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Article

Big data-driven Market-Oriented Information System for the Internationalisation and Strategic and Sustainable Management of SMEs

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Abstract: There have been many discussions on the globalisation of SMEs, but it is true that there is not enough academic achievement after such the study of Born global (BG) ventures. The internationalisation of SMEs (Small and Medium Enterprises) is not easy because they lack resources or capabilities compared to multinational corporations. This study investigated the role of government in assisting the internationalisation of SMEs. In particular, SMEs lacked the ability to acquire market-oriented information, so we've established the scheme of efficient information support system for the internationalisation of SMEs. In other words, we proposed an information analysis system through the establishment of a relational database constructed for market-oriented information support. KISTI (Korea Institute of Science and Technology Information), which is one of the government-funded research institutes in the Republic of Korea, provided information support to the SMEs dealing with hydrazine related products. This study suggests this case for the market-oriented information support of the government in the internationalisation of SMEs. The research on information support of the government is meaningful in that it suggests a way to support SMEs in practical level.

Keywords: Internationalisation of SMEs; Big data; Market-oriented information; Relational database; Supply chain network; Optimized database; Trade condition; Data visualization

1. Introduction

SMEs account for a significant portion of the economy. In the OECD economy, SMEs and microenterprises not only account for more than 95% of enterprises and 60-70% of employment and 55% of GDP but creating new jobs as well [1]. Also, European Commissioner Günther Verheugen announced at a press pack from 2006 as following; "SMEs are the backbone of the European economy and the best potential source of jobs and growth," [2]. In Korea, similarly, the number of small and medium-sized enterprises comprised 99.9% of the total industry, and those engaged in SMEs also account for 90.2% by statistics in 2015 [3]. In other words, in every country in the world regardless of the development stage, from this perspective based on the fact that SMEs account for the majority the

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number of companies and employment, it is said that the main character of the economy is not a large company but an SME. The researches and policies that have been focused on economic growth centred on large corporations can be said to be due to the mistaken or exaggerated interpretation of 'modernity.' Instead, it is a problem today that we overlook the fact that economic growth has become more active in regions and clusters where traditional SMEs have developed [1, 4].

Meanwhile, it is accepted that the participation of SMEs in the internationalisation of production should be revitalised in the era of globalisation as a consensus of many researchers [5-17]. Researches on the importance of geographical expansion, namely globalisation or internationalisation, to strengthen the growth of SMEs have been actively conducted around the 1990s. Globalisation refers to the operation and management of a company at an international level outside of a specific region and country. As market globalisation accelerates, market conditions, including marketing, distribution, production, and so forth, are changing drastically, companies are faced with a global competition system because of the pressure and hurdles of traditional exports [19-20]. Thus, according to Barringer and Greening [17], such an international (or geographical) expansion is essential to the growth of SMEs, even for the SMEs that focus on local markets and have limited geographic areas of activity.

However, studies on the internationalisation of SMEs are still relatively insufficient in the literature [18-21]. Of course, research on the internationalisation of SMEs has also made remarkable achievements on specific topics over the last decades, such as international entrepreneurship [16], born-global ventures [22-23], and newly emerging international venture companies [24]. Nevertheless, there are still numerous issues not yet revealed in this field. That is because researches on international management (IM) and international business (IB) have been concentrated on Multinational corporations (MNCs) rather than SMEs [21].

Simon [25] argues that the export competitiveness of a particular country is determined by a "hidden champions," which are innovative SMEs relatively unknown to the general public than large corporations, though, dominating the world market in each field. Even, the interests in 'Born-global' start-ups, which have entered into international business (especially exports) from the start with the young and innovative entrepreneurial spirit, have also increased, since their innovative activities can foster the growth of new markets and create a virtuous cycle of recreating the way companies operate in those markets [22-23]. Therefore, it is necessary to study the theoretical basis and method to establish effective globalisation strategies and efficiently execute action plans for contemporary SMEs.

The problem is that SMEs are weaker than large corporations or MNEs in international markets. That is because there are weaknesses that are inherent in the characteristics of SMEs, and related researches have been extensively studied [26-27]. For instance, differences in firm size generate strategic advantages in recognising and responding to trade barriers [28-29]. Generally speaking, the many studies indicate that larger firms with more capital and infrastructure can better cope with these trade barriers than SMEs [30-34]. In other words, SMEs are faced with a shortage of business capabilities compared to large enterprises that have achieved elaborate knowledge and resource management over an extended period. While large firms are exporting based on developed systems, SMEs are less likely to overcome difficulties in exporting because of their lack of resources and capabilities in many ways [34]. The unique characteristics of these SMEs and their position in the market competition system are the major factors that make it difficult for SMEs to enter the international market [35-36].

Accordingly, SMEs are confronted with more risks than large corporations in the process of internationalisation. That is due not only to the restricted financial resources, but also to the high level of uncertainty, high-cost information, and lack of market experience and knowledge [37-39]. Of course, SMEs may choose maturity by accumulating long-term experience, know-how and knowledge in the domestic market to reduce risk and uncertainty in the international market entry. However, for SMEs competing in the high-tech sector, selecting the above-mentioned method can make it difficult to gain competitive advantage due to the nature of high-tech such as technology discontinuity, dynamic changes of market structure, etc [40]. Spontaneously, one of the most critical

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factors affecting the SMEs' performance in the dynamic high-tech marketplace is the rate of internationalisation [41]. In the end, SMEs may experience a lack of time to consolidate prior knowledge and exploit their international strategies before they even implement them [42].

