a cross-country setting. The effect of higher energy prices on firm-level outward FDI is estimated for a sample of 3 364 listed firms operating in nine manufacturing sectors across 24 OECD countries over the time period 1995-2008, using an instrumental variable method. The results show that higher domestic energy prices relative to energy prices abroad are indeed positively associated with the share of foreign assets firms hold. This effect is, however, small in magnitude. Moreover, while firms increase their share of foreign assets following an increase in domestic energy prices, a decrease in domestic energy prices is not followed by an increase in the share of domestic assets.

Background

Increases in FDI might be motivated by rising energy prices

Foreign direct investment (FDI) has gained more importance with the increasing global dimension of production processes over the past four decades as reported by, for example, UNCTAD. Investing in foreign assets might be beneficial to the investing firm in terms of improving the efficiency of its production lines and gaining access to the local market, while the host country might benefit from technology and know-how transfers as well as from economic development (De Mello, 1997[108]; Saggi, 2002[109]; see also OECD, 2002[110] for a survey). However, improving production patterns and accessing local demand might not be the only reasons for firms to invest abroad – they might want to circumvent tighter domestic environmental policies by shifting their production to countries with laxer regulations. Figure 5.1 shows the share of foreign assets over total assets for the sample of firms underlying this study over the period 1995-2008, along with the evolution of energy prices in the domestic market of these firms. As can be seen from Figure 5.1, both FDI and energy prices both rose from the early 2000s, suggesting that part of the rise in FDI could have been associated with off-shoring in the face of higher energy prices.

Figure 5.1. International assets as a share of total assets and average domestic energy prices, 1995-2008



Note: Averages based on annual firm-level data. Energy prices are in real terms and shown in log.
Source: Garsous, Koźluk and Dlugosch (2020[1]).

Carbon leakage effect through FDI

The so-called pollution haven effect predicts that firms will respond to tighter domestic environmental policies by shifting production activity towards countries with less stringent environmental policies. Since countries with laxer environmental policies are predicted to gain a competitive advantage in heavily polluting industries (Pethig, 1976[2]; Siebert, 1977[3]; Yohe, 1979[4]), tighter environmental policies should provide incentives for firms to relocate parts of their production processes to countries with laxer regulations (Siebert, 1977[3]; McGuire, 1982[5]; Merrifield, 1988[6]). Assuming that capital is sufficiently mobile across countries, and transportation costs are not too high, this relocation effect is of particular concern for pollution-intensive industries when implementing new environmental regulations. It can lead to carbon leakage, whereby emissions are not reduced by new environmental regulations but simply shifted to other locations, which is a particular concern for global pollutants such as CO_2.

The empirical literature comprises mainly single country studies

The empirical evidence around the pollution haven effect has focused mostly on single country studies until now (see Garsous, Koźluk and Dlugosch (2020[1]) for a detailed review of the literature and Rezza, (2015[7]), for a meta-analysis). This focus is often data-driven, as is probably the geographical focus on the United States. Moreover, the literature is inconclusive so far, with results varying from significant effects (Hanna, 2010[8]; Chung, 2014[9]), to no effects (Eskeland and Harrison, 2003[10]; Kirkpatrick and Shimamoto, 2008[11]; Manderson and Kneller, 2012[12]). Other studies find that the effects vary with, for example, the ability to relocate (Kellenberg, 2009[13]; Cole and Elliott, 2005[14]), the host country's characteristics (Ben Kheder and Zugravu, 2012[15]) or the firm's home country characteristics (Dean, Lovely and Wang, 2009[16]). However, the proxies for environmental regulation vary across studies, as does the definition of the FDI variable, which could potentially account for the different effects found in the studies.

The first cross-country study, accounting for endogenous firm choice of fuel inputs

This study offers three main contributions to the literature. First, it provides the first cross-country analysis on the relationship between energy prices and FDI at the firm level. Second, the use of energy prices as a proxy for environmental policies, allowing for a better understanding of various environmental policies compared to previous studies, which focuses on pollution abatement costs. Most climate and air pollution policies ultimately affect energy prices – be it directly through additional taxes, or cap-and-trade systems, or indirectly through command-and-control mechanisms – making it a valuable proxy. Third, this study addresses endogeneity concerns about firms' choices of fuel substitution by using an instrumental variable approach to remove the effects of firms' substitution choices from the effect of observed energy prices.

