ANALYSIS

The Impact of Energy Costs on Trade and Production in Sweden

2024

Summary

Energy costs for households and industry increased sharply as a result of the Russian invasion of Ukraine. Changes in energy costs can affect the competitive position of Swedish firms on international markets, and studying the relationship between energy costs, production, and trade is therefore highly relevant. This report aims to provide a background understanding of the dynamics between energy costs, industrial output and trade in the Swedish context since 2004.

Using data on energy costs, energy use, production, and international trade at individual firm level, several descriptive correlations are identified. Electricity costs are generally lower in the northern regions of Sweden, which is also where more energy intensive industries are located. Electricity costs tend to be lower for firms engaged in international trade, and this finding holds for all regions of Sweden. Swedish exporting firms tend to be more energy intensive than Swedish firms in general, and energy intensity tends to be higher for firms that export a larger share of their production. Finally, firms with higher energy costs are associated with lower export values and this is seen across most sectors. We also find indicative evidence that firms engaged in international trade are able to pass on a larger share of their energy cost increases to final consumers.

This report offers a snapshot of the trade and energy cost context in Sweden. The descriptive findings on the relationship between energy costs and trade do not lend themselves to strong conclusions or policy recommendations. Policymakers should take a wider approach to this question than considering the statistical correlations presented here. For instance, market and negotiating power could partially explain the lower energy costs for larger (exporting) firms, but so could government policy through implicit fossil-fuel and other energy subsidies.

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1 Introduction

The purpose of this report is to shed light on the impact of energy price changes on the production and trade of Swedish firms between 2004 and 2021. While this report is not the first to look at the relationship between energy costs and production and trade,[1] its firm-level perspective is relevant to exploit the heterogeneity in energy use, costs, and contracts at firm level. The relationship between changes in energy costs and the response of Swedish industrial players is relevant, especially considering the energy crisis that hit much of the Western world after the Russian invasion of Ukraine in February 2022. Sweden is a trade-dependent country, and the weaponisation of energy could be a threat to the performance of Swedish industry. At the same time, the massive shift towards renewable energy generation presents an opportunity for Sweden to develop their energy production and become an important player.

While this report comes too early to look at the energy price shock in 2022 due to data availability, it provides a background understanding of the dynamics between energy costs and industrial output and trade since 2004. Findings in this report do not necessarily translate to other countries, even if these countries look rather similar at first glance. Differences in natural resource abundance such as gas and oil and differences in taxation and other support policies regarding energy and electricity have resulted in different industrial structures. Sweden has to import almost all of its non-electricity energy demand but is a large producer of electricity and therefore became one of the largest net exporters in Europe in recent years.[2]

1.1 Context of the Swedish electricity market

Sweden's industrial sectors have long benefited from the availability of relatively cheap and stable electricity supply. In 2011, Sweden was divided into four different electricity bidding zones with limited cross-region transmission of electricity.[3][4] The north of the country has an abundance of electricity generated by hydroelectric power plants. The south relies more on nuclear power plants, but also on fossil fuel-based generation as well as renewables. These regions have different prices, with those in the south more affected by international price fluctuations due to the connectedness with the continental European grid. The north, on the other hand, is less affected by international price fluctuations. Naturally, several energy-intensive industries have therefore chosen to locate themselves in the north of Sweden where energy prices tend to be lower. Transmission capacity from the north of Sweden to the south has actually

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1 See, for a number of recent reports, here: Cost Pass-Through and the Rise of Inflation (CAE, 2023), and How have higher energy prices affected industrial production and imports? (ECB pages 40-46, 2023). A report using survey data by Business Sweden can be found here: Electricity price shock and Swedish exports (Business Sweden, 2023).

2 Sweden briefly was the largest net exporter in the EU in the first two quarters of 2022: Sweden overtakes France as Europe's biggest net power exporter (EnAppSys, 2022)

3 Bidding zones are generally created to reflect regional electricity market conditions and create a price based on regional demand (incl. exports to other bidding zones) and supply. Some countries with multiple bidding zones have different prices for each zone, others have sufficient transmission capacity to balance the prices. For more information, see Bidding areas | Nord Pool.

4 While *bidding zones* are the official English translation of the Swedish term "elområde", we use *electricity zones* to highlight the geographical and electricity market differences.

decreased between 2012 and 2021, and about half of the time in 2021, transmission between north and south was limited by capacity, not demand.[5] Sweden is able to export electricity to a number of countries through so-called interconnectors. The two northern electricity zones are connected to Norway and Finland, whereas the two southern electricity zones are connected to Norway, Finland, Denmark, Germany, Poland, and Lithuania.[6]

1.2 Data sources

This paper relies on microdata from Statistics Sweden. More specifically, it uses firm-level data on energy use and costs, by type of energy.[7] This energy dataset contains detailed information on quantity and cost information on electricity use, fuels used in production, heating of the premises, and fuel for transportation. It is important to note that the energy data is from a sample of firms and that the same firm is therefore unlikely to be observed each year of our sample spanning the period 2004-2021. Therefore, for each year, the figures will be based on a different sample of firms. As the main focus of this report is energy use in the production process, we do not include fuel for transportation, and will be explicit when we talk about electricity use or energy use (which is the sum of electricity, heating, and fuels used in the production process). Data on heating and fuels used in production are converted to MWh to facilitate the comparison across firms.[8]

We then link the energy use and price data to information on firm-level imports and exports, production, sales, investment, employment, and industrial sector classifycation. This allows us to delve deeper into the differences in firm-level energy use, how firms may be affected by changing energy costs and how this effect varies across regions.

5 For more information, see report in Swedish: Från stabilt till volatilt (Kunskapsverket, 2023)

6 See Swedish interconnectors: monitoring report no. 16 (Svenska Kraftnät, 2020).

7 ISEN: Industrins energianvändning. See: https://www.scb.se/isen-en. A broad description of the Swedish energy system over time can be found here, in Swedish: Energimyndighetens webbshop (a-w2m.se).

8 Technical note: We drop any firm-year observation that falls within the 1 per cent highest and lowest energy cost and electricity cost. We also exclude firms with the highest 1 per cent of export intensity (exports divided by production). Firm-level data is weighted in chapter 2 (where different firms are present in the data each year, but all face the same national/ regional electricity costs). Firm-level data is not weighted in the analyses of chapter 3, as different firms may appear in different years, with different levels of energy intensity.

Definitions

Electricity costs

Throughout this report, electricity costs are defined as the total costs for electricity that the firm pay, divided by the amount of electricity that the firm used. These costs are expressed per kWh, and include the raw price for electricity, but also network costs, taxes, levies, and VAT.

Energy intensity

In this report, energy intensity is defined as energy use divided by value added. As we only have data on the energy use of the Swedish firm, we also use the value added by that Swedish firm to create this measure. Therefore, this merely reflects the energy intensity of the Swedish part of the production value chain.

Electricity zones

The Swedish electricity market is divided into four bidding zones, each reflecting the regional electricity market conditions. Zones 1 and 2 are in the north and are mostly based on hydroelectric power generation. Zones 3 and 4 are in the south.

SE1: Umeå	SE3: Stockholm
SE2: Sundsvall	SE4: Malmö

2 Electricity costs for Swedish firms: 2007–2021

This section presents an overview of electricity costs faced by Swedish firms between 2007 and 2021. It first places the Swedish situation into perspective vis-à-vis a number of other European countries. It then provides detailed insights into electricity costs for different subsets of firms, for instance for firms located in each electricity zone. Lastly, it sheds light on how different firm characteristics are related to electricity costs firms face, such as export intensity and export and import values. Unless otherwise specified, these electricity costs are expressed in Swedish crowns (SEK) per kilowatt-hour (kWh). Values are also converted to 2020 prices to adjust for inflation.

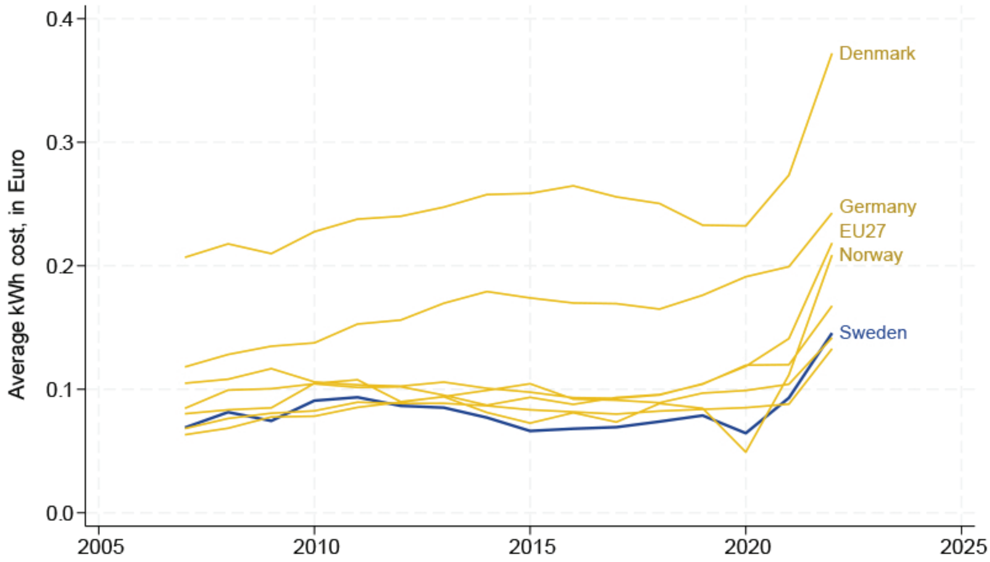
2.1 Swedish electricity costs from an international perspective

A first look at the relationship between electricity costs and trade requires an international perspective. Despite partially connected electricity grids, differences in electricity costs across European countries persist. Other than pure electricity prices, these differences can be caused by levies and different taxation levels. The figure below shows electricity costs for firms using between 2 000 and 19 999 MWh per year[9] for Sweden and a range of comparable countries.[10] Note that these electricity costs are expressed in euros, so that direct comparisons with other graphs in this report are not desirable, and changes in the Swedish electricity costs can also be explained by exchange rate fluctuations. Swedish electricity costs are among the lowest of the set of countries, at comparable levels to Finland, Poland, and the Netherlands. Electricity costs for this representative firm are significantly higher in Denmark, Germany, and Norway.

