KOMMERSKOLLEGIUM
NATIONAL BOARD OF TRADE SWEDEN

The Impact of Foreign Acquisitions on Swedish Firms' Carbon Emissions and Energy Use

2025

Preface

Industrial decarbonisation and the transition towards more energy-efficient production are two enormous tasks for Sweden and the world. Attracting the required investments is a massive challenge, and looking abroad for funding and technologies can be a viable solution. Facilitating the green transition by attracting foreign capital and technologies also has an economic security dimension. Higher energy efficiency and lower carbon emissions will make Sweden's economy more resilient to the challenges of the twenty-first century.

In this report, we aim to deepen our understanding of the impact of foreign acquisitions of Swedish firms on their production intensities. More specifically, we compare carbon dioxide emissions and energy use before and after the acquisition of a Swedish firm. This enables us to identify potential synergies between the Swedish government's policy objectives – maintaining Sweden as an attractive destination for foreign direct investment while achieving ambitious climate targets. The purpose of this report is to provide a more comprehensive assessment of the costs and benefits of foreign acquisitions in Sweden.

This report has been written by Ebba Lundqvist and Erik Merkus, with support from Patrik Tingvall. We also acknowledge valuable comments and suggestions from Sophie Berner-Eyde and Neil Swanson at the National Board of Trade Sweden, and Shon Ferguson at the Swedish University of Agricultural Sciences (SLU) in Uppsala.

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Anders Ahnlid
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Summary

Foreign direct investment (FDI) is often associated with a number of economic benefits to the host country. Such benefits include stimulated economic growth, improved productivity, and enhanced research and development (R&D) and innovation. However, the relationship between foreign acquisitions and environmental indicators, such as a firm's carbon emissions and energy usage, is complex and less explored. A common concern is that the increase in economic activity will increase carbon emissions and energy use, thereby affecting the environment negatively. However, if a foreign acquisition results in a systemic shift towards more sustainable industries or the introduction of clean(er) technologies, environmental harm can be mitigated.

The purpose of this report is to analyse whether firm-level production intensities are different after foreign acquisitions of Swedish firms. In this report, production intensities are based on reported carbon dioxide emissions or energy use per unit of value added for each firm. Specifically, we use Swedish firm-level data from 2008 to 2022 to answer the following two questions:

- Are firms being selectively acquired by foreign firms on the basis of their production intensities?
- Are production intensities lower in Swedish firms after a foreign acquisition?

A key concept throughout the empirical analysis and discussions in this report is the 'greenness' of a firm. 'Green' firms are defined as firms that have production intensities below the industry-level median production intensity. Each firm included in the analysis is classified either as 'green' or as 'non-green', and this classification is used in the statistical analyses.

The results of our report suggest:

- **No selection of 'green' firms.** The first part of the analysis reveals that the greenness of a Swedish firm does not systematically matter for the probability of a foreign acquisition. This result is robust for several alternative specifications.
- **Firms become 'greener' after a foreign acquisition.** The results suggest that Swedish firms have lower production intensities after being acquired by foreign firms. The effect is especially pronounced in carbon- and energy-intensive firms, for firms in the manufacturing sector, and for small- and medium-sized firms (SMEs).

The findings in this report highlight some important aspects of the relationship between foreign acquisitions and production intensities, which could have the following implications for several policy processes:

1. An important target in Sweden's Strategy for Foreign Trade and Investments is to remain an attractive and competitive destination for foreign investment. The results of this report show that the potential benefits from investments reach beyond the economic realm into environmental outcomes, which also could have implications for the design of FDI screening mechanisms and thus economic security. Another result of this report is that foreign entities do not selectively target Swedish frontrunners based on their production intensities, but that Swedish firms in general remain attractive investment objects. Therefore, it is important to maintain the current approach as laid out in Sweden's Strategy for Foreign Trade and Investment.
2. Sweden's goal to become a net-zero economy by 2045 requires massive investments in low-carbon and energy-efficient technologies. Foreign investments could play a major role in this transition, which is essential to maintaining the competitiveness of Swedish industry. The results of this report indicate that foreign acquisitions do indeed lead to lower production intensities for the average firm. The massive capital costs to meet EU emission targets (e.g., through the reduction of EU ETS permits over the next 15 years) could be partially facilitated by foreign investments.
3. The current approach to attract investments to Sweden facilitates its ability to achieve the ambitious targets of Agenda 2030. This report shows that production intensities are lower after a foreign acquisition, which contributes to meeting the energy efficiency goals outlined in the Implementation Strategy of Agenda 2030. An open and transparent investment climate could support and accelerate the green transition by providing foreign capital for the necessary investments.

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1. Introduction

FDI is often associated with the economic benefits it can bring to the host economy. FDI stimulates economic growth (Otieno & Aduda, 2022; Alfaro et al., 2010), improves productivity (Haskel et al., 2007; National Board of Trade; 2023, Görg & Lehr, 2024), increases wages (Swedish Agency for Growth Policy Analysis, 2017), and facilitates R&D and innovation (Aitken & Harrison, 1991; Bandick et al., 2014). Another potential benefit of FDI could take the form of technology transfers (Girma et al., 2015). This happens when the foreign firm uses technologies and knowledge to improve existing production processes in the acquired firm, including low-carbon technologies and improvements to energy efficiency.[1]

However, the relationship between FDI and environmental outcomes is not straightforward. One way to look at this relationship is by borrowing a framework often used in the international trade and environment literature. This framework, introduced by Grossman and Krueger (1993), entails three different elements: scale, composition, and technique. Firstly, the scale effect refers to how trade or investments increase economic activity by expanding production, which, all else being equal, increases the usage of material inputs, energy consumption, and emissions. The composition effect reflects shifts in economic structures, where trade or investments reallocate resources and labour to acquired firms, which can either raise or lower overall emissions. Finally, the technique effect highlights how trade or investments can introduce new and cleaner technologies (the aforementioned technology transfer), mitigating environmental harm in the host economy. Ultimately, the overall environmental impact of increased trade or investments depends on the interplay between these three effects.

As one of the world's largest recipients of FDI, the link between investments and environmental outcomes is especially relevant for Sweden.[2] At the same time, Sweden should remain a prioritized partner for the green and digital transitions, as per its Strategy for Foreign Trade.[3] Sweden also aims to reach net-zero greenhouse gas emissions by 2045, and strives for a reduction in energy intensity per unit of GDP of 50 per cent by 2030 (compared to 2005 levels).[4] At the European level, climate policies will eventually impact industrial production processes through the reduction of carbon permits under the EU ETS, while the energy transition is facilitated by, among other things, a recent update of the Energy Efficiency Directive. To reach these ambitious targets, substantial efforts are needed. FDI can be a strategic opportunity to facilitate these transitions by enabling the transfer of clean technologies and sustainable practices from foreign firms, or by bringing in additional financial capacity for the necessary capital investments. This is also mentioned in the Draghi report on EU competitiveness, which focuses both on a joint decarbonisation and competitiveness plan, and addresses issues around low investments in the EU.[5]

1. Note that for the purpose of this report, technology transfer is different from technology spillover. The latter generally affects firms close to the FDI firm, including its suppliers and partners (see, e.g., Girma et al., 2015). The absorption capacity (Bu et al., 2019) for new technologies in Sweden is not considered to be a problem.
2. Fourth in Europe and 13th in the world (Business Sweden, 2024).
3. In Swedish: Strategi för Sveriges utrikeshandel, investeringar och globala konkurrenskraft.
4. More on the Swedish Climate Act on the Swedish EPA's website and more on the energy intensity goal in the Agenda 2030 implementation strategy of the government.
5. The Future of European Competitiveness: the Draghi Report (2024).

1.1 Purpose of the report

The purpose of this report is to empirically investigate whether foreign acquisitions lead to changes in production intensities (based on reported carbon dioxide emissions and energy use) of Swedish firms.[6] To account for the fact that larger firms use more energy and emit more carbon dioxide, we focus on intensities rather than absolute values.[7] This allows us to assess the effect in relation to the firm's production. Using Swedish firm-level data from 2008 to 2022, we aim to analyse the following questions:

- Are firms being selectively acquired by foreign firms on the basis of their production intensities?
- Are production intensities lower in Swedish firms after a foreign acquisition?

