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The Many Channels of Firm's Adjustment to Energy Shocks: Evidence from France

In this policy brief, Lionel Fontagné and his co-authors study how French manufacturing companies have reacted to changes in energy prices over a long period. This granular approach, made possible by highly detailed new data, highlights the many channels (energy demand, export competitiveness, activity reallocation) through which manufacturing companies adjust to energy price rises.

Contrary to early warnings in the wake of the Covid crisis and the start of the invasion of Ukraine, energy prices have peaked in 2022 without triggering the sudden drop in industrial production that was feared in Europe. This foreshadows adjustments that do not primarily involve production cuts, but other channels. The way in which the European economy might adjust and adapt to a Russian energy embargo has been analyzed in a series of papers (Bachmann *et al.*, 2022; Baqaee, Ben Moll *et al.*, 2022; Moll, Schularick, and Zachmann, 2023). In a recent work (Fontagné, Martin and Orefice, 2023), we provide new evidence on how French manufacturing firms and plants reacted to changes in energy price over a long period. This granular approach highlights the many channels through which manufacturing firms adapt to energy price hikes, including the pass-through of these prices into export prices and the resulting impact on the competitiveness of French exporters.

Statistics on corporate energy consumption and prices

We combine plant and firm level data for the period 1996-2019 on energy consumption from the annual survey on energy consumption (EACEI) with information on output, employment, energy efficiency, exports and imports from balance sheets and custom data. One limit of using historical data to shed light on the recent crisis is that idiosyncratic firm level shocks occurred up to 2019 can be different from the aggregate shock experienced in Europe in 2022. Therefore, past channels of adjustment may not be identical, qualitatively and quantitatively, to those of 2022. However, some year-on-year energy price shocks experienced by French plants during the period 1996-2019 are in fact comparable to the price rises observed during the recent energy crisis. After considering the increase in the price of manufactured goods (excluding energy), the real energy price increase that French companies had to face over the period March 2022-March 2023, relative to the average price in 2019, was around 30% for electricity and

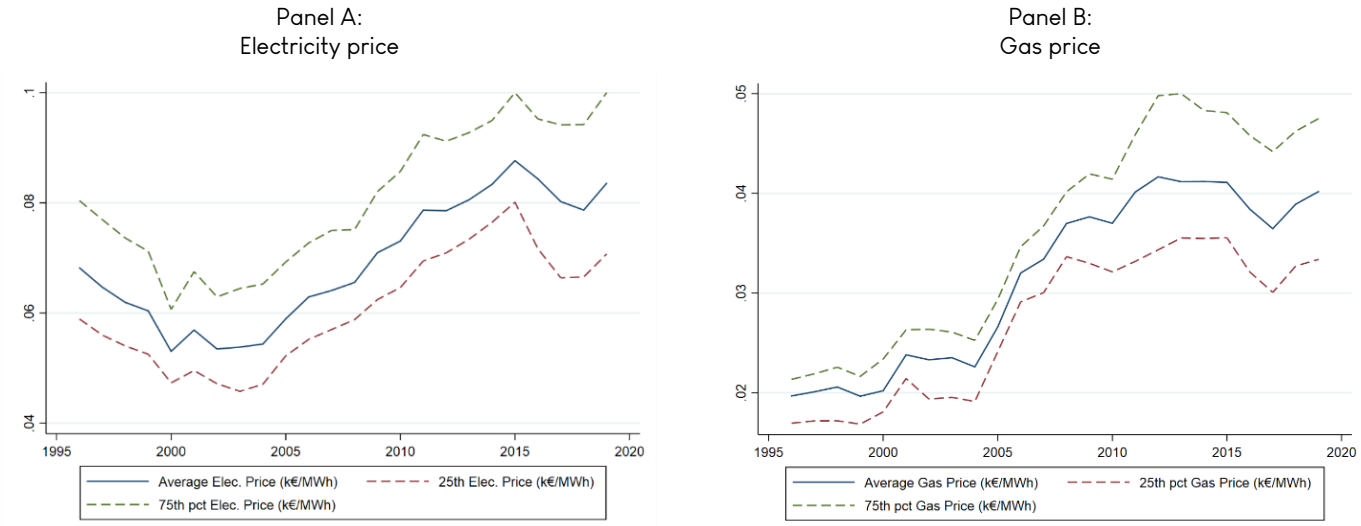
and 100% for gas. These statistics are comparable with price peaks observed in the period 1996-2019. Indeed, the upper quartile of annual price variations at plant level in our sample is 36.2% for electricity and 53.1% for gas.

But how did such price increases materialize over the period 1996-2019? One of the main characteristics of the French electricity market is that many contracts coexist with regulated and market-determined prices. Over the analysis period, several regulatory changes have interacted with market movements. Firms can pay **regulated electricity prices or market prices**, have several contracts with several producers (for example multi-plant firms), and may also produce their own electricity. Importantly for us, many changes in regulations occurred during the period covered by our data, meaning that many different electricity rates co-existed and were affected by several changes. Finally, the electricity price also depends on several taxes, in relation to distribution and transport which are complex, firm specific and change every year. Additional taxes can even vary at the city and department level. All these peculiarities contributed to decorrelate price changes across firms. Also, yearly price changes can be large for firms shifting from one contract to another of facing market price swings that we interpret as mostly exogenous to the evolution of firm characteristics.

France as a quasi-natural experiment to test the impact of energy price shocks on firms

The plausibly exogenous expiration date of contracts with energy suppliers means the time variation of prices is quasi-random. These features of the institutional context make France a nice laboratory to test the firm-level consequences of energy price shocks. This context is illustrated in *Figure 1* where we plot the average electricity (panel A) and gas (panel B) price in our sample, as well as the price paid in the 25th and 75th percentiles of the distribution respectively. For instance, in 2015 we observe a 20 percent difference in the electricity price paid on average by these two subgroups of firms.