[9] Note that other bins of electricity use show very similar patterns.

[10] Denmark, Germany, Finland, France, Poland, the Netherlands, and Norway.

Figure 1. International comparison of electricity costs for a firm using between 2 000 and 19 999 MWh per year, in euros

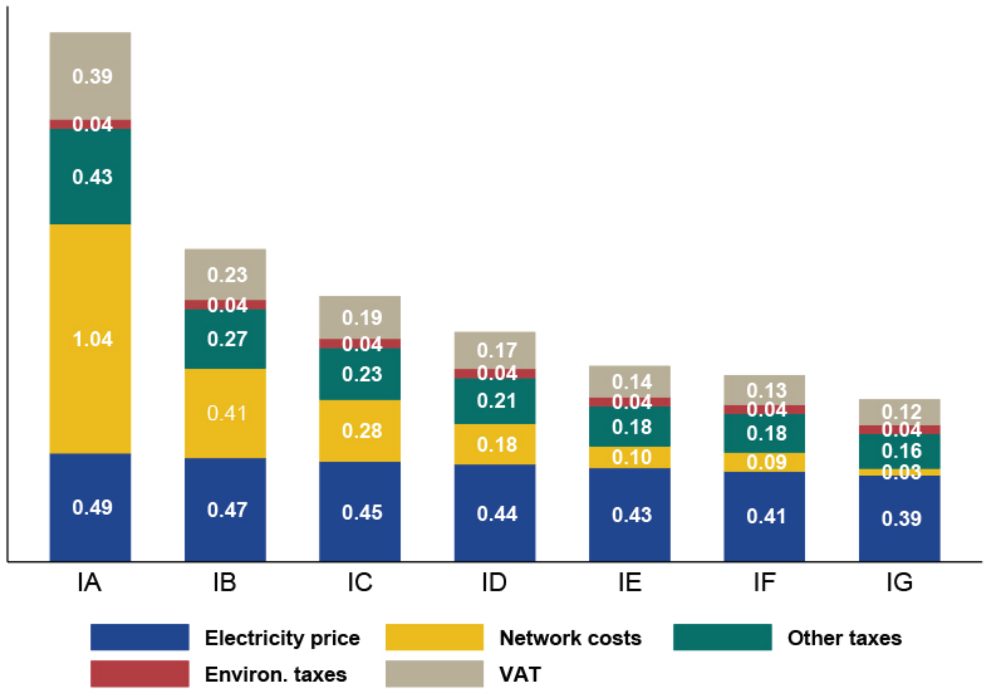


Source: Eurostat table [NRG_PC_205], with annual averages calculated by the author. Data on annual average electricity costs in Finland, Poland, and the Netherlands are also plotted in the figure above, but their labels are suppressed to avoid cluttering the figure.

2.2 Electricity costs in Sweden, dissected

Electricity costs are made up of a number of elements. The main element is the electricity price, the per kWh amount the consumer has to pay for the electricity. A second element is the network cost, the cost the consumer has to pay to be connected to the electricity grid to the network provider. On top of these come several levies and taxes, including VAT. A breakdown of the relative importance of each of these elements for Swedish industrial players is provided in the figure below. This data comes from Eurostat and is therefore not derived from the firm-level database used in the remainder of the paper. Individual firms can therefore have negotiated different contracts than depicted here, with different costs as a result.

Figure 2. Breakdown of non-household electricity costs in Sweden in SEK per kWh, by type of user (sorted from small to large)



Source: Eurostat table [NRG_PC_204_C], calculations by the author. Labels on the x-axis denote the type of non-household consumer. IA is a firm that uses less than 20 MWh per year, and this increases to more than 150 000 MWh per year for group IG. Note that values on the y-axis are suppressed to avoid cluttering the figure, and the average total cost value for each type of non-household is of secondary importance.

The breakdown of different elements differs vastly by type of user. Overall, firms in group IA (with a consumption of less than 20 MWh per year) pay more for their electricity per kWh than firms in group IG (consumption over 150 000 MWh per year). Electricity prices are monotonically declining, with firms that use most electricity paying about 0.1 SEK less per kWh than smaller users. This difference in electricity prices could be an indication of market and negotiation power of larger firms. The largest difference between small and large users is in network costs, which is likely caused by large, fixed costs for industrial consumers. If these fixed costs are divided by total consumption, the per kWh cost is lower for larger consumers. Similarly, the "Other taxes"[11] tend to be higher for smaller consumers too, but that can be explained by the lower electricity tax rate for the use of electricity in industrial processes.[12] VAT is simply a fixed percentage of (most of) the other elements in the figure that therefore exacerbates differences between the types of firms displayed in the figure. This overall pattern in the figure may explain some of the findings below.

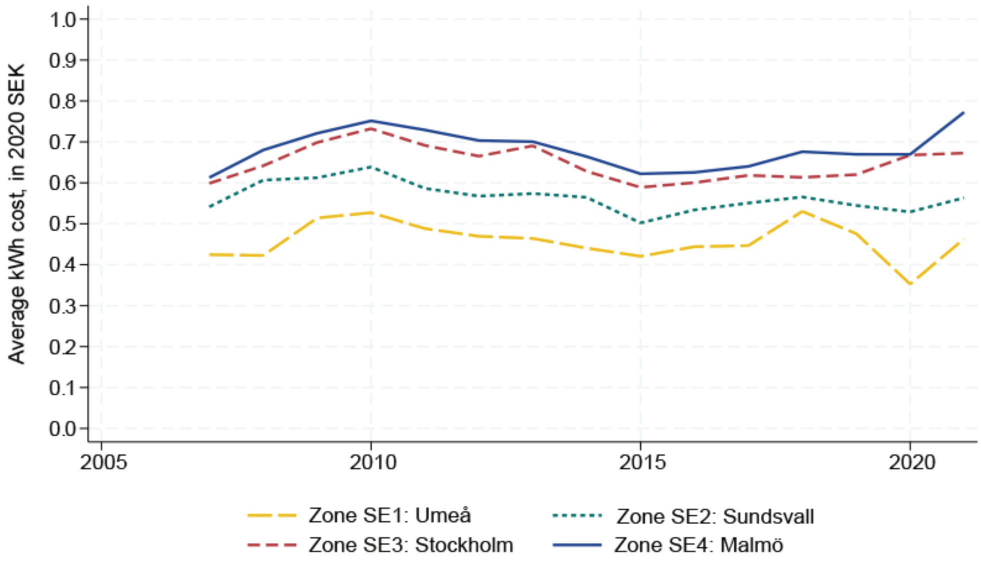
[11] Eurostat defines "other taxes" as *"taxes, fees, levies or charges not covered by any of the previous five categories: support for district heating; local or regional fiscal charges; island compensation; concession fees relating to licences and fees for the occupation of land and public or private property by networks or other devices."* Electricity prices for household consumers - bi-annual data (nrg_pc_204) (Eurostat).

[12] Swedish Tax Authority: Energy tax | Skatteverket

2.3 Electricity costs by firm location

As discussed earlier in this report, Sweden is divided into four electricity zones, with limited transmission capacity between the zones.[13] The figure below shows that electricity costs are lower in zones 1 and 2, which are located in the north of the country. Electricity costs for firms located in the two southern electricity zones of Sweden are (between 10 and 20 per cent) higher than for firms in the north of Sweden. Over time, however, electricity costs are relatively stable across all four zones between 2007 and 2021. Note that these differences are smaller than are often portrayed in electricity price data, because levies and taxes are included in the electricity costs and have a mediating effect.

Figure 3. Average electricity cost per kWh, by electricity zone



Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported MWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value for each electricity zone.