To the best of our knowledge, this report is the first to analyse the dynamics of foreign acquisitions and emissions and energy in Swedish firms. Most studies on the interplay between foreign investments and production intensities focus on regional or country-level data and use FDI flows or stocks (Elliot et al., 2013; Sarkodie & Strezov, 2019; Hubler & Keller 2010; Yi et al. 2023). Even firm-level analyses often suffer from data limitations and can only distinguish between domestic- and foreign-owned firms at a single point in time (Albornoz et al., 2009; Bu et al., 2019). Existing evidence that uses data and methods similar to those used in our report comes mostly from low- and middle-income countries. Cole et al. (2008) find that Ghanian firms use more environmentally friendly energy sources after foreign acquisition. For Indonesian firms, Brucal et al. (2019) find that foreign acquisition leads to a 26 per cent reduction in energy intensity, though more so for firms with higher initial intensities. For a more thorough discussion of this literature, see Cole et al. (2017).

This report primarily serves to deepen the understanding of the relationship between foreign acquisition and the environment in a high-income country and to create awareness and further interest in the topic.

1.2 Structure of the report

The remainder of the report is structured as follows. In the next chapter, we present the data sources, describe the main variables of interest, and present some descriptive statistics. Chapter three describes our methodological approaches, and the fourth chapter presents our results on the two research questions. Finally, chapter five concludes.

6. Note that domestic acquisitions (e.g. Swedish firms acquiring another Swedish firm) may have a similar impact on production intensities. However, data on Swedish acquisitions is not available at this moment. From a statistical standpoint, if domestic acquisitions have the same impact on production intensities, it only makes it harder to identify the effect solely on foreign acquisitions. Therefore, the lack of information on domestic acquisitions should not be considered problematic.
7. Carbon emissions and energy use per unit of value added by the firm. Value-added, as the name suggests, represents how much a firm adds to the total price/valuation of a product or service.

2. Data and descriptive statistics

2.1 Data sources

The data used in this report is a comprehensive firm-level database provided by Statistics Sweden (SCB). The database contains a series of firm-level datasets that are linked through unique serial numbers, which allows for the combination of data on firm characteristics, foreign ownership information, carbon emissions, energy usage, and international trade.

Information on firm characteristics is sourced from the Structural Business Statistics (FEK) dataset. This dataset contains data on, for example, firm-level production, value added, number of employees, investments, and capital stock. All active firms that operate within Sweden are included.[8] In a similar fashion, information on firm-level imports and exports (at the product level) are also available through the Statistics Sweden portal.

The main variable of interest in this report is based on information on foreign ownership of firms active in Sweden. Data on foreign ownership is obtained from the Swedish Agency for Growth Policy Analysis and contains information on the nationality of the majority owner of firms.

This report looks at two outcome variables that capture production intensities: carbon intensity and energy intensity (see Section 2.2 for more information). Carbon dioxide emissions for each firm are derived from data in the Emissions to Air dataset of the environmental account statistics (*Utsläpp till luft* in Swedish). This dataset contains information on firms' carbon dioxide (CO_2), nitrogen oxides (NO_x) and sulphur dioxide (SO_2) emissions each year. This data is created by combining information from several primary and secondary sources, both from Statistics Sweden's own data and from the Swedish Environmental Protection Agency (*Naturvårdsverket*).

Information on firms' energy use comes from the Energy Use in Industry dataset (ISEN). This data, which covers the years 2004–2022, is collected by the Swedish Energy Agency and is a survey that obliges selected firms to respond.

2.2 Variables

Our two measures of production intensities are "carbon intensity", which is based on carbon dioxide emissions per unit of value added, and "energy intensity", defined as non-transportation energy used in production per unit of value added. Please refer to the appendix for a discussion on the control and matching variables used in the analysis.

- **Foreign acquisition:** A firm is classified as foreign owned if more than 50 per cent of the voting rights belongs to one or several foreign owners. We then infer from foreign ownership data when the foreign acquisition took place, which is assumed to the be first year in which the firm is listed as foreign owned.

8. A firm is considered active if it has paid taxes for employed staff, paid VAT or F-tax.

- **Production intensities:**
  - **Carbon intensity:** Carbon intensity is derived from carbon dioxide emissions for firms each year, which is divided by the firm's value added. The outcome variable in the descriptive statistics of Section 2.3 and the statistical analysis in Chapter 4 is a kilogram carbon dioxide emission per SEK 10 value added (this is comparable to the often-used carbon intensity of kilogram CO2 per USD in many other reports).
  - **Energy intensity:** Similar to carbon intensity, energy intensity is calculated using the non-transportation energy use of each firm, divided by the firm's value added. The descriptive statistics in Section 2.3 and the statistical analysis in Chapter 4 are expressed in MWh energy per million SEK value added.
- **Firm *greenness*:** The main variable of interest in this report, and an important firm-level characteristic in the statistical analysis, is based on the *greenness* of the firm. The label *green or non-green* is determined by the average firm-level production intensity, which is either based on its carbon intensity or energy intensity. For firms acquired by a foreign entity, this average production intensity is calculated using the years prior to the foreign acquisition. For firms that are permanently Swedish, it is based on the average across all available years. Firm-level production intensity averages are then compared to the median sectoral production intensity at the NACE 2-digit level. Firms with production intensity averages above the sectoral median production intensity are classified as *non-green*, while firms with production intensity averages below the sectoral median production intensity are classified as *green*. This designation is time-invariant (i.e., assigned to all years in which the firm is active) to avoid any endogeneity in the statistical analysis.

2.3 Descriptive statistics

As described above in Section 2.2, data on firms' emissions and energy use is based on a sample of Swedish firms. We refer to these subsets of firms as *analysis samples*, and they are comprised of firms that have at least one year of reporting in either the carbon emissions database or the energy usage database.

2.3.1 Number of firms in analysis samples

Table 1. Number of firms included in the analysis samples, 2008 to 2022. displays the number of firms in each analysis sample, by ownership. Firms designated as *permanently Swedish* have a Swedish majority owner for all the years the firm is present in the data-set, whereas firms that were acquired by a foreign entity at some point in time are classified as *foreign acquired*.[9] Around 7 per cent of the firms in either analysis sample were acquired by a foreign entity at some point between 2008 and 2022. In the *emissions sample*, 468 Swedish firms become foreign-owned, while 783 Swedish firms become foreign-owned in the *energy sample*.

9. In all analyses in this report, a firm that has been acquired by a foreign entity remains in the "foreign acquired" group of firms for all years after the acquisition.

Table 1. Number of firms included in the analysis samples, 2008 to 2022.

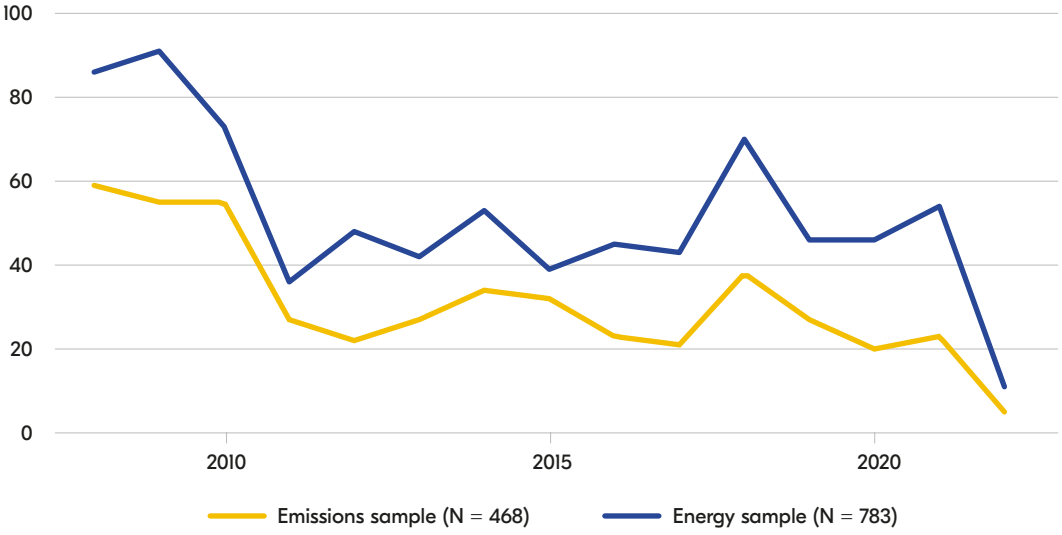
	Permanently Swedish	Foreign acquired	Total
Emissions sample	6 734	468	7 202
Energy sample	9 598	783	10 381
Combined sample*	11 442	843	12 285
Overlapping sample*	4 890	408	5 298

Note: The emissions and energy samples contain all firms that report both firm-level emissions and energy use.