Empirical set-up

Absolute versus relative energy price changes

The pollution haven effect predicts that it is the *difference* between the investors' and the receiving country's energy prices which drive FDI patterns, rather than changes in the domestic energy prices per se. Therefore, this study uses changes in *relative prices* as the main explanatory variable. The relative price changes are proxied by taking the difference in domestic energy prices and energy prices in China in the same sector.[2] China is the country that had the lowest energy prices over estimation period and was an increasingly important destination country for FDI. In addition, the study also tests whether changes in domestic energy prices directly trigger investments abroad.

An instrumental variable approach is used to avoid endogeneity problems in the estimation

There might be industry-level factors which influence both FDI patterns and trends in energy prices, leading to potential endogeneity problems in the estimation of the effects. Technological changes or industry-level shocks to output demand might affect the distribution of industry fuel demand, and consequently energy prices (Linn, 2008[17]). At the same time, these factors might influence FDI decisions of firms, for example, a new clean technology becoming available might make firms rely on a particular fuel more, while at the same time delaying investment in international assets. To avoid such an endogeneity bias, this study follows Linn (2008[17]) and Sato and Dechezleprêtre (2015[18]) by using as an instrumental variable sector-specific energy prices which are weighted according to time-invariant proportions of fuel used at the sector-level. Using these constant weights removes effects of technological change or other industry-specific shocks from the observed energy prices.

Empirical model

This analysis focuses on long-term impacts of changes in energy prices on outward FDI flows by estimating long-differences equations: the first and last observation for each firm are used to estimate the equation below. This implies that short-run effects of variations in energy prices will not be captured in the analysis. The following equation is estimated using a two-stage least squares within estimator:

$$\log(FDI)_{ijct} = \alpha + \beta\log(EP)_{jct} + \gamma X_{ijct} + \mu_i + \lambda_{ct} + \varepsilon_{ijct}$$

where FDI_{ijct} are the international assets of firm i in sector j in country c at time t. The FDI variable is defined as for-profit assets held by a firm which can be priced. EP_{jct} is, depending on the estimation, either the domestic energy price for sector j, constructed by weighting country-level fuel prices (oil, gas, coal and electricity) by their relative consumption in each country-sector-year, instrumented by fixed-weights energy prices as described above, or the relative energy price difference of country c with regard to Chinese energy prices, instrumented by the difference in fixed-weight prices. X_{ijct} is a set of firm-level control variables including firm size measured as number of employees, total assets and international sales as a measure of international openness. μ_i is a firm fixed-effect, λ_{ct} is a country-year dummy which controls country-specific effects such as institutional settings at the country level, and ε_{ijct} is the idiosyncratic error term.

Data

The dataset is an unbalanced panel from 1995 to 2008 which covers 3 364 firms, operating in 24 OECD economies and 9 different manufacturing sectors. The firm-level data are taken from the Thomson Reuters Worldscope database, which provides balance sheet information about listed firms. Only firms, which are already engaged in FDI are part of the analysis. The data on energy prices are taken from Sato et al. (2019[19]) , who provide a fixed-weight index of energy prices (based on weights from the baseline year 1995).

Results

Relative energy prices are a driver of FDI as opposed to absolute prices

The main results show that relative prices matter for FDI flows, while there is no statistically significant effect detected for absolute prices alone. Table 5.1. shows the main results of the estimation where the coefficient of the domestic energy price variable is insignificant, while the coefficient of the difference between domestic and Chinese energy prices is significantly positive. An increase of the relative energy price of 1% is estimated to be associated with a 0.5% increase in firms' international assets. The coefficients of the control variables are also significant and of expected sign, supporting the suitability of the estimated model.