Figure 1.
Electricity and gas price over time, manufacturing firms, France



Source: EACEI data.

Taking benefit of this granular information, we estimate the effect of gas and electricity price shocks on firm level energy demand, energy efficiency, export prices, exports, employment, production and profits of French firms. Identification challenges have to be addressed, but the data at hand combined with a conservative estimation strategy leads to sound estimates. The main identification challenge is that firms choose their energy provider, the energy contract that best fits their activity and anticipation of future prices, and they negotiate the energy price provided they have some market power. For these reasons, the level of the price paid by a firm is likely endogenous to its intrinsic (time-invariant) characteristics, which can easily be absorbed by firm fixed-effects. In addition, the French institutional context implies that the changes in the energy price of firms can be considered exogenous to the firm: the evolution of electricity and gas prices of a firm with long-term contract partly depends on its expiration date, which is arguably exogenous to firm-specific characteristics and/or economic shocks. A last concern is that unobserved firm-specific shocks may affect the negotiation of the energy price when the new contract is signed, which raises an endogeneity issue. The latter is addressed using alternatively the lagged price of electricity (or gas) as an independent variable or an instrumental variable strategy and a standard Bartik (shift-share) approach.

It is important to note that we can distinguish between electricity and gas shocks: electricity shocks affect employment and output in all companies, while gas shocks affect only the most gas-intensive companies, which account for a small proportion of manufacturing output and employment. Yet in the current crisis, electricity prices in the manufacturing sector have risen much less than gas prices.

The many channels of adjustment to energy shocks

Our empirical results suggest that firms respond to an energy price shock by reducing their **energy demand**. This is intuitive but the response is surprisingly large. Over the whole period, our preferred (and conservative) estimates of the average elasticity of demand at the firm level are around -0.4 for electricity and -0.9 for gas. Meaning that a 10% increase in the price of electricity and gas implies respectively a 4% and 9% reduction in the demand of electricity and gas. Only a small part of the fall in energy demand comes from a fall in production, which is consistent with the observed resilience of the manufacturing sector. For large price shocks, more similar to those experienced in 2022, elasticities are smaller and equal to -0.2 for electricity and -0.7 for gas but still quantitatively (and statistically) significant. In addition, the price elasticity of energy demand has decreased over time due to improved energy efficiency. While our results suggest a significant adjustment of firms' demand to energy price shocks, it also implies that in the current crisis, we should be more cautious and use lower (in absolute terms) but still non-zero energy price elasticities.

A second result is that manufacturing firms pass-through the full impact of energy costs shocks into their (export) **prices**, as also observed by Lafrogne-Joussier, Martin and Méjean (2023). This in turn reduces their competitiveness and entails a fall in demand for their products. To compensate this competitiveness loss, a 7% (3%) bilateral depreciation of the euro would be necessary. In the present crisis, although the euro has depreciated in real effective terms (around 3% according to the ECB in 2022 relative to the 2019-2021 period), this has clearly not compensated the energy price shock.

The competitiveness loss translates into a sizable fall in **export quantities**. The impact is consistent with the **international price elasticity around 5** already reported in previous work (Fontagné, Martin and Orefice, 2018). The impact of changes in the price of energy is large: a 10% increase in electricity (gas) prices reduces exports quantities by around 2% (1%). This generates a fall in production and employment, which is consistent with the size of the price increase. For example, a 10% electricity price increase translates at the firm level into a 1.6% and 1.5% fall in production and employment. **Energy efficiency** increases at the firm level. Profits fall but modestly or only for the most gas intensive firms. Overall, we interpret these results as a suggestive that firms are able to adjust and adapt strongly to the energy shock.

Another adjustment channel we highlight is that **multi-plant firms relocated their energy demand** (and probably their production) to plants that benefit from lower energy prices, and/or to less energy intensive plants. We also show that French manufacturing firms increased their imports of intermediate inputs (probably those that are more energy-intensive): for electricity price shocks, firms increased their imports of intermediate inputs as a consequence of substitution towards lower energy price sources of production.

Conclusion and implications

To put these results into perspective, note that manufacturing companies have become more resilient to energy price shocks: the impact of these shocks on employment, output and profits has been reduced over time. For example, over the 2012-2019 sub-period (the closest in our sample to the energy crisis), the impact of energy price shocks on employment and output is close to zero and insignificant, in contrast to the beginning of the period (1996-2003) when it was negative and significant. Our interpretation is that companies adapted their technology and production processes to the upward trend in energy prices illustrated in *Figure 1*, and that a selection process eliminated those unable to adapt.

The adjustment mechanisms we have identified from pre-crisis data are consistent with post-crisis survey data. For example, the French National Institute of Statistics (INSEE) documents that, faced with the energy shock, French manufacturing companies adapted their production methods (38%) and invested to reduce or optimize their consumption (29%).

What implications can we draw from these results in terms of economic policy? Clearly, our results make a distinction between short- and long-term policies. In an emergency, European governments adopted policies aimed at cushioning the energy price shock for some manufacturing companies. There are discussions on whether and how to subsidize energy costs for manufacturing firms in some European countries. The concern is valid as we show the competitiveness impact of energy costs is significant in terms of lost exports. In the longer term, the attractiveness of a domestic location could also be at stake for energy-intensive manufacturing producers. However, subsidies would be very costly, potentially inconsistent with climate objectives and unlikely to be sustainable in the long term. Given the observed ability of companies to adapt to energy price shocks through energy efficiency, public financing should be used to support the transition to cleaner and cheaper energies and technologies that are less dependent on energy imports.

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