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.

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...
back-up fuel for stable electricity generation is increasing the volatil-
ity 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 de-
mand 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 fore-
cast 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], responsible consumption of energy in response to
market signals through smart metering and alternative technolo-
gies [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 manage-
techniques do not reduce the vulnerability of production sys-
tems to energy security: dependence on energy in the production
system increases as slack is removed from the system and the rel-
ative value of energy becomes more significant [8]. Demand char-
acteristics and dependency play a critical role in shaping the vul-
erability 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 multi-
ple markets and legislation. The security of energy as a production
input is influenced by availability and affordability, often depend-
ton 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 volatil-
ity is a particularly relevant consideration for the security of en-
ergy 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 sur-
vival 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 peri-
ods of rising prices as percentage changes equate to larger mone-
tary values [3]. The complexity of the supply chain accentuates
this risk as connections (transactions between firms) and purchas-
ing 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 sys-
tem approach that extends the analysis through the supply chain
and over time and space, it is limited in its incorporation of inter-
dependency 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 com-
modities 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 intermedi-
ate 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, repre-
senting 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 manu-
facturing 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 con-
structing 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 opera-
tional 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 en-
ergy and metal inputs. During this stage of research it was identi-
fied 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 inter-
views for explanatory clarity [26,27] and to examine the phenom-
ena 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 indus-
try, 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 promi-
nence 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 relation-
ships. Cross-case analysis was undertaken through matched trans-
actions 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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