2.4 Electricity costs by firm trading status

The relationship between electricity costs and competitiveness of Swedish firms in the global market has gained importance in recent months. The figure below sheds light on the relationship between electricity costs and firm trading status between 2007 and 2021. This is relevant for two reasons. The first is that it could make firms uncompetitive on the global market if the shocks to electricity costs are local or regional (the Russian invasion of Ukraine caused the electricity costs in Europe to increase more than in the US, for instance). The second concern is that local producers may be priced out of the domestic market if electricity costs go up, when firms further down the value chain replace domestically sourced intermediate products for cheaper foreign alternatives. While it is out of the scope of this report to study this behaviour (as one

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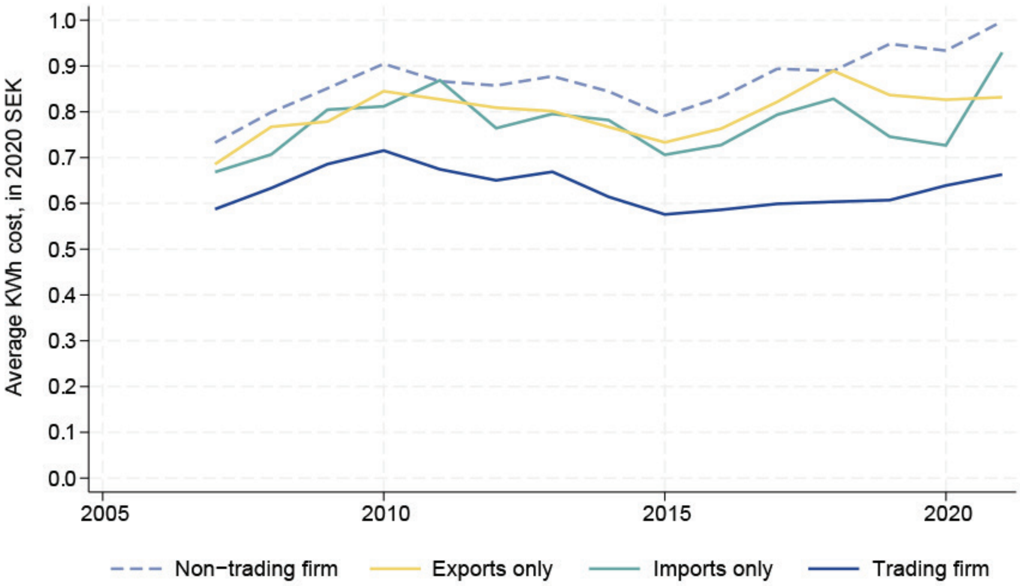
13 See this analysis in the southern region of Skåne for an analysis of how limited transmission affects prices: [Scenario för det skånska elsystemet (Region Skåne, 2020)](#).

would need more recent and more high-frequency data), the figure below shows the differences in electricity costs faced by four different types of firms. Firms that are active on foreign markets, by both exporting and importing, report the lowest electricity costs for every year between 2007 and 2021. The dark blue line in the figure below shows that electricity costs are consistently below firms that either only export or import, or do not engage in foreign trade at all.[14]

Figure 4. Average electricity cost per kWh, for trading and non-trading firms



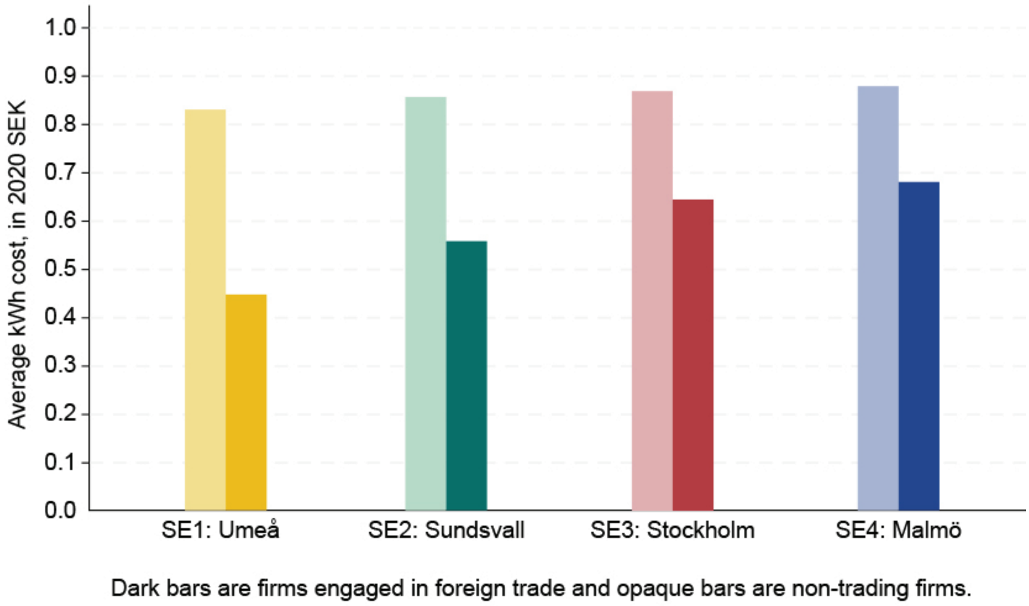
Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported MWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value for each type of trading relationship.

2.5 Electricity costs by firm trading status and firm location

Combining the two previous graphs sheds light on how electricity costs differ by electricity zone and trading status of the firm. As seen in Figure 4, firms that are engaged in international trade face consistently lower electricity costs than non-trading firms. The lower electricity costs for firms engaged in international trade holds within each of the four electricity zones, and the cost difference is largest in the northern regions (1 and 2).

14 Note that "trading firms" only includes firms that directly engage in foreign trade. Suppliers to trading firms, or purchasers of imported products through wholesalers are not included in the "trading firm" category.

Figure 5. Average electricity cost per kWh, for trading and non-trading firms by electricity zone



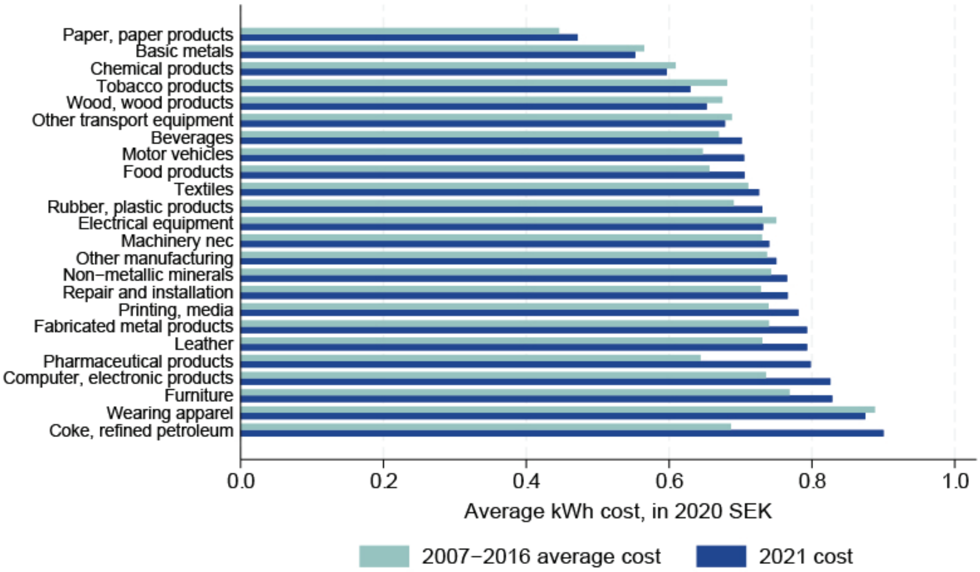
Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported MWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value for each type of trading relationship and electricity zone.

2.6 Electricity costs by manufacturing subsector

In the figure below, we zoom in on the electricity costs faced by the manufacturing sector of the Swedish economy. Average electricity costs between 2007 and 2016 are compared to 2021 costs. Most subsectors in manufacturing now face higher costs than they did 10 years ago, even after adjusting for inflation. There is an interesting variation between the subsectors, with heavy industry such as basic metals at the lower end of the distribution and computer, electronic products towards the higher end. This cost difference may to some extent be explained by location choice or size, but also by the length of the electricity contract that the firm has signed.[15] In general, the manufacturing sector faces lower costs than the other sectors of the economy.

[15] Note that some of these differences may be due to differences in sampled firms for each year. However, as these values are all weighted by firm size, these figures remain representative of the subsector.

Figure 6. Average electricity cost per kWh, by manufacturing subsector



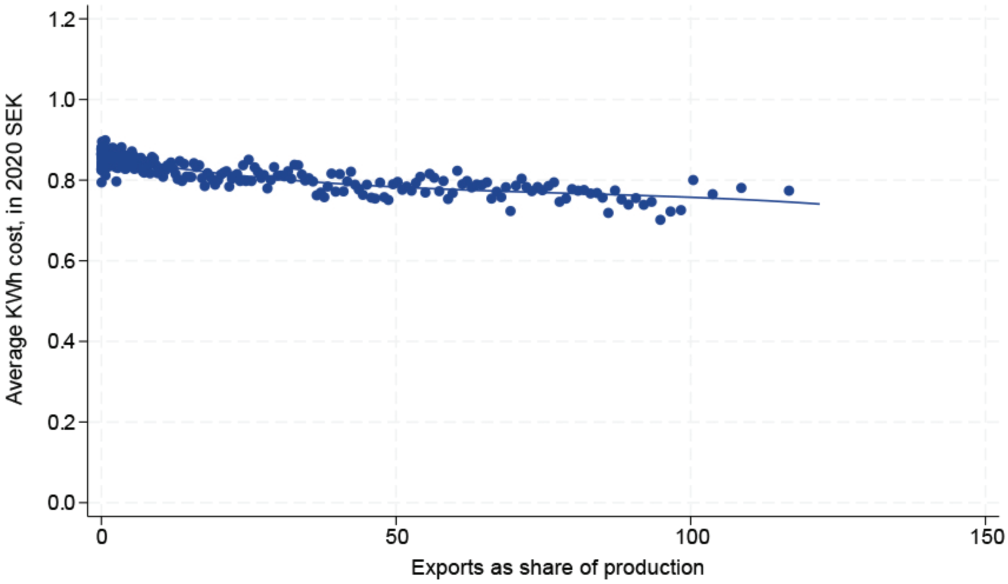
Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported MWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value for each manufacturing subsector.