* The two final rows contain the combined, or pooled, sample that report firm-level emissions OR energy usage for at least one year, and the overlapping sample of firms that report firm-level emissions AND energy usage for at least one year. These two samples are not used in any analysis, but merely show the scope of the data.

Between 2008 and 2022, the number of foreign acquisitions fluctuates over time, with on average around 50 foreign acquisitions per year in the energy sample and around 30 acquisitions per year in the emissions sample (Figure 1. Annual number of acquisitions, by analysis sample.). There seem to be more foreign acquisitions of Swedish firms in the immediate aftermath of the 2007-2008 global financial crisis, with a more stable number of yearly acquisitions in the post-2010 period. Since the Covid pandemic, the number of foreign acquisitions seems to have dropped significantly.[10]

Figure 1. Annual number of acquisitions, by analysis sample.



Note: Authors' calculations based on SCB data.

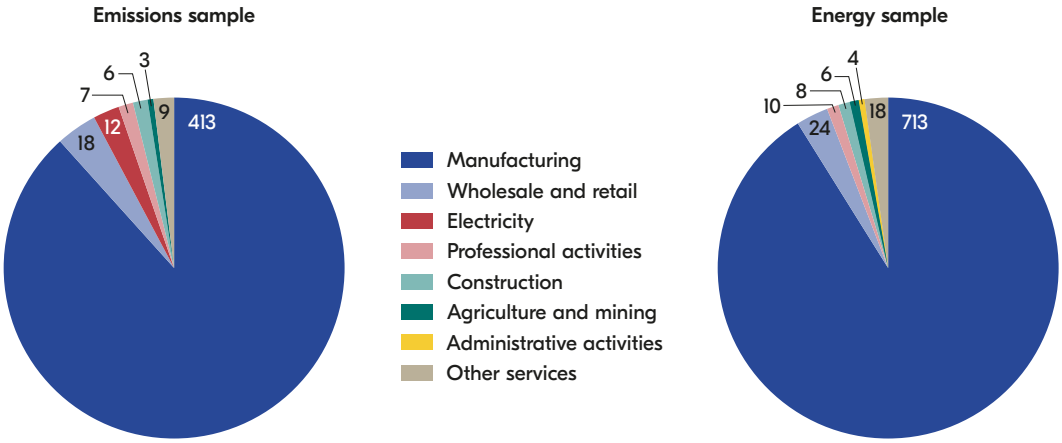
2.3.2 Foreign acquisition by sector

Most foreign acquisitions of firms in the analysis samples are within the manufacturing sector, which accounts for around 80 per cent of the total number of acquisitions (see Figure 2. Sectoral division of foreign acquisitions). Around 8 per cent of the foreign acquisitions are within the wholesale and retail sector. The remainder are mostly in the services sectors, with only 3 (4) foreign acquisitions in the agricultural and mining sectors in the emissions (energy) sample. The surveys on firm-level carbon emissions and energy use are predominantly targeted on the largest emitters and users of energy,

10. Looking at the whole population of Swedish firms, between 2008 and 2022, there was an annual average of around 1500 foreign acquisitions of Swedish firms, suggesting that our sample contains between 2 and 3.5 per cent of all acquisitions.

which naturally skews the surveys toward the manufacturing industry. Hence, these numbers only represent the analysis samples and not the economy as a whole.

Figure 2. Sectoral division of foreign acquisitions

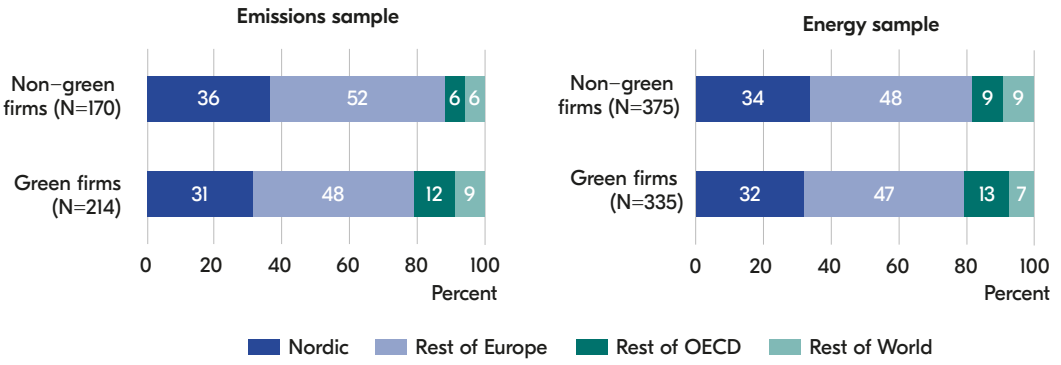


Note: Authors' calculations based on SCB data. Each acquisition is classified to one NACE code, which is then aggregated further to the groups in the legend.

2.3.3 Where does the acquiring firm originate?

While the number of foreign acquisitions in our analysis samples is too small to draw any quantitative conclusions about the specific country of origin, Figure 3. Origin of foreign ownership by 'greenness' of firm, in per cent displays the region of origin of the acquiring firms. In the emissions sample, the vast majority of firms are acquired by foreign entities from the Nordics or from the rest of Europe. About one in five foreign acquisitions of green firms involves firms from the rest of the OECD and non-OECD countries, while only one in eight foreign acquisitions of non-green firms originates from outside of Europe. For the energy sample, a similar pattern can be identified. Around 20 per cent of foreign acquisitions originate from outside of Europe, of which non-OECD countries only play a marginal role in the analysis samples.

Figure 3. Origin of foreign ownership by 'greenness' of firm, in per cent

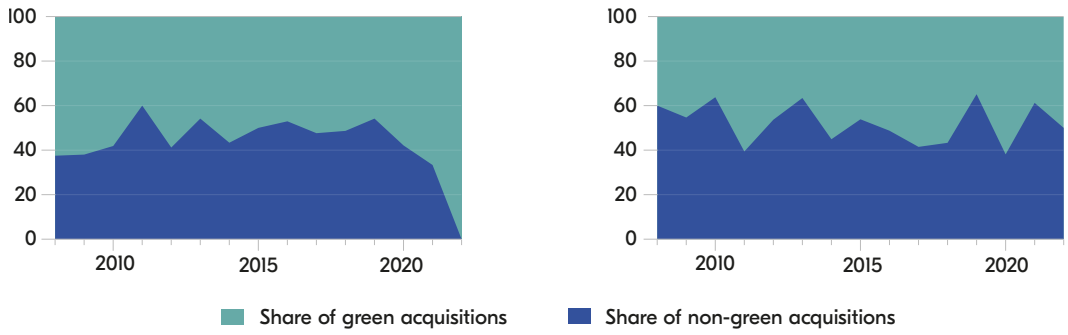


Note: Authors' calculations based on SCB data.

2.3.4 Acquisitions by level of 'greenness'

A large part of the analysis relies on whether the firm can be classified as green or not. The distinction between green and non-green firms is based on the intensity of firms relative to industry median levels (see Section 2.2). Throughout the period between 2008 and 2022, the share of green and non-green acquisitions is relatively stable, as Figure 4. Share of acquisitions in total, by level of 'greenness' displays. For both samples, around half of the foreign acquisitions are of firms that have below-median carbon or energy intensity. The other half are acquisitions of firms that have carbon or energy intensity levels that are above the industry median level.

Figure 4. Share of acquisitions in total, by level of 'greenness'

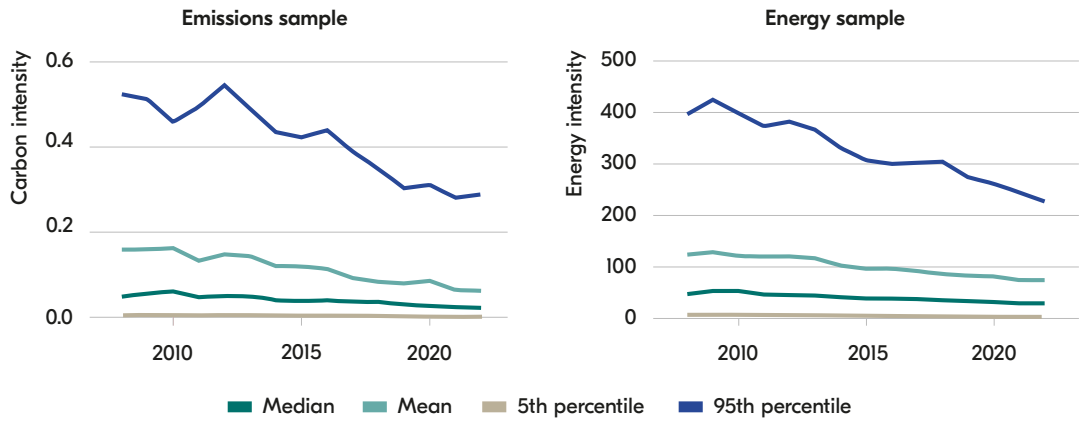


Note: Authors' calculations based on SCB data. Each foreign acquisition is classified as either non-green or green, and this figure represents the share of each group by year.