Table 5.1. FDI effects - main estimation results

Dependent variable: International assets (log)	Absolute energy prices (1)	Relative energy prices (2)	Absolute energy prices (3)	Relative energy prices (4)
Domestic energy price (log)	0.625			
	(0.481)			
Relative energy price (= log domestic energy price – log Chinese energy price)		0.510**		
		(0.259)		
Energy price (log) * Dummy for increasing energy prices			0.613	
			(0.483)	
Energy price (log) * Dummy for decreasing energy prices			0.659	
			(0.500)	
Relative energy price (log) * Dummy for increasing domestic energy prices				0.711**
				(0.326)
Relative energy price (log) * Dummy for decreasing domestic energy prices				0.412
				(0.302)
Country-year fixed effects	YES	YES	YES	YES
Number of observations	6,728	6,728	6,728	6,728
Number of firms	3,364	3,364	3,364	3,364
R-squared	0.312	0.315	0.312	0.314

Notes: Column 1 uses the FEPL index from Sato et al. (2019[19]) as an instrument for observed energy prices. Column 2 uses relative prices as measured by the difference between domestic and Chinese prices. The differences between the domestic and Chinese FEPL index from Sato et al. (2019[19]) is used as an instrument for observed relative prices. Column 3 and 4 use interaction terms, indicating whether the firm faced an energy price increase or decrease over the observation period. All estimations include the size of firm, total assets and international sales as additional control variables. The coefficient estimates are not shown here for reasons of brevity. Robust standard errors clustered at the country-sector level in parentheses: ***, ** and * represent p<0.01, p<0.05, p<0.1 respectively.

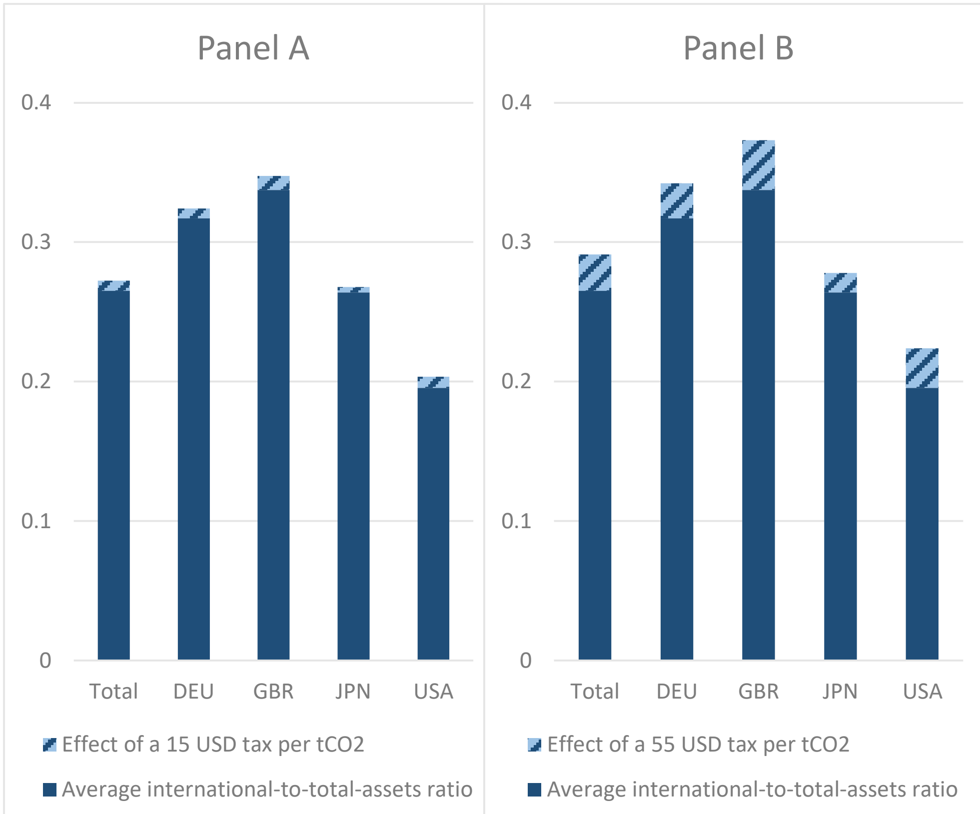
Firms respond differently depending on whether they face an increase or decrease in energy prices

Firms might react to different energy price scenarios in different ways. While an increase in absolute or relative energy prices might incentivise firms to invest more in assets abroad, a decrease in energy prices might not immediately lead firms to withdraw their investments abroad. To study this hypothesis, the energy price variable is interacted with a dummy variable indicating whether the firm faced an increase or a decrease in energy prices over the observation period. The results in Table 5.1. (column 3 and 4) show that relative price changes are significantly positively associated with FDI only in the case of energy price increases, but not statistically significantly so for decreases. A 1% increase in relative energy prices is associated with a 0.7% increase in international assets by firms.