2.7 Electricity costs by export intensity

This section presents electricity costs for all Swedish firms between 2007 and 2021 based on their export intensity (exports as a share of production). This figure is a so-called *binned* scatterplot, which means that all information for all these individual firms is combined into (up to) 250 dots in the figure. Firms with similar levels of export intensity or trade values are likely to end up in the same dot in the figures. This approach succinctly summarises roughly 58 000 observations into 250 dots and easily conveys a lot of information in a comprehensive manner. It also provides a rough display of correlations between electricity costs faced by the firm, and their export intensity.

The correlation between firm export intensity and electricity costs faced by the firm is displayed in the figure below, where the average electricity cost is plotted against export intensity. Export intensity is calculated as a share of production that is exported. There is a small, negative relationship between these two variables, suggesting that export intensive firms tend to face relatively low energy costs.

Figure 7. Average electricity cost per kWh, by share of exports in production



Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported MWh used in that year. The scatter plot uses for year fixed effects to control for time trends. Exports as a share of production are, as the name suggests, exports divided by the value of production. This can be larger than 100 per cent.

3 Energy intensity of Swedish firms

This section presents an overview of energy intensity between 2004 and 2021, for different subsets of firms. Energy intensity is calculated as the amount of energy MWh used per 1 000 SEK value added.[16] Energy is defined as the sum of electricity and other sources of energy, as reported in the ISEN database. We also use the conversion of gas and other energy carriers to MWh, following the ISEN conversion key.

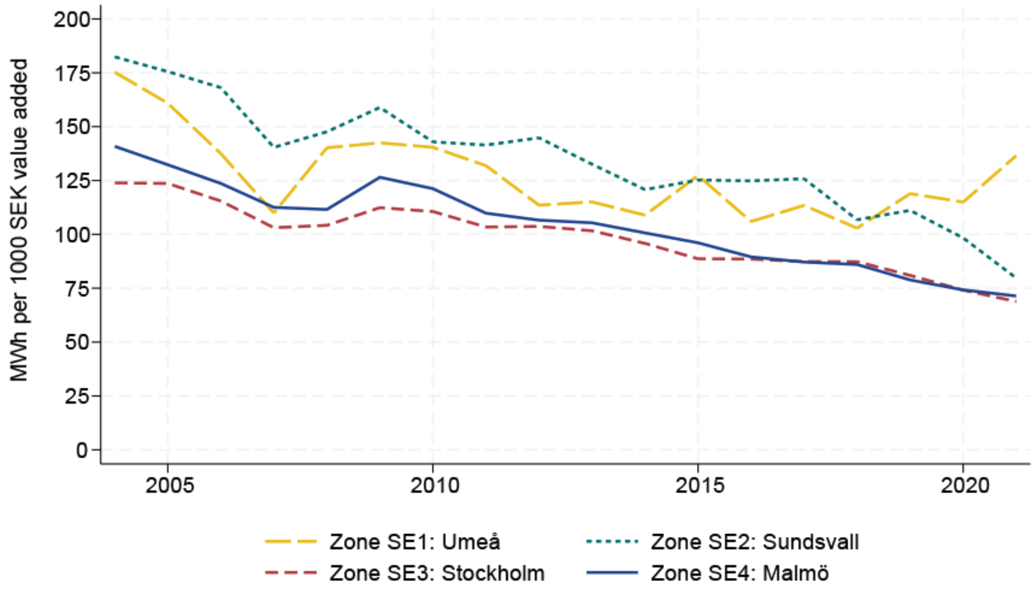
All figures in this chapter use this energy intensity, the same figures for electricity intensity can be found in the appendix. Most, if not all, of the conclusions we can draw from this chapter readily translate from energy intensity to electricity intensity. The appendix also contains the same analysis as in sections 3.1 and 3.2 for firms that survive at least 15 out of the 18 years. This approach will eliminate the potential biased effect of different samples of firms each year. Including only firms that are present in the dataset for at least 15 years means that the *composition effect* is eliminated. All patterns described in sections 3.1 and 3.2 below are also valid for this smaller subset in the appendix.

3.1 Energy intensity by firm location

Energy intensity of Swedish production (value added) is decreasing steadily across the country. The figure below divides this time trend into the four electricity zones. Recall that electricity zones 1 and 2, located in the north of Sweden, have lower electricity costs. At the same time, we see that energy intensity tends to be higher in the north than in the south of Sweden, though this is most likely the result of business decisions that also consider issues unrelated to energy costs. In the two northern zones, the average annual decrease in energy intensity was 2.5 per cent, while the average energy intensity in the two southern regions decreased 3.5 per cent annually.

[16] Note that this definition may be different than what is used in most reports. However, data is only available for the Swedish part of the production value chain (e.g. Swedish value added, and Swedish energy use). Therefore, dividing total energy use by production value leads to biased results, as it only includes foreign value added, but not foreign energy use.

Figure 8. Average energy intensity, by electricity zone

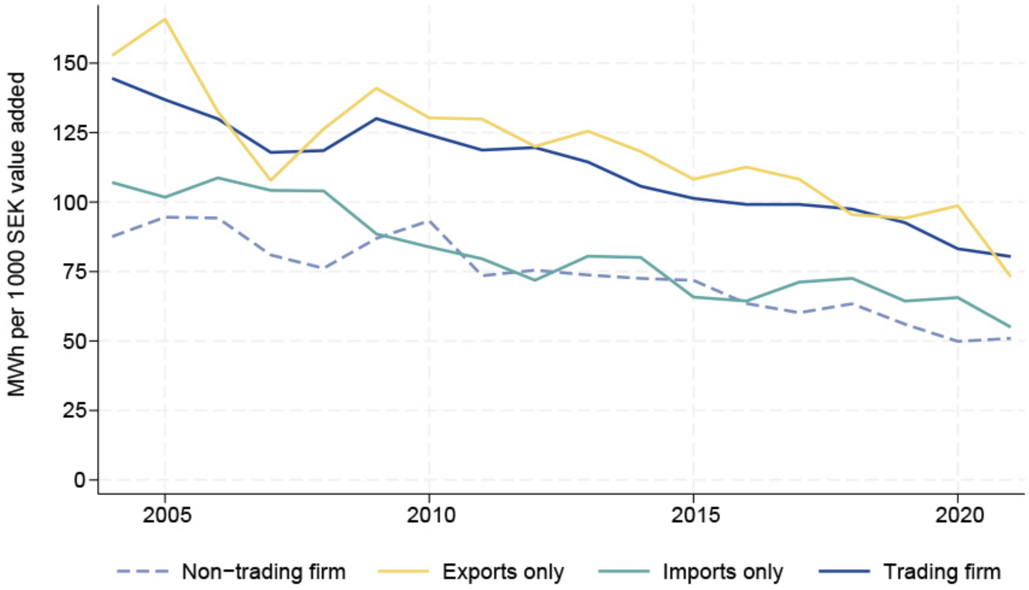


Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added for each firm.

3.2 Energy intensity by firm trading status

When firms are divided into groups based on their trade status (only exporter, only importer, both exporter and importer, non-trading), the figure below shows a similar downward trend over time. That is, all types of firms become less energy intensive. The main take-away is that firms engaged in trade tend to be more energy intensive than those that only import or do not engage in foreign trade at all, and this pattern holds throughout the time period.

Figure 9. Average energy intensity, for exporting and non-exporting firms

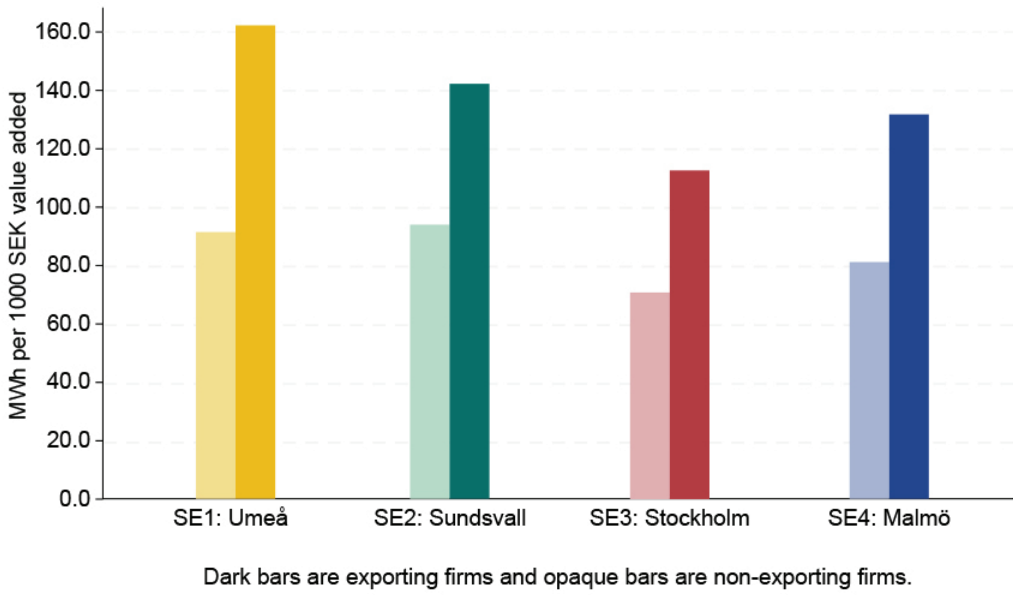


Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added.

3.3 Energy intensity by firm trading status and firm location

Combining the findings in the two figures above, the final division of firms in Sweden is across trade status and by location, that is, electricity zone. Much like we saw in the figure above, firms engaged in foreign trade tend to be more energy intensive than non-exporters, and this holds for all electricity zones.