2.3.5 Carbon and energy intensity over time

Figure 5. Production intensities over time, by percentile presents the trend over time for the firm that has the median, mean, and 5th percentile highest and lowest carbon and energy intensities. The figure shows that there seems to be a downward trend across the distribution of firms. Between 2008 and 2022, the carbon and energy intensities for the median and mean firms is consistently lower each year. It is noteworthy that the average carbon and energy intensity is more than twice that of the median firm. This indicates that there are a small number of firms with very high carbon and energy intensities. To be precise, the firms in the 95th percentile, which have the highest intensities in the sample, have carbon and energy intensities that are 8 times higher than the median firm.

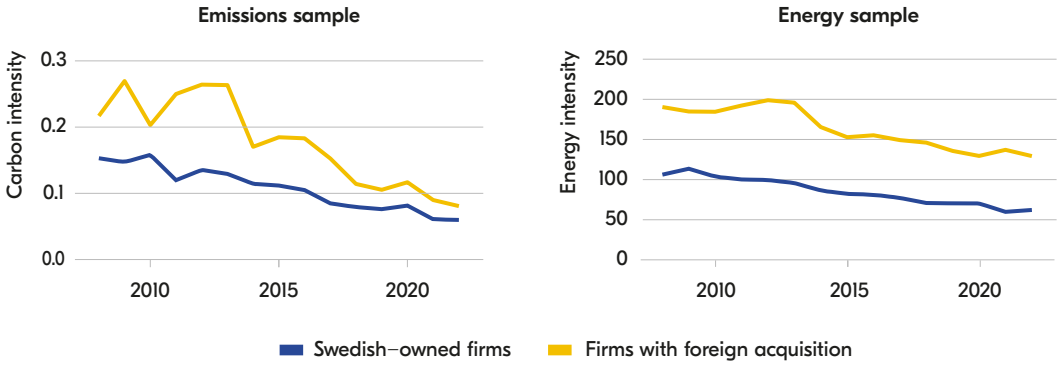
Figure 5. Production intensities over time, by percentile



Note: Authors' calculations based on SCB data.

A first insight into the relationship between the foreign acquisition of Swedish firms and firm-level environmental indicators can be found in Figure 6. In both samples, firms that are never acquired by a foreign entity have higher production intensities. For instance, average energy intensity is twice as high for firms that are acquired by a foreign entity at some point in time than it is for firms that remain in Swedish hands throughout the years.

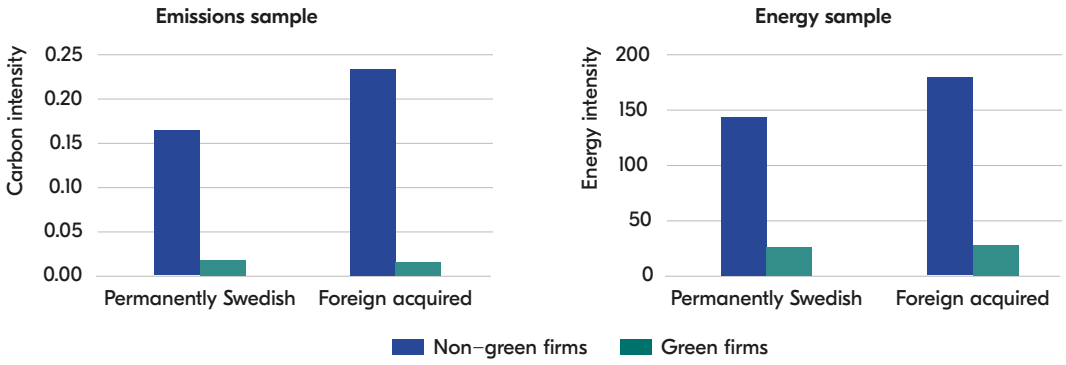
Figure 6. Average production intensities, by acquisition status



Note: Authors' calculations based on SCB data. If a firm has been acquired by a foreign entity at any time between 2008 and 2022, it is classified as *firm with foreign acquisition*.

Figure 7 displays average production intensities, split by acquisition status (foreign acquired or permanently Swedish) and greenness. In the case of non-green firms, average production intensities are 20 to 30 per cent higher for foreign acquired firms than those that remain in Swedish hands. It seems that foreign acquisitions of non-green firms are focused on the upper end of the production intensity distribution. Average production intensities of green firms are not significantly different between permanently Swedish firms and those that are acquired by foreign entities.

Figure 7. Average intensities (2008-2022), by acquisition status and firm 'greenness'



Note: Authors' calculations based on SCB data.

3. Method

This chapter discusses the methods used for the analyses. Readers who are not interested in the methodology can proceed to Chapter 4 without missing any essential information.

The analysis consists of three parts. First, we estimate the probability that the *greenness* of a firm (based on production intensity) is an important determinant of foreign acquisition. That is, are green firms or non-green firms more likely to be acquired by a foreign entity? We apply a logit model to analyse this. Secondly, we focus on the question of whether average production intensities are different before and after a foreign acquisition. We use standard difference-in-differences and event models to answer this question, though we will refrain from making causal claims. Thirdly, we use a matching algorithm to find a more similar control group of permanently Swedish firms to test the findings of the second part. Firms that are acquired by a foreign entity at some point in time may not be directly comparable with the universe of Swedish firms. Through matching, we find a pool of Swedish firms that are more similar to those firms that are acquired by foreign entities.

3.1 Production intensities and acquisition probability

This section outlines the methodological approach used to estimate whether the greenness of a firm impacts the probability of foreign acquisition. The sample analysed here consists of all Swedish firms that report either their carbon emissions and/or energy use in at least one year between 2008 and 2022, so that their *greenness* can be determined. We end up with 468 (783) acquired firms for the emissions (energy) sample.

While the box below discusses the model in more technical terms, the method helps us identify which factors affect the probability of foreign acquisition. In this case, the main

determinant of interest is the *greenness* of the firm. As foreign acquisition is a binary choice (either a firm gets acquired or it does not), a logit model is used. To isolate the impact of 'greenness', we include a number of firm-level variables known to affect the probability of a foreign acquisition, such as the value of international trade, the size, the productivity, and the age of the firm.

The results are presented as odds ratios, where a value of 1 indicates no impact and a value of 1.2 indicates a 20 per cent increase in the probability of being acquired for firms with that respective characteristic.

Technical box. Logit model

The empirical specification of the logit model employed in this section of the report relies on a binary logistic regression framework. More specifically, the empirical specification is as follows:

$$\ln\left(\frac{\pi_{i,t}}{1-\pi_{i,t}}\right) = \alpha + \beta GREEN_i + \gamma X_{i,t} + \varepsilon_{i,t}$$

in which case it takes the value of 1 and 0 otherwise. The years after a foreign acquisition are dropped from the analysis. The right-hand side contains the factor of interest – a measure of firm greenness that is time invariant (see Section 2.2). Other potentially relevant factors are captured by the X term. The list of control variables contains firm imports, exports, size, productivity, capital intensity, age, and age squared. The model presented in the results section also includes year fixed effects to capture economy-wide shocks. On the left-hand side, foreign acquisitions of firm *i* in year *t* are captured by the π term.

3.2 Impact of foreign acquisition on production intensities

The description below outlines methods used to study the different production intensities of firms after acquisition. The methods described involve the closely related difference-in-differences method and dynamic event study design.

3.2.1 Difference-in-differences

In order to estimate the impact of foreign acquisition on production intensities, we use an off-the-shelf version of the difference-in-differences method. This is often used to analyse the impact of a policy change or specific event on outcome variables, in this case production intensities. The specific event that affects a subset of Swedish firms is, in this report, foreign acquisition. By applying this method, we can compare the production intensities between two groups of firms: a group of firms affected by foreign acquisition (treatment group) and a group of firms not affected by foreign acquisition (control group). The so-called treatment effect is then the average difference in production intensities between these two groups of firms.

