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Energy price risk and the sustainability of demand side supply chains

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HIGHLIGHTS

- Energy is an increasingly significant production input due to rising and increasingly volatile prices.
- Technical risks from volatility in prices can impact the stability of individual firms and their supply chains.
- Extended temporal commitments in energy supply contracts reduce the flexibility of firms in managing price changes.
- The capacity to transfer price movements through the chain is reduced due to embedded understandings.
- Some key inputs, such as energy, have more significant and differentiated impacts on different firms' performance.

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ABSTRACT

Energy is a critical input for production industries. As production becomes increasingly fragmented the management of inputs along the supply chain is a significant factor to stability and the competitiveness of the individual firm and the wider chain. Sustainable supply systems will require changes in how energy is managed particularly to ensure energy security. Rising and increasingly volatile industrial prices create technical price risks to individual firms and the supply chains they are within. A comparison is made between the management of metal and energy price volatility in the intermediate metal processing industry (IMP) in the West Midlands, UK. Results indicate significant variance between the management of price risks from the inputs due to the structure of the supply market, the political-economic context of energy as a carbon source and industrial conventions within the sector. Interdependence between economic actors in the demand-side supply chain can generate risk to the competitiveness of the firm and supply chain from the ability to transfer, or share, price changes in energy inputs through the supply chain. This is an important aspect of energy security in demand-side chains that threatens the sustainability of industrial activity.

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1. Introduction

Energy security takes a holistic approach to the systems of energy supply and demand. The consumption of energy is an important, and increasingly relevant, aspect of energy security. Energy security is progressively challenging the competitiveness of national economies, but is also a sector-based and firm level issue. For countries, energy security is particularly important for energy intensive economic activities that play a critical role in advanced manufacturing supply chains, for example aerospace and automotive, and account for 70% of industrial energy use [1]. At the firm-level energy security and related volatility enhances uncertainty and may undermine investment in capital equipment and research and development. As the energy environment changes and low cost, stable and sustainable energy inputs are not guaranteed, the interdependency of energy and the performance of production systems, and the firms within it, needs to be incorporated into supply chain management [2].

Energy (gas or electricity) purchased for production has seen significant price rises globally since 2002 [3]. Energy costs have increased for the European Union (EU) by 5.8% in 2012 alone and have been consistently rising on average across the EU over the past five years [4]. In the United Kingdom (UK) there has been a transition towards higher and more volatile wholesale prices of gas since 2004 [5], generating a relatively volatile retail price market. The UK has the fourth most volatile retail industrial gas and electricity price relative to EU and Organisation for Economic Co-operation and Development (OECD) countries (22 selected with data available): the standard deviation of the annual natural log of price is just under 30% for electricity and 45% for gas between 1990 and 2010 [6]. Price volatility in becoming a more consistent feature of regional gas markets and the large-scale transition to using gas as a

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back-up fuel for stable electricity generation is increasing the volatility in demand [3]. Although gas prices have reduced considerably in the US from the development of unconventional gas sources [3], the limited storage capacity in the UK means that its development in the UK is unlikely to stabilise prices significantly [7]. Global demand for energy is forecast to increase substantially over the coming decades, most notably driven by emerging economies [1]. Alongside this, regional price differences in gas, and largely electricity, are forecast to be significant at least until 2035, accentuating competitive differences in the industrial bases of global economies [1].

Energy use in production chains has been thought of in terms of logistics rather than a strategic concern for the performance of the supply chain [2,8,9], as production systems have been constructed on the assumption of affordable and available energy inputs [2]. There is increasing focus now, however, on the role of energy in affecting the productivity and competitiveness of a supply chain [4,10,11]. Particular attention is given to the potential for demand side management techniques, such as energy efficiency of products and process [12], responsive consumption of energy in response to market signals through smart metering and alternative technologies [13] and also as revenue generating streams, either indirectly through the production process [14] or directly from alternative energy technologies [15]. However, these demand-side management techniques do not reduce the vulnerability of production systems to energy security: dependence on energy in the production system increases as slack is removed from the system and the relative value of energy becomes more significant [8]. Demand characteristics and dependency play a critical role in shaping the vulnerability of demand-side supply chains to the availability and affordability of energy sources [8,16].