Figure 10. Average energy intensity, by electricity zone and trade status

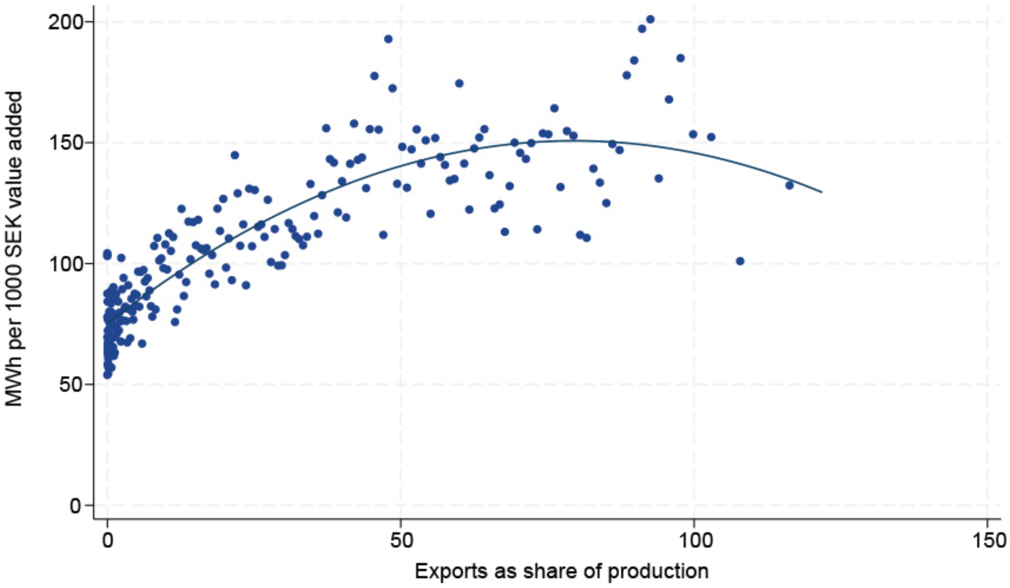


Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added.

3.4 Energy intensity by export intensity

The figure below plots the export intensity of firms against the energy intensity. This figure is a binned scatterplot, see Section 2.2 for an explanation. The pattern that becomes visible here is that firms that are more export intensive (e.g. export a larger share of their production) tend to be more energy intensive. This finding could be related to the finding that export intensive firms are generally larger, and also associated with lower electricity costs (see chapter 2). Linking lower electricity costs and higher energy intensity for more export-intensive firms fits with the narrative that Swedish industry tends to be relatively energy intensive in their exports.

Figure 11. Average energy intensity, by share of exports in production



Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added. The scatter plot uses for year fixed effects to control for time trends. Exports are divided by the reported production value on the horizontal axis. Note that exports as a share of production can be above 100 per cent in some instances (e.g. in case of running down inventory by selling products a year after they are produced).

4 Energy costs and Swedish exports

4.1 How sensitive are Swedish exports to energy costs?

In this section we look at the price elasticity of exports.[17] One should interpret an elasticity as follows: if the estimated elasticity is -1.5, it means that an increase in energy costs by 3 per cent correlates with a decrease in exports of 4.5 per cent.
To account for the heterogeneity across industries, the analysis is conducted at the SNI 2-digit level making up for 64 industries. One expects most price elasticities to be negative, which reflects that an increase in energy costs lowers the competitiveness of domestic firms and therefore lowers exports.

Technical note

To find out how exports react to changing energy costs the following equation is estimated:

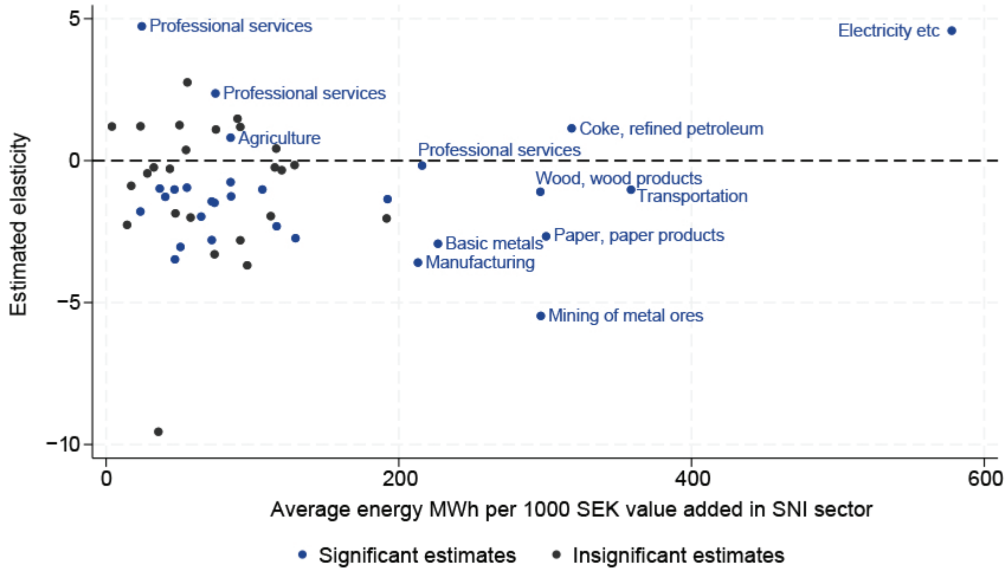
$$\ln(Exports_{i,t}) = \beta \ln(MWh\ cost_{i,t}) + \delta_s + \delta_t + \epsilon_{i,t}$$

for each firm i, in each year t. We also include 5-digit SNI code fixed effects and year fixed effects and estimate this for each of the 64 SNI 2-digit industries. The estimated elasticities are then plotted against the average SNI 2-digit average energy intensities.

The results from the above-described regression analysis are displayed in the figure below. As expected, in most industries exports are falling with increased energy costs. That is, higher costs reduce the competitiveness of these firms on the global market, who therefore experience a decrease in their exports. Contrary to the results for most industries, for five sectors, the estimated price elasticity is positive and significant.
A deeper look suggests that two out of these five are 'special' sectors with a co-dependence on energy prices in the calculation of the price elasticity, the coke and the refined petroleum sector. This could explain the positive calculated price elasticity.
A positive relation is also found for agriculture and the professional services sectors, which is more surprising and could have a variety of explanations (incl. purely statistical) that are beyond the scope of this report.

[17] Note that the technical name of the elasticity is price elasticity and is therefore used in the description of the approach. We still use electricity and energy costs to estimate these elasticities. Recall that costs include prices, but also levies and taxes.

Figure 12. Estimated price elasticities and average energy intensity by SNI-2 sector



Source: Statistics Sweden, calculations by the author. Vertical axis shows the estimated beta term in the regression outlined above. Average energy intensity is calculated as the total reported MWh used in that year divided by value added on the horizontal axis.

4.2 Do higher energy costs lead to increased product prices?

The extent to which firms are able to transfer higher energy costs to higher product prices is called "the cost pass-through rate". In this section we estimate these cost pass-through rates of shocks to energy prices between 2007 and 2021 for Swedish firms.

Technical note

To find out the average cost pass-through rates of Swedish firms, the following equation is estimated:

$$\Delta\, \boldsymbol{ProductPrice_{ipt}} = \boldsymbol{\beta}\Delta\, \boldsymbol{EnergyCost_{it}} + \boldsymbol{\gamma X_{ipt}} + \boldsymbol{\alpha_i} + \boldsymbol{\alpha_{pt}} + \boldsymbol{\epsilon_{ipt}}$$

where the left-hand side is the change in unit prices for product p, firm i, in year t. Similarly, the first term on the right-hand side is the change in energy costs of firm i in year t. Both are indexed to be 100 for the first year that the firm reports this data (the starting year therefore differs by firm). Control variables are included in half the specifications and are the firm-level labour costs and firm-level production values (both in logarithms). Fixed effects are included for firms, and product-year in some specifications and firms, products, and year separately in the remaining specifications.

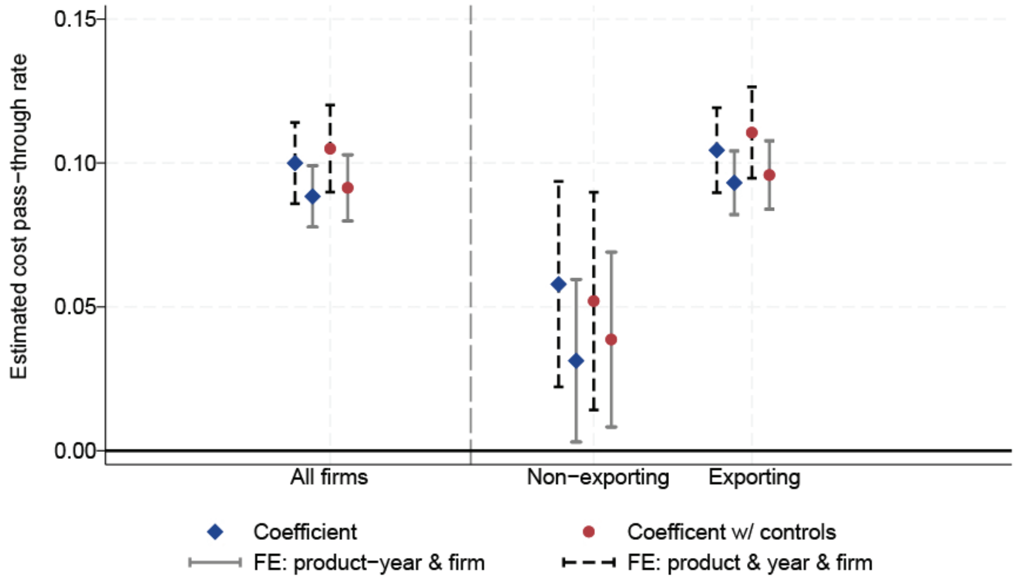
The analysis is divided into three groups: all firms, non-exporters, and exporting firms.[18][19]

[18] Technical note: to estimate the differential cost pass-through rates for non-exporting and exporting firms, we interact the *EnergyCost* variable in the regression outlined in the technical note in the main text with an exporter dummy.