Technical box. Difference-in-differences

the empirical specification of the difference-in-differences model employed in this section of the report relies on the two-way fixed-effect (TWFE) framework. More specifically, the empirical specification is as follows:

$$ProductionIntensity_{i,t} = \alpha + \beta_1 ForeignAcquired_{i,t} + \gamma_{s,t} + \mu_i + \varepsilon_{i,t}$$

Here, *ProductionIntensity* is either the carbon intensity or energy intensity for firm *i* in year *t*. This is then regressed on a dummy variable that takes the value 1 if firm *i* is acquired by a foreign entity in year *t* and 0 otherwise. Note that *ForeignAcquired* retains the value 1 for all years after the foreign acquisition has taken place. The is the estimated effect of being acquired by a foreign entity on production intensity. To filter out firm and year specific characteristics that could partially impact the intensity measure, each specification also includes year-sector-specific, and time-invariant firm fixed effects.

Furthermore, several specifications contain interaction terms with relevant characteristics such as sector, firm size, but also a measure of firm greenness (see Section 2.2). These characteristics are interacted with the *ForeignAcquired* variable and added to the empirical specification. All results include robust standard errors.

3.2.2 Event study

The comparison between foreign acquired and Swedish-owned firms made in the previous section only holds if there are no underlying systemic differences between these two groups of firms. One (non-conclusive) way to verify this assumption is to compare the production intensity levels of acquired and non-acquired firms before the acquisition. Before the acquisition, the two groups should share the same trend, the so-called parallel assumption. We then follow the dynamic year-by-year effect of the acquisition on our outcome variables. The output of the event study is presented as a graphical representation spanning 6 years prior to the acquisition until 10 years post-acquisition.

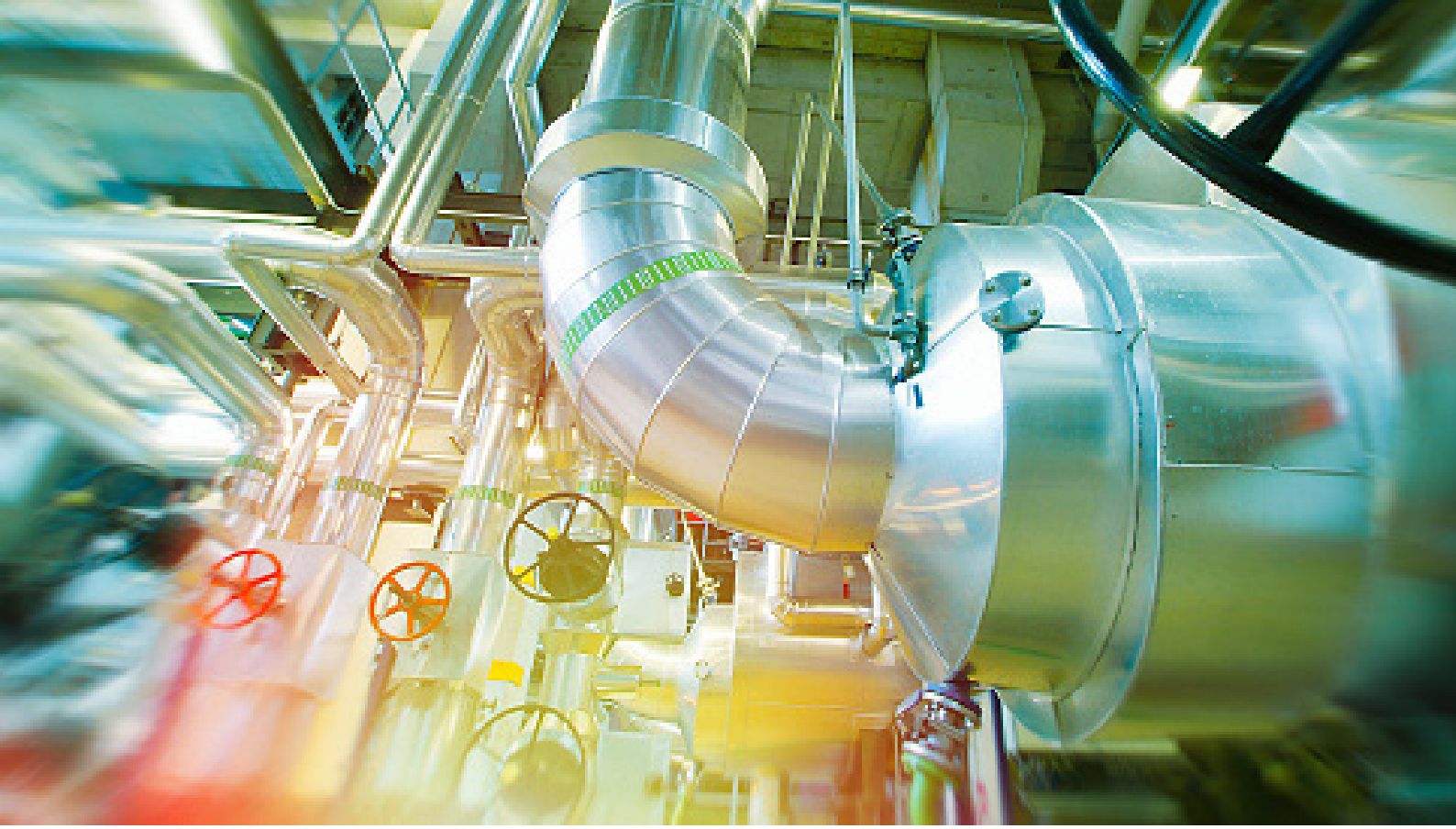
Technical box. Event study design

The empirical specification of the event study model employed in this section of the report is as follows:

$$Intensity_{i,t} = \alpha + \sum_{\tau=-6}^{\tau=10} \beta_\tau ForeignAcquisition_{i,t+\tau} + \gamma_{s,t} + \mu_i + \varepsilon_{i,t}$$

Here, *intensity* is either the carbon intensity or energy for firm *i* in year *t*.

The right-hand side contains a set of dummy variables that take the value of 1 in a period if the firm has been acquired by a foreign entity for that number of periods. For instance, in year , only those firms that are 3 years away from being acquired by a foreign entity will be assigned the value 1; all other firms will be assigned 0. In year , only firms that were acquired 5 years ago will be assigned 1, with all others receiving a 0. Sector-specific (*s*) year (*t*) fixed effects and firm fixed effects are included. All results include robust standard errors.



3.2.3 Matching

The methods outlined in Section 3.2.1 use all permanently Swedish firms as a comparison group in the empirical analysis. Not all firms will prove to be a proper comparison group for the firms acquired by a foreign entity. In order to identify a control group of firms that are more similar to acquired firms, we employ coarsened exact matching (Iacus et al., 2009). We use information on firm characteristics for the last 3 years prior to foreign acquisition for acquired firms, and all years for permanently Swedish firms to match.

4. Results

4.1 Production intensities and acquisition probability

Quick insight

The greenness of a Swedish firm does not systematically matter for the probability of a foreign acquisition.

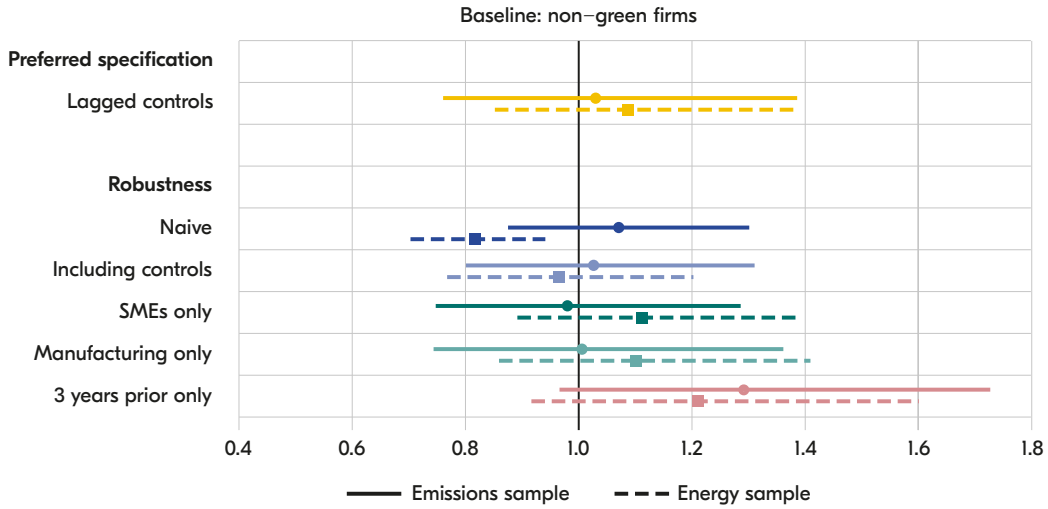
The results of the logistic regression are presented in Figure 8. Influence of firm greenness on probability of foreign acquisition. The overall results indicate that the level of 'firm greenness' does not significantly impact the probability of a foreign acquisition. Any significant deviation from the vertical line at the value of 1 would mean that the characteristic has a statistically significant impact on the probability of foreign acquisition. Our preferred specification contains control variables that are lagged one year. This is because the decision to acquire a firm is based on past (last year's) observed firm characteristics. In any case, there does not seem to be any differential probability of foreign acquisition between green and non-green firms.