As supply chains become increasingly complex the potential for risks to stability, disruption and efficiency increases [17,18]. The development of carbon reduction political agendas, deregulation of supply markets and rising energy costs has transformed energy into a complex and volatile commodity input, influenced by multiple markets and legislation. The security of energy as a production input is influenced by availability and affordability, often dependent on the specific characteristics of usage [16]. Energy security poses several risks to business continuity, including technological, financial and regulatory burdens from taxation schemes, pressures on margins, brand management and operations [10]. Price volatility is a particularly relevant consideration for the security of energy systems because changes in input prices generate a technical risk that can be compounded through the supply chain [16] and potentially cluster in different industrial sectors of the economy [19]. Technical risks have direct implications for the survival of individual firms and the sustainability of supply chains that come from the (in)ability of firms to manage energy prices within the chain. The impact of price volatility is also exaggerated in periods of rising prices as percentage changes equate to larger monetary values [3]. The complexity of the supply chain accentuates this risk as connections (transactions between firms) and purchasing agreements, both for supply inputs and products, shape how risk is managed and transferred along the supply chain [20,21].

The focus has been to examine aspects of energy security such as governance, responsibility, internationalisation and time, space and scale that can build an appreciation of wider system security [22,23]. Although these aspects provide an appreciation of a systems approach that extends the analysis through the supply chain and over time and space, it is limited in its incorporation of interdependency in the system between individual actors; be that firms, industries or regions. This is a distinct characteristic of demand-side supply chains. To illustrate the influence of interdependency in the use of energy as a production input a comparison of the management of metal and energy price volatility within demand-side supply chains is provided. A case study of the intermediate metal processing (IMP) industry in the West Midlands region of the UK is used to illustrate the different approaches to these commodities and the resultant risks created within supply chains. The industry produces semi-manufactured products and components for further manufacture and as such, the industry is an intermediate supplier to other manufacturers and part of extensive global production systems. In addition, the industry is a relatively large consumer of energy and therefore energy is a critical input, representing on average 8.6% of the cost base [21].

The following section outlines the methodology of the research process, followed by an overview of the intermediate metal manufacturing industry in the West Midlands, UK. A detailed overview of two of the industry's primary inputs is then provided; metal and energy. Following this, the role of energy as an input in the sustainability of supply chains is explored and finally concluding comments made.

2. Methodology

An intensive industry study was conducted from July 2009 to October 2010 on the IMP industry in the West Midlands. The industries were identified using the 2003 UK Standard Industrial Classification (SIC) code that represents the principal activities undertaken by the firm, SIC 27.5 and 28.4 for casting and forging activities respectively. A population of firms in the industry was constructed based on Companies House records of VAT registered companies and combined with additional trade registers and searches to increase the accuracy of the population (total of 153 firms), which is considered the most effective method for constructing industry populations [24]. A random sampling procedure was then undertaken to generate a sample of 45 IMP firms (29.4% of population in West Midlands, 3.8% of UK population) based on an average response rate of 61.1% throughout the study (Table 1).

In-depth qualitative interviews were conducted with operational managers at each firm (supplementary interviews were undertaken with additional firm representatives where possible), generating a total of 54 interviews of between 45 and 120 min each. Interview topics were framed by prior discussions with industry representatives from trade bodies and focussed on the challenges facing the industry, including the management of energy and metal inputs. During this stage of research it was identified that inter-firm relationships within the supply chain were significant to the management of these commodities. IMP firms experienced difficulty in managing commodity price movements independently and sought to engage their direct customers in the issue.

Case studies were used to examine causal relationships in interviews for explanatory clarity [26,27] and to examine the phenomena from another perspective [28]. A series of ten interviews were undertaken with customers and suppliers identified from the interview data that were significant trading partners to the industry, generating five direct transactional case studies (limited by data availability on trading partners) and five industry significant trading partner interviews to provide context. Due to the prominence of trading relationships identified in the first stage, case studies were used to examine these relationships and transactions, specifically exploring the transfer of risks between parties. The case studies were purposefully selected based on the significance of the relationship to the IMP firm (based on value of turnover) to provide the greatest access to these topics and trading relationships. Cross-case analysis was undertaken through matched transactions using multiple trading partners from the IMP sample where possible to increase the validity of the findings. The results are not intended to be representative but provide an exploratory analysis of the dynamics of the IMP industry and its wider supply chains around energy and commodity management.

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