[19] The division in exporting and non-exporting firms is an interesting empirical question. Considering that exporting firms are exposed to international competition, one might suspect these firms to be

The results from the cost-pass-through analysis are depicted in the figure below. The figure shows the results for "all firms" on the left-hand and "exporters" and "non-exporters" on the right-hand side. The results for "all firms" suggest that for every 1 percentage point increase in energy costs, firms are able to pass through/ increase product prices by around 10 per cent. This effect is relatively stable across specifications.

Figure 13. Estimated cost pass-through rates of energy costs on unit prices for Swedish firms



Source: Statistics Sweden, calculations by the author. The left part of the horizontal axis shows the estimated beta term in the regression outlined above, the right part the gamma term below.

The results for exporters and non-exporters are reported on the right-hand side of the figure, and what we find here is that for non-exporting Swedish firms, the pass-through rates found in the table above are about halved. That is, non-exporting firms, that are not exposed to international competition in the same way as exporting firms are, display a lower pass-through of increased energy costs on product prices. For non-exporters, only between 4 to 6 percent of the cost increase is passed on through higher product prices. For exporting firms, the corresponding number is about a 10 per cent pass-through rate, no different from the "all firms" result above.

The conclusion of this analysis is that exporters are better able to pass through increased energy costs, in the sense that a larger share of the cost increase is passed over to the consumers through higher product prices.

more sensitive to changing energy costs than other firms. On the other hand, is has been shown that exporting firms tend to have some kind of market power (Segerstrom, P. S., & Stepanok, I. (2018). *Learning how to export. The Scandinavian Journal of Economics*, 120(1), 63-92.) suggesting that they may be less sensitive to changing energy prices.

5 Conclusion

This descriptive report on the relationship between energy prices and trade, with a firm-level perspective, does not lend itself to strong conclusions or policy recommendations. Caution is warranted, and policymakers should take a wider approach to this question than merely looking at statistical correlations presented here. While market and negotiating power could partially explain the lower electricity costs for larger (exporting) firms, so can government policy through implicit fossil-fuel subsidies. Other factors that are out of the scope of this report play a large role in decisions on how firms respond to energy costs, and how the energy market functions more generally.

However, from a trade perspective, several summarising points can be made.

Electricity costs are:

- generally lower in the northern regions of Sweden;
- generally lower for firms engaged in foreign trade, and this holds for all regions in Sweden; and
- lower for firms that export a larger share of their production.

Energy intensity tends to:

- be higher in production that takes place in the northern regions of Sweden;
- be higher for firms that are engaged in foreign trade, and this holds across all regions; and
- be higher the more the firms export as a share of their production.

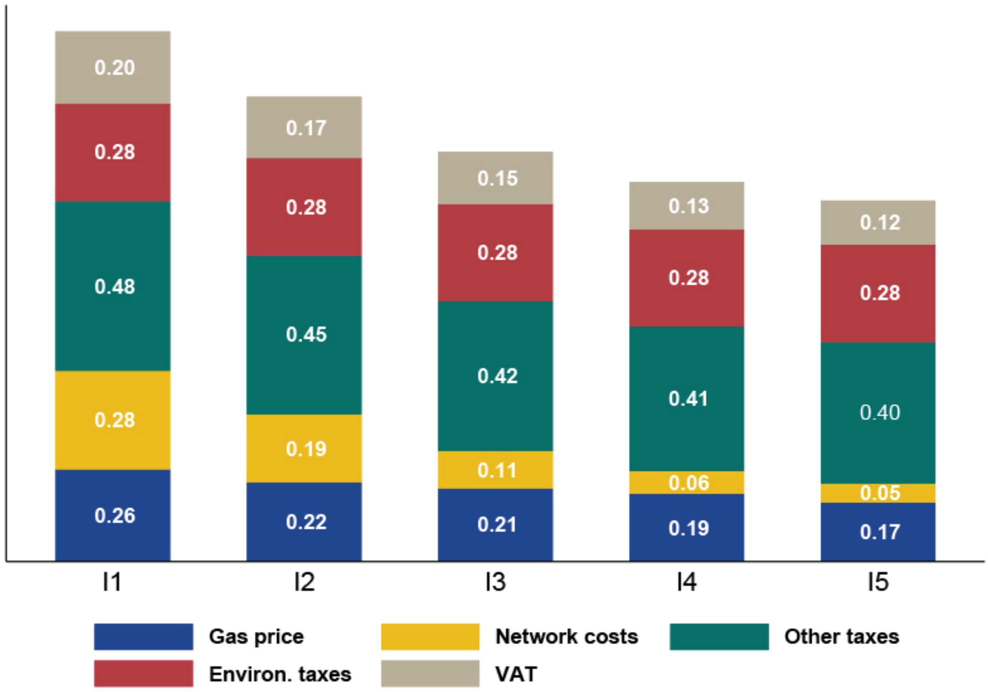
In addition, we identify the following two stylized facts concerning energy costs and trade:

- In most sectors firms export less when energy costs are higher.
- Firms engaged in foreign trade are able to pass on a larger share of their energy cost increases than firms that solely supply to domestic consumers.

6 Appendix

6.1 Additional figures for chapter 2

Figure 14. Breakdown of non-household gas costs in Sweden in SEK per kWh, by type of user (sorted from small to large)



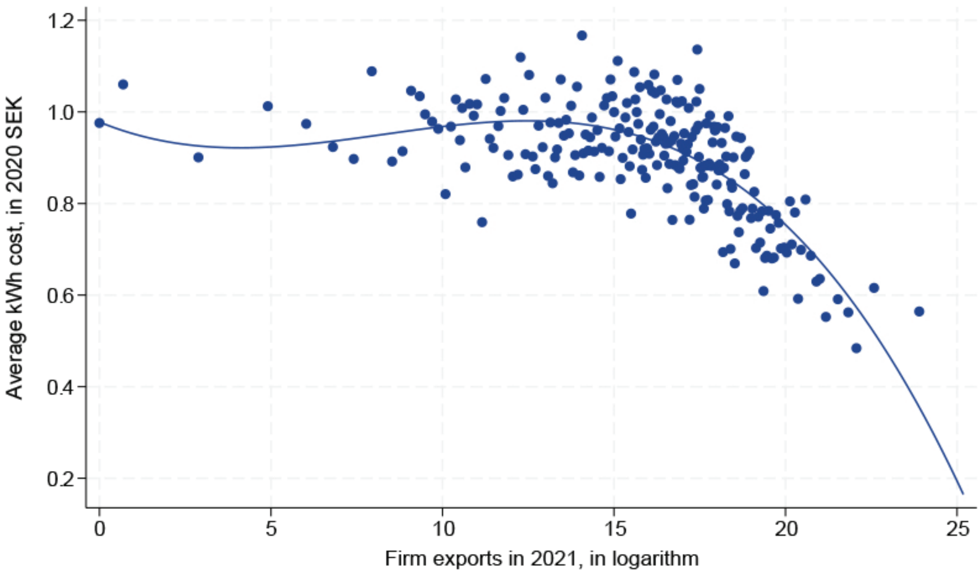
Source: Eurostat table [NRG_PC_205_C], calculations by the author. Labels on the x-axis denote the type of non-household consumer. I1 is a firm that uses less than 1000 GJ per year, and this increases to more than 1 000 000 GJ per year for group I5.

Average electricity costs per kWh, by export and import volume

The figures below show that firms that export and import more tend to have lower electricity costs. Taken at face value, there seems to be little correlation between the value of firm exports and electricity costs until around 10 million SEK worth of exports (see the value of 16 on the horizontal axis below[20]). Above an export value of 10 million SEK, we see that lower electricity costs are associated with (or coincide with) higher export values. While we do not account for differences between (manufacturing) sectors here, these findings coincide with findings earlier in this section, where certain sectors, on average, face lower electricity costs. A similar conclusion can be drawn when average electricity costs are plotted against firm imports.

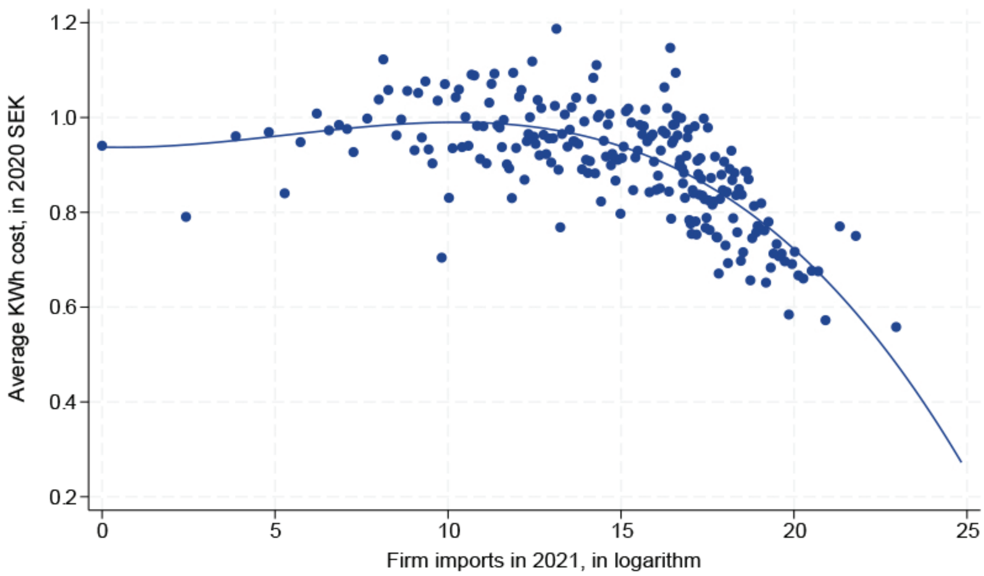
[20] This number is calculated as 10 million = log(16)

Figure 15. Average electricity cost per kWh, by firm exports in logarithm



Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported kWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value. Firm exports are expressed in logarithmic terms.