For readers who would like more details, Table 4 in the appendix shows the estimated odds ratios for all variables included in the preferred specification. Based on Table 4, we can note that while firm *greenness* is not significantly correlated with the probability of foreign acquisition, it seems that the probability of being acquired (in these samples) increases with a firm's size and level of imports. Similarly, the probability of foreign acquisition is lower for older firms.[11]

11. One possible explanation for the finding that imports are a determinant of foreign acquisitions may be the bond established with a foreign entity through the import relationship. This is a potential avenue for future research, as it is beyond the scope of the present paper.

The conclusion drawn from looking at determinants of foreign acquisitions is that firm *greenness* does not systematically matter for the probability of foreign acquisition and that the result is robust for several alternative specifications.

Figure 8. Influence of firm greenness on probability of foreign acquisition



Note: the results are presented as odds ratios, where the value of one ('1') indicates no impact on the likelihood of being acquired. To determine significance, if the confidence interval crosses the vertical line at the value of one, the greenness of the firm does not have a statistically significant impact on the probability of foreign acquisition. The naïve specification is a bivariate logit regression that only includes the green firm indicator. (Lagged) Control variables are firm exports, imports, size, productivity, capital intensity, age, and age squared (the first 5 in logarithms). The "3 years prior" specification only includes permanently Swedish firms, and the last three years prior to acquisition of firms acquired by a non-Swedish entity.

4.2 Impact of foreign acquisition on production intensities

The above section indicated that neither green nor non-green firms are being systematically targeted in foreign acquisitions. However, foreign acquisition may still have implications for production intensity by restructuring the firm after acquisition. In this section, we therefore investigate whether firms have different production intensities after a foreign acquisition.

As a first step, we analyse the post-acquisition performance in terms of the production intensities of acquired firms compared to the matched non-acquired Swedish firms. The time period for the analysis spans foreign acquisitions that have taken place at some point in time between 2008 and 2022.

4.2.1 Results – firms' carbon intensity

Quick insight

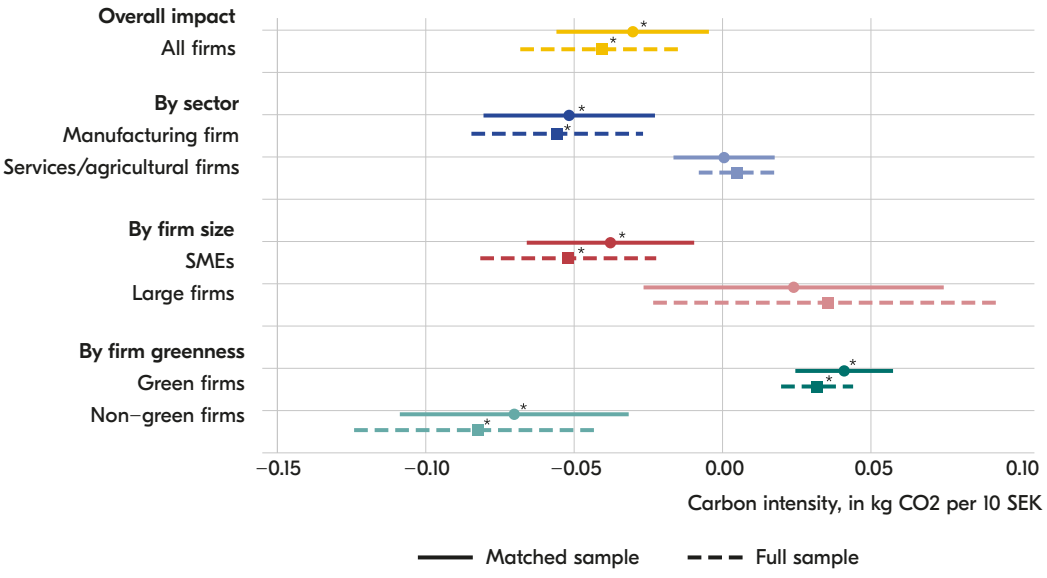
Overall, firms have lower carbon intensities after being acquired by a foreign entity. This effect is especially pronounced in carbon-intensive firms and for firms in the manufacturing sector.

The impact of foreign acquisition on carbon intensity

The results of the acquisition analysis are graphically depicted in Figure 9, and the results suggest that firms acquired by a foreign entity have lower carbon intensities in their production. The negative relationship between foreign acquisition and carbon intensity is much stronger in carbon-intensive firms and the manufacturing sector. The estimates of the services and agricultural/mining firms on the other hand, display no significant relationship between foreign acquisition and carbon intensity. Firm size also matters, as foreign acquisition and the carbon intensity of SMEs are negatively correlated, whereas foreign acquisitions of large firms yield no significant results.

The most surprising results can be found when the firms are split by their 'greenness'. Foreign acquisition of non-green firms (those with above sectoral-median carbon intensities) tends to be negatively associated with carbon intensities after the acquisition. What this means is that for these carbon intensive firms, carbon intensity is lower after the foreign acquisition. Simply put, non-green firms become greener. The opposite holds for firms that are classified as green (within their sector). The estimated effect of foreign acquisition on carbon intensity for firms classified as green is positive. We interpret this result as potential evidence that the marginal costs of further carbon emission reducing technologies are higher than the marginal benefit, and such investments are not made after foreign acquisition. As the rest of the sector makes such investments, the estimated effect is positive because the gap between these clean firms and the sectoral average becomes smaller.

Figure 9. Difference-in-differences results for the carbon emission sample

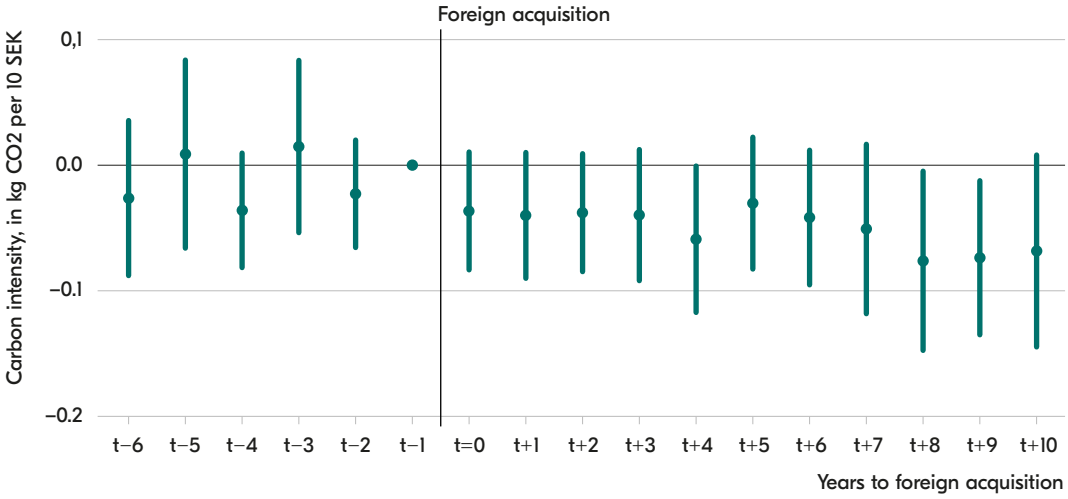


Note: Estimated results as per strategy outlined in section 3.2.1. The dependent variable is the carbon intensity, defined as carbon emissions per SEK 10 value added. The plotted effects are for the dummy variable, indicating foreign ownership, with the horizontal lines representing the 95 per cent confidence interval and * indicating a significant result.