The economic magnitude of the effect is small

Only a very high carbon tax would be able to influence FDI patterns in an economically significant way. Using a back-of-the-envelope calculation, this study evaluates the effect of the implementation of a high carbon price in developed countries. It assumes that energy prices only rise in countries implementing the carbon tax. A low and a high carbon tax scenario is evaluated. The low carbon tax scenario, based on a carbon tax of USD 15/tonne CO_2, would increase energy prices by 5% on average, which would translate into an increase of 0.74 percentage points in the ratio of foreign assets to total assets. The higher carbon tax scenario relies on a carbon tax of USD 55/tonne CO_2 and would be expected to raise energy prices by 20% on average for the sample, translating into an increase of 2.6 percentage points in the FDI ratio. As Figure 5.2 shows, these estimated changes in the FDI ratio are rather small compared to the baseline level of the FDI ratio. The calculations have to be taken with a grain of salt, however, as they are based on average effect estimates and rely on a range of other assumptions.

Figure 5.2. Simulated effect of unilateral carbon tax on outward FDI



Note: These figures report the simulated effect of the introduction of a carbon tax on the international-to-total-asset ratio for the whole sample as well as for selected countries. Panel A shows a low carbon tax scenario (USD 15/tonne of CO_2), Panel B shows a higher carbon tax scenario (USD 55/tonne of CO_2).

Conclusion

Support for the pollution haven effect found – but magnitude is small

The results of this study show that relative energy prices (i.e. the difference between domestic energy prices and foreign energy prices) matter as a driver of FDI, but the magnitude of the effect is small. The effect is only found for firms facing an energy price increase at home, while a reduction in domestic energy prices is not correlated with a lower amount of international assets. For those firms which did see energy prices rise in their home country, a 1% increase in relative energy prices was associated with an increase of 0.71% in the firms' international assets. With an average share of international over total assets of 27% in the sample, this average effect on international assets is small.

The sample is limited to listed firms, and only the intensive margin is studied

These results are based on a specific sample of firms, namely firms which are listed on the stock market. While these firms are often larger, thus more engaged in international trade, and contribute a large part in explaining overall changes in the economy, this study is not able to make inferences about smaller companies. However, given that those firms already possess assets across various jurisdictions, they should be in theory the most inclined to undertake foreign investment and international relocation. Therefore, it is reasonable to assume that the effects should be smaller for smaller, less internationally exposed companies not covered in this study. It is also not possible to infer from this analysis whether firms, which did not already engage in FDI at all, will invest abroad because of higher energy prices since this study only covers firms which already engage in FDI.

Carbon leakage concerns are likely to be overstated

The simulation undertaken in the context of this analysis reveals that only a high carbon price would have an economically meaningful effect on the share of international assets held by firms. While the analysis relies on a carbon price of USD 55 /tonne of CO_2, the OECD has used a carbon price of USD 34/tonne of CO_2 as lower bound estimate of the social costs of carbon (OECD, 2015[20]; OECD, 2015[21]). If governments would agree to implement a carbon tax equal to the social costs of carbon or even above, this would, based on the results of this study, only have limited effects in terms of carbon leakage through foreign direct investment.

Notes

[1] This chapter is a summary of the paper "Do energy prices drive outward FDI? Evidence from a sample of listed firms" (2020[1]) by G. Garsous, T. Koźluk and D. Dlugosch, *The Energy Journal,* Vol. 41/3. An earlier version of this paper was published as the OECD Working Paper "Foreign Direct Investment and The Pollution Haven Hypothesis: Evidence from Listed Firms" by G. Garsous and T. Koźluk (2017[22]), OECD Economics Department Working Paper, No. 1379.

[2] The energy price data is deflated and converted to constant 2010 USD for tonnes of oil equivalent (toe).

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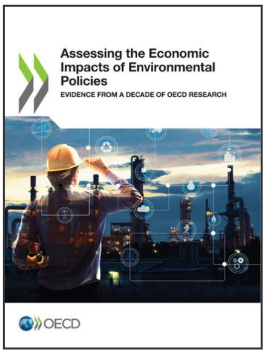

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