Figure 16. Average electricity cost per kWh, by firm imports in logarithm



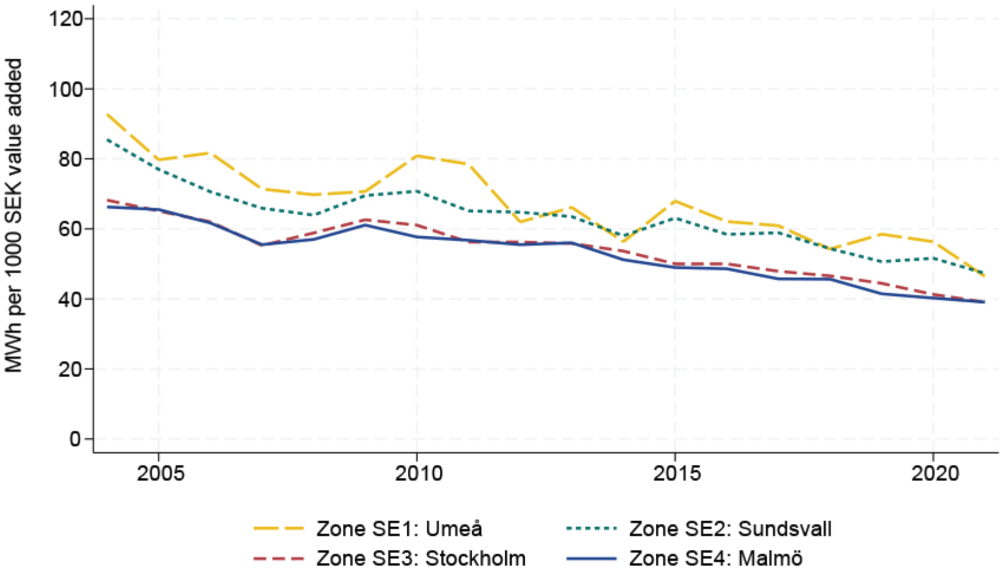
Source: Statistics Sweden, calculations by the author. Average electricity costs are calculated as the total expenditure of each firm on electricity, divided by the total reported kWh used in that year. Averages are created by weighing these firm level electricity costs by the firm's production value. Firm imports are expressed in logarithmic terms.

6.2 Additional figures for chapter 3

Electricity intensity by firm trading status and firm location

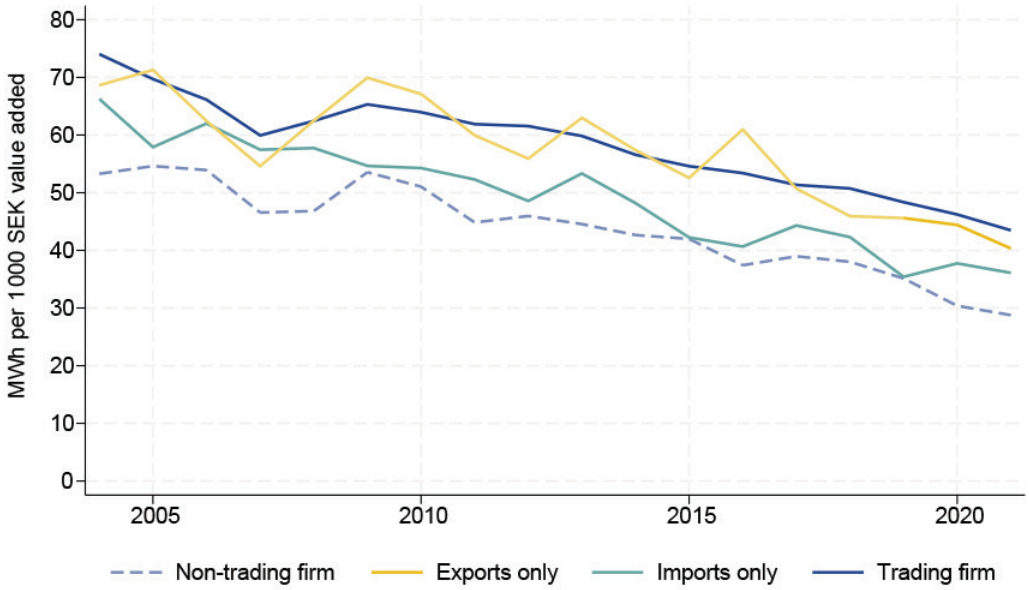
Figure 17. Average energy intensity, by electricity zone

Linear



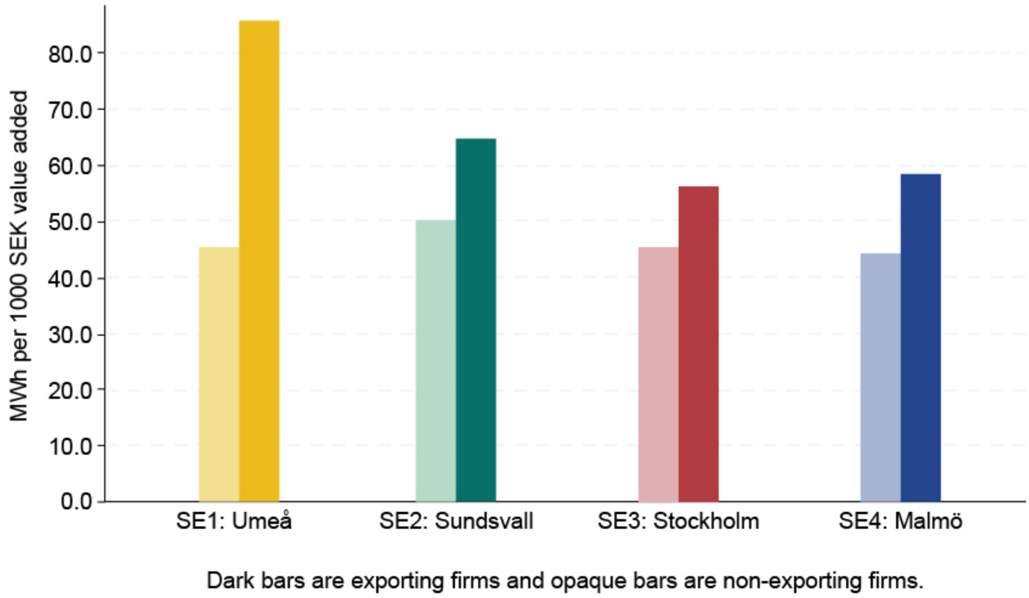
Source: Statistics Sweden, calculations by the author. Average electricity intensity is calculated as the total reported MWh used in that year divided by value added for each firm.

Figure 18. Average energy intensity, for exporting and non-exporting firms



Source: Statistics Sweden, calculations by the author. Average electricity intensity is calculated as the total reported MWh used in that year divided by value added.

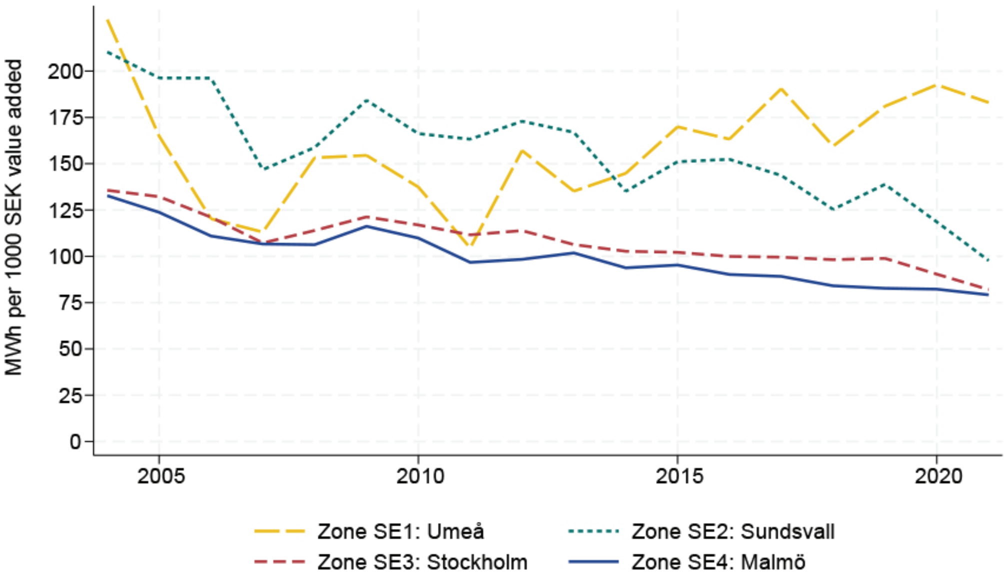
Figure 19. Average energy intensity, by electricity zone and trade status



Source: Statistics Sweden, calculations by the author. Average electricity intensity is calculated as the total reported MWh used in that year divided by value added.