Dynamic effects on firms' carbon intensity

How do carbon intensities evolve after a foreign acquisition? In the event-study, we follow Swedish firms six years before and ten years after a foreign acquisition (see Figure 10. Dynamic effects of foreign acquisitions on firms' carbon intensity.). We note that prior to acquisition, there is no significant difference between acquired and non-acquired firms, suggesting that the assumption of parallel trends is not violated. The foreign acquisition happens sometime between t-1 and t0, and there seems to be a slightly negative correlation with carbon-intensities after a foreign acquisition has taken place. While this impact is not statistically different from zero for individual years, the trend indicates that it could take time before internal investments into cleaner production methods show any effect. The effect seems to be persistent throughout the 10 years after foreign acquisition, which means that foreign acquired firms have lower carbon intensities than their permanently Swedish-owned counterparts.

Figure 10. Dynamic effects of foreign acquisitions on firms' carbon intensity.



Note: Estimated results as per strategy outlined in Section 3.2.2.

4.2.2 Results – firms' energy intensity

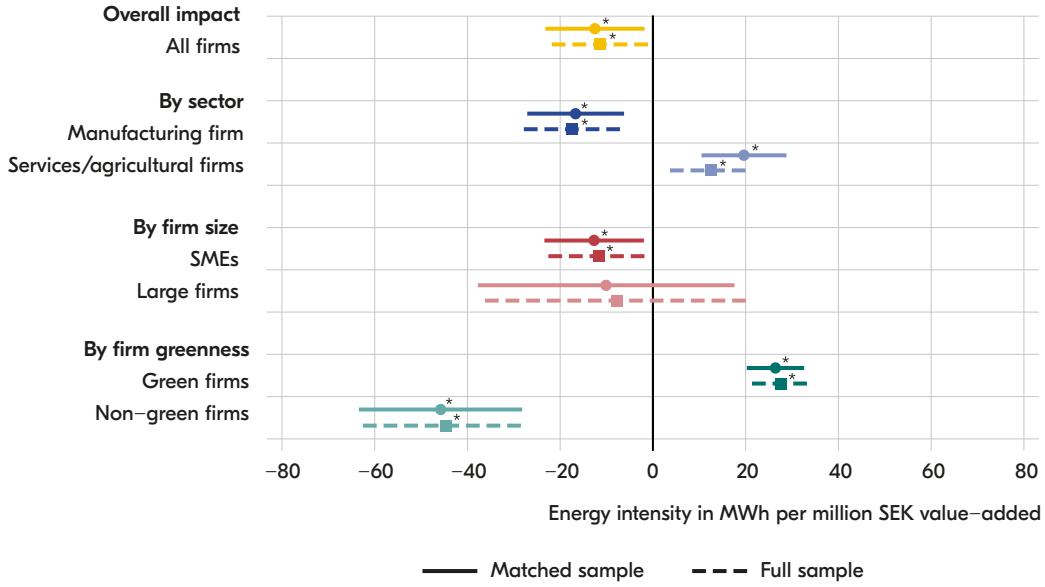
Quick insight

Overall, firms have lower energy intensities after being acquired by a foreign entity. This effect is especially pronounced in energy-intensive firms and for firms in the manufacturing sector.

The impact of foreign acquisition on energy intensity

The results of the acquisition analysis are graphically depicted in Figure 11 and suggest that firms acquired by a foreign entity have a lower energy intensity in their production after acquisition. The negative correlation between foreign acquisition and energy intensity is stronger in energy-intensive firms, SMEs, and the manufacturing sector. Remarkably, green firms (relative to their peers in the sector) have a higher energy intensity after being acquired by a foreign entity. In line with the explanation above for the carbon intensity metric, this could be explained by potentially higher marginal costs for energy efficiency gains for firms with already-low energy intensities.

Figure 11. Difference-in-differences results for the energy sample

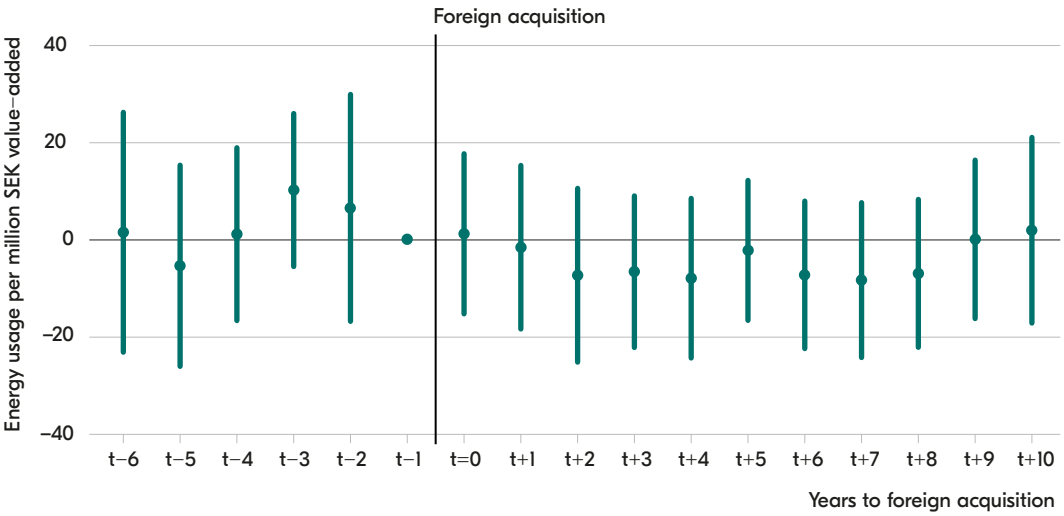


Note: Estimated results as per strategy outlined in Section 3.2.1. The dependent variable is the energy intensity, defined as energy usage per SEK 1 million value added. The plotted effects are for the dummy variable indicating foreign ownership, with the horizontal lines representing the 95 per cent confidence interval and the * indicating a significant result.

Dynamic effects on firms' energy intensity

It may take time to restructure a firm in a way that has a measurable impact on energy intensity. The event study follows firms six years before and ten years after a foreign acquisition. The results depicted in Figure 12. Event study regression results for energy sample suggest that after comparing firms acquired by foreign entities with the matched sample of Swedish firms, there is no significant difference in energy intensity after the foreign acquisition has taken place. This analysis suggests that there may be a delay of several years before a firm is restructured in such a way that it becomes visible in the energy intensity data.

Figure 12. Event study regression results for energy sample



Note: Estimated results as per strategy outlined in Section 3.2.2.

5. Conclusion and policy implications

In this report, we analysed firm-level data of foreign acquisitions in Sweden and investigated whether these foreign acquisitions impacted their 'greenness'. Specifically, we first analysed whether green firms (with low production intensities) are selectively being acquired by foreign firms. Secondly, we looked at the question of whether emission and energy intensities are lower after a foreign acquisition.

5.1 Conclusions

Our results lead to the following conclusions:

Foreign acquisitions are not selectively targeting green firms
The analysis reveals no statistically significant relationship between the probability of foreign acquisition of a Swedish firm and its production intensities. This means that there is no systematic preference of foreign firms for acquiring green Swedish firms.

Foreign acquisitions make firms greener
Overall, the results support the hypothesis that acquired firms are greener after foreign acquisitions. This effect is larger for production-intensive firms. Firms with high carbon intensities see larger than average reductions in their carbon intensities, with similar results for energy intensive firms. The impact is also more pronounced for firms in the manufacturing sector and SMEs than for other groups of firms. The estimated effects on emission and energy intensity come on top of the general trend towards lower emission and energy intensities over time.

In order to dive into the mechanisms that could partially explain these conclusions, future work on this topic could focus on case studies of foreign acquisitions. It could also be beneficial to take a long-term perspective on within-firm changes in capital investments in low-carbon and energy-efficient technologies.