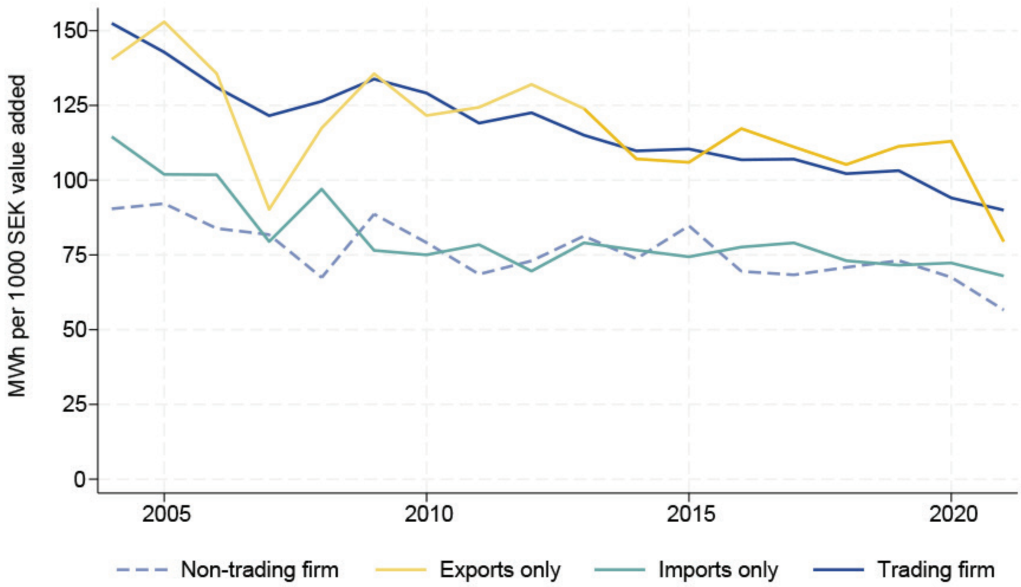
Energy intensity for firms with more than 15 years of data

Figure 20. Average energy intensity, by electricity zone for surviving firms



Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added for each firm.

Figure 21. Average energy intensity, for exporting and non-exporting firms for surviving firms



Source: Statistics Sweden, calculations by the author. Average energy intensity is calculated as the total reported MWh used in that year divided by value added.

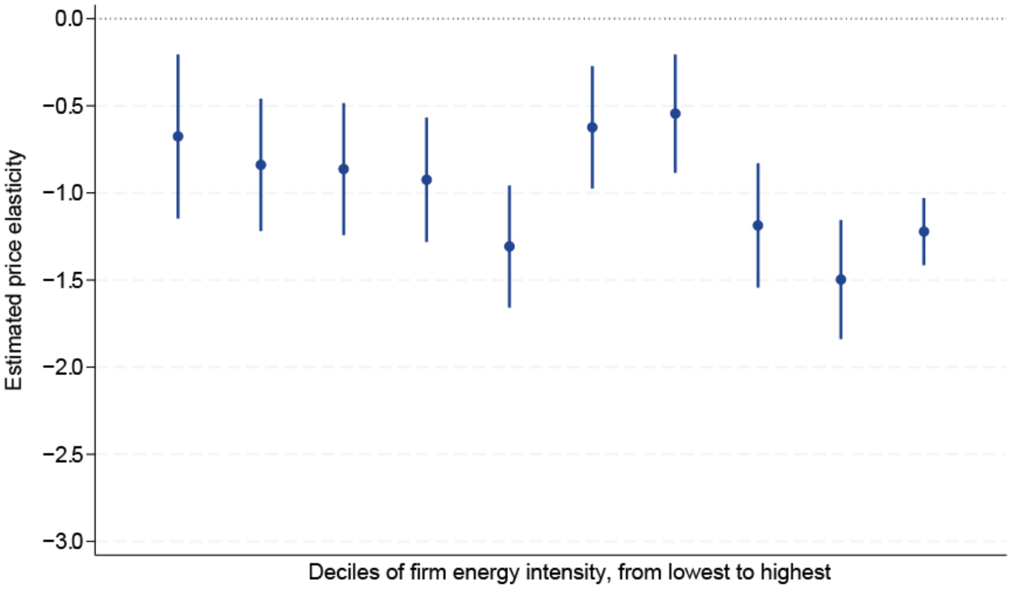
6.3 Additional analyses

Price elasticities by decile energy intensity

In the figure below, we estimate the regression in section 4.1 for each of the 10 deciles of firm-level energy intensity. That is, all firms are assigned a decile, with the least energy-intensive firms in decile 1 and the most energy-intensive firms in decile 10. Estimated price elasticities are plotted for each decile.

Exports of energy-intensive firms are more sensitive to energy price changes than non-energy-intensive firms. However, the estimated price elasticities for the vast majority of firms (e.g. at least the 80 per cent least energy-intensive) are very similar to each other. The average estimated price elasticity for these 80 per cent is around -1.2, which means that if energy costs increase by 10 per cent, exports decrease by around 12 per cent.

Figure 22. Estimated price elasticity for each decile of firm-level energy intensity



Source: Statistics Sweden, calculations by the author. The vertical axis shows the estimated beta term in the regression outlined above. The horizontal axis is split in 10 deciles, based on the firm-level energy intensity calculated as the total reported MWh used in that year divided by value added. The first decile on the left includes the least energy-intensive firms, the one on the right includes the most energy-intensive firms.

Energy price elasticities of demand

The energy price elasticity of demand is a measure of sensitivity of demand on price changes. A cross-price elasticity of demand denotes changes in demand for one product because of price fluctuations in another. Using firm-level energy consumption and costs, we can estimate the own-price elasticity of electricity and energy demand, but also the cross-price elasticity of electricity and energy demand. The generic regression for this analysis is:

$$\ln\left(consumptionX_{i,t}\right) = \beta \ln\left(costX_{i,t}\right) + \gamma \ln\left(costY_{i,t}\right) + \delta_i + \delta_t + \epsilon_{i,t}$$

where the left-hand side of the equation is consumption. X is either electricity or non-electricity energy (e.g. gas, district heating). The right-hand side of the equation contains the costs for good X and Y, where Y is the other good. Therefore, the β terms will provide the own-price elasticity, and the γ terms the cross-price elasticity.

Estimating the equation above for electricity results in an own-price elasticity of -0.2 and a cross-price elasticity around 0. These results indicate that 1 per cent higher electricity costs are correlated with 0.2 per cent lower electricity demand. Cost changes in non-electricity energy seem uncorrelated with electricity demand.

Estimates of similar magnitudes arise from an analysis for non-electricity energy demand. The own-price elasticity for non-electricity energy demand is -0.4, whereas the cross-price elasticity is 0.1 per cent. Changes in electricity costs do not seem to affect demand for non-electricity energy.

Sammanfattning på svenska

Summary in Swedish

Energikostnaderna för svenska hushåll och industrier ökade kraftigt efter den ryska invasionen av Ukraina. Förändringar i energikostnader kan påverka svenska företags konkurrensställning på internationella marknader och därför är det högst relevant att analysera sambandet mellan energikostnader, produktion och handel. Denna rapport syftar till att ge en bakgrundsförståelse för dynamiken mellan energikostnader och svensk industriproduktion och handel sedan 2004.

Genom att använda data om energikostnader, energianvändning, produktion och internationell handel på individuell företagsnivå identifierar rapporten flera beskrivande samband:

- Elkostnaderna är generellt sett lägre i de norra delarna av Sverige, där också mer energiintensiva industrier finns.
- Elkostnaderna är också lägre för företag som bedriver internationell handel, och detta gäller för alla regioner i Sverige.
- Svenska exportföretag är sannolikt mer energiintensiva än svenska företag i allmänhet, och energiintensiteten är generellt sett högre för företag som exporterar en större del av sin produktion.
- Företag som handlar internationellt kan sannolikt föra över en större del av sina energikostnadsökningar till slutkonsumenterna.

De beskrivande resultaten av sambandet mellan energikostnader och handel räcker inte för långtgående slutsatser eller policyrekommendationer. För att kunna dra slutsatser inför eventuella policyåtgärder behöver annan analys göras utöver de statistiska samband som presenteras i den här utredningen. Till exempel kan företagens marknads- och förhandlingsstyrka delvis förklara de lägre energikostnaderna för större (exporterande) företag, men det kan också vara regeringens politik, till exempel implicita fossila bränslesubventioner eller andra energisubventioner, som är orsak till skillnaderna i företagens energikostnader.

The National Board of Trade Sweden is the government agency for international trade, the EU internal market and trade policy. Our mission is to facilitate free and open trade with transparent rules as well as free movement in the EU internal market.

Our goal is a well-functioning internal market, an external EU trade policy based on free trade and anopen and strong multilateral trading system.

We provide the Swedish Government with analyses, reports and policy recommendations. We also participate in international meetings and negotiations.

The National Board of Trade, via SOLVIT, helps businesses and citizens encountering obstacles to free movement. We also host several networks with business organisations and authorities which aim to facilitate trade.

As an expert agency in trade policy issues, we also provide assistance to developing countries through trade-related development cooperation. One example is Open Trade Gate Sweden, a one-stop information centre assisting exporters from developing countries in their trade with Sweden and the EU.

Our analyses and reports aim to increase the knowledge on the importance of trade for the international economy and for the global sustainable development. Publications issued by the National Board of Trade only reflect the views of the Board.

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