5.2 Policy implications

The results of this report could have implications for several policy processes:

1. An important target in Sweden's Strategy for Foreign Trade and Investments is to remain an attractive and competitive destination for foreign investment. The results of this report show that the potential benefits from investments reach beyond the economic realm into environmental outcomes, which also could have implications for the design of FDI screening mechanisms and thus economic security. Another result of this report is that foreign entities do not selectively target Swedish frontrunners based on their production intensities, but that Swedish firms in general remain attractive investment objects. Therefore, it is important to maintain the current approach as laid out in Sweden's Strategy for Foreign Trade and Investment.
2. Sweden's goal to become a net-zero economy by 2045 requires massive investments in low-carbon and energy-efficient technologies. Foreign investments could play a major role in this transition, which is essential to maintaining the competitiveness of Swedish industry. The results of this report indicate that foreign acquisitions do indeed lead to lower production intensities for the average firm. The massive capital costs to meet EU emission targets (e.g., through the reduction of EU ETS permits over the next 15 years) could be partially facilitated by foreign investments.
3. The current approach to attract investments to Sweden facilitates its ability to achieve the ambitious targets of Agenda 2030. This report shows that production intensities are lower after a foreign acquisition, which contributes to meeting the energy efficiency goals outlined in the Implementation Strategy of Agenda 2030. An open and transparent investment climate could support and accelerate the green transition by providing foreign capital for the necessary investments.

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Appendix

Matching variables and outcome

The following variables are used to match foreign acquired firms with permanently Swedish firms with similar characteristics:

- Firm size is based on a firm's annual revenue
- Imports are total goods imports of a firm
- Exports are total goods exports of a firm
- Productivity is based on the value added for each employee (labour productivity)
- Capital intensity is based on the book value of buildings and machinery per unit value added
- Firm age is based on the first year a firm is active in the data[12]

The results of the matching are displayed in Table 2. Matching results of emissions and energy samples.. The top panel shows the emission sample, and the bottom panel displays the energy sample. To see how the matching improves the similarity between acquired firms, the two leftmost columns compare the foreign acquired firms with all permanently Swedish firms in the emissions sample, whereas a comparison using the matched sample is presented in the two rightmost columns. Note that although the t-statistics continue to show significant differences for most of the variables, the matching still results in a relatively similar control group.

Table 2. Matching results of emissions and energy samples.

Emission sample						
	Full sample			Matched sample		
Variable	Foreign	Swedish	t-statistic	Foreign	Swedish	t-statistic
Carbon intensity	0.114	0.085	-3.45	0.129	0.105	-2.18
Firm size	844 880	312 648	-9.61	1004 746	396 406	-5.68
Imports	188 077	53 297	-10.02	241 747	78 810	-5.14
Exports	415 865	153 350	-7.40	578 795	226 899	-4.98
Productivity	922	720	-16.49	960	700	-16.21
Capital intensity	623	410	-10.42	604	389	-6.27
# Firms	529	6,673		222	363	
Energy sample						
	Full sample			Matched sample		
Variable	Foreign	Swedish	t-statistic	Variable	Foreign	Swedish
Energy intensity	98.92	86.98	-3.03	91.72	96.65	1.10
Firm size	516 619	175 023	-11.18	486 862	227 661	-9.58
Imports	125 942	28 588	-14.71	121 102	44 210	-10.77
Exports	237 058	72 104	-10.05	239 353	102 673	-8.41
Productivity	900	702	-26.50	881	761	-15.32
Capital intensity	515	325	-15.28	428	353	-7.28
# Firms	878	9,503		669	2,769	

12. Data starts in 1990, so the maximum firm age is 32 in this analysis. As we do not interpret these coefficients, this is no problem.

Table 3. Logistic regression results: probability of acquisition

	Emissions sample	Energy sample
Green firm dummy	0.891 (0.168)	1.087 (0.134)
Imports (ln)	1.082*** (0.019)	1.075*** (0.013)
Exports (ln)	1.029 (0.016)	1.039** (0.012)
Production (ln)	1.716*** (0.161)	1.660*** (0.112)
Productivity (ln)	0.727* (0.116)	0.871 (0.101)
Capital intensity (ln)	0.964 (0.036)	0.974 (0.023)
Firm age	0.699*** (0.034)	0.737*** (0.023)
(Firm age)2 Superscript 2	1.011*** (0.002)	1.009*** (0.001)
Observations	47,732	91,492

Notes: Odds ratios, preferred specification with lagged control variables. See Section 3.1 for more information.

Sammanfattning på svenska

Summary in Swedish

Litteraturen om effekter av och motiv bakom utländska direktinvesteringar (UDI) är omfattande. Forskningen visar att UDI ofta är förknippat med fördelar, såsom ekonomisk tillväxt, tekniköverföring och produktivitet. Däremot är frågan om företagsförvärv och dess miljöpåverkan komplex och mindre utredd. En vanlig oro är att ökad ekonomisk aktivitet efter ett företagsförvärv kan leda till ökade koldioxidutsläpp och mer energianvändning, något som kan påverka miljön negativt. Om utländska förvärv däremot leder till en förändring till mer hållbara industrier, eller om förvärvet gör att ren(are) teknologier introduceras i verksamheten, kommer detta sannolikt mildra de miljömässiga skadorna.

Syftet med denna rapport är att analysera om företagens energi- och/eller koldioxid-intensitet förändras efter utländska förvärv av svenska företag. I denna rapport baseras dessa på rapporterade koldioxidutsläpp eller energianvändning per enhet förädlingsvärde. Specifikt använder vi svenska företagsdata från 2008 till 2022 för att besvara följande två frågor:

- Förvärvas svenska företag selektivt av utländska företag utifrån deras energi- och/eller koldioxid-intensitet?
- Leder utländska förvärv till lägre energi- och/eller koldioxid-intensitet?

Ett nyckelbegrepp i denna rapport är företagens ”grönhet”. ”Gröna” företag definieras som de företag som har en energi- och/eller koldioxid-intensitet som är lägre än medianen för branschen det verkar i. Alla företag i analysen klassificeras antingen som ”gröna” eller som ”icke-gröna”, och denna klassificering används genomgående i de statistiska analyserna.

Resultaten från studien visar:

- **Ingen selektion av gröna företag:** Den första delen av analysen visar att ett svenskt företags grönhet inte har någon systematisk betydelse för sannolikheten för ett utländskt förvärv.
- **Företag blir ”grönare” efter utländska förvärv:** Resultaten tyder på att svenska företag som förvärvas av utländska aktörer minskar sin energi- och koldioxid-intensitet. Effekten är särskilt utmärkande för utsläpps- och energiintensiva företag, för företag inom tillverkningssektorn och för små och medelstora företag.

Resultaten i denna rapport belyser viktiga aspekter av relationen mellan utländska förvärv och dess påverkan på energi- och/eller koldioxid-intensitet i uppköpta företag, vilket kan ha följande policyimplikationer:

1. Ett viktigt mål i Sveriges utrikeshandelsstrategi är att fortsätta vara en attraktiv och konkurrenskraftig destination för utländska investeringar. Resultaten i denna rapport visar att fördelarna med investeringar sträcker sig bortom den ekonomiska sfären till att även omfatta miljömässiga aspekter, vilket även kan ha implikationer för ekonomisk säkerhet och utformandet av investeringsgranskningsmekanismen. Ett annat resultat i denna rapport är att utländska aktörer inte selektivt riktar in sig på att förvärva svenska företag som ligger i framkant vad gäller energi- och/eller koldioxid-intensitet, utan att svenska företag i allmänhet förblir attraktiva investeringsobjekt. Det är därför viktigt att upprätthålla och värna om det nuvarande förhållningssättet i enlighet med Utrikeshandelsstrategin.

2. Sveriges mål att bli en netto-noll-ekonomi till 2045 kräver stora investeringar i koldioxidsnål och energieffektiv teknologi. Utländska investeringar kan spela en stor roll i denna omställning, som är avgörande för att svensk industri ska kunna behålla sin konkurrenskraft. Resultaten i denna rapport visar att utländska förvärv leder till lägre energi- och koldioxid-intensitet för det genomsnittliga företaget. Mot bakgrund av minskningen av tillgängliga utsläppsrätter inom EU ETS under de kommande 15 åren och den förväntade prisökningen på koldioxidutsläpp, skulle de enorma finansiella kostnaderna för denna omställning delvis kunna underlättas av utländska investeringar.
3. Det nuvarande tillvägagångssättet för att attrahera investeringar till Sverige underlättar uppfyllanden av de ambitiösa målen i Agenda 2030. Denna rapport visar att företagens energiintensitet går ner efter ett utländskt förvärv, vilket bidrar till att uppnå de energieffektivitetsmål som anges i genomförandestrategin för Agenda 2030. Ett öppet och transparent investeringsklimat skulle kunna stödja och påskynda den gröna omställningen genom att tillhandahålla utländskt kapital för de nödvändiga investeringarna.

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