Therefore, in order to survive in rapidly changing international market pressures, it is necessary for technology-oriented SMEs to develop a mechanism to respond quickly to market opportunities and promote capability to efficiently allocate resources in a short time frame [43]. This has been steadily studied by various researchers dealing with the internationalisation of SMEs from the perspective of the resource-based view (RBV). The RBV suggests that businesses must create value through unique products or services that can satisfy their target customers in order to achieve superior performance in international markets [44]. To this end, many researches indicate that SMEs should actively utilize the diverse resources available from external environments or inter-firm networks [45-48]. Information is one of the most important resources that new ventures or SMEs need to leverage [49]. It is also important for firms to obtain information acquisition capability, and adaptive capability [39, 50-54]. The former refers to the ability to gain, absorb, and consolidate information to grasp customer needs and market opportunities [44], and the latter means to adjust, recombine, and allocate resources in accordance with market information [55].

However, SMEs are vulnerable to collecting and using market-oriented information [56]. Previous studies have shown that, unlike large MNCs, where these corporations can simply rent or purchase information resources, SMEs often have difficulty securing the core resources such as international markets and financial capital information that are crucial for them to explore opportunities in overseas markets, because they need to find the resources that external organizations provide [44, 57]. Ultimately, SMEs need to take advantage of institutional resources belonging to government agencies as an option for obtaining quality market information, including taking part in government programs [58-59], or another option is gaining it from partners such as suppliers, customers, and even competitors [16, 60-61].

Therefore, we focus on information and information analysis methodologies that can be provided and supported in terms of institutional resources for internationalisation of SMEs. There is little research on what kind of information is necessary for the internationalisation of SMEs in practice and how to analyse such information and provide it at the governmental and/or public level. In this paper, we suggest and discuss the types of information that can be provided for the internationalisation of SMEs, and the results of the information analysis performed by Korea Institute of Science & Technology (KISTI) in the public sector, which provides market-oriented information to SMEs through supply chain network system embodiment system. And this study aims to contribute to the practical policy implication of the government and the public for the internationalisation of SMEs.

The rest of this paper is structured as follows. In Section 2, theoretical backgrounds are suggested concerning prior researches related to the internationalisation of SMEs in various perspectives, and market-oriented information provision of public sector for SMEs. And then, the research objectives, data source, the framework of the market-oriented information system are described in Section 3. In Section 4, the specific case of information support of KISTI for SMEs is showed. Finally, in Section 5 and 6, the conclusions, implications and limitations are suggested and discussed.

2. Theoretical background

2.1. Internationalisation of SMEs

Up to the 1980s, SMEs had a strong tendency to concentrate mainly on their original countries or regions [62]. That is because, for SMEs with limited resources and market competitiveness, the internationalisation was a somewhat challenging strategy [63]. Rather, region-based SMEs prefer to focus entirely on domestic and regional markets, as they can have a competitive advantage in the domestic market over foreign competitors [57, 64].

However, the pressure of globalisation due to liberalisation of the economy caused the reduction of trade barriers due to international trade liberalization, resulting in the integration of the world economy [19, 22, 43, 65]. SMEs could not be free from this huge flow of globalisation, and since the

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1990s, 'international new ventures (INVs)' or 'born globals (BGs)' have begun to emerge. They gain competitive advantages from inception by rapidly entering the international market and utilising resources and products in diverse countries [13, 23, 66-69].

Before the concept of 'born global' emerged, the initial internationalisation model of firms was an incremental stage model represented by 'the Uppsala model' [42, 62, 70-71]. This model has its rationale in behaviour theory of the firm [72-73] and Penrose's [74] theory of the growth of the firm.

Comparisons of theses traditional internationalisation models of firms and the models emerging afterwards would be discussed in the following sections.

2.1.1. Traditional internationalisation model of SMEs

Initial researches on firm's internationalisation have focused primarily on large MNCs, and on that account, the characteristics of SMEs have been pretermitted [16, 75]. In the 1970s, a model for the internationalisation of firms appeared with the Nordic countries as the centre. The model is referred to as the Uppsala model (U-model) [16]. In accordance with this model, SMEs accumulate enough experience in the domestic market first. Based on this, they would gradually expand and intensify their international business capabilities, starting with geographically and/or culturally close foreign countries, and gradually moving into more distant regions. Therefore, the internationalisation of enterprises in this model is a slow, incremental and gradual process of growth of firms [42, 71].

To put the practical internationalisation process based on this traditional model specifically, it is as follows. Firms start exporting when their domestic base is strong and exports are ready to be phased in. In the beginning of exporting, to reduce the risk of uncertainty about the overseas market, they started exporting to other countries through an agent, and then we established sales subsidiaries later. The local production in that countries is the final stage of the internationalisation. The factor that plays a role when choosing the region where the export begins is 'psychic distance'. Psychic distance is closer to a region with similar linguistic and cultural identities. The export of SME usually extends from the area near psychic distance to the area far away [42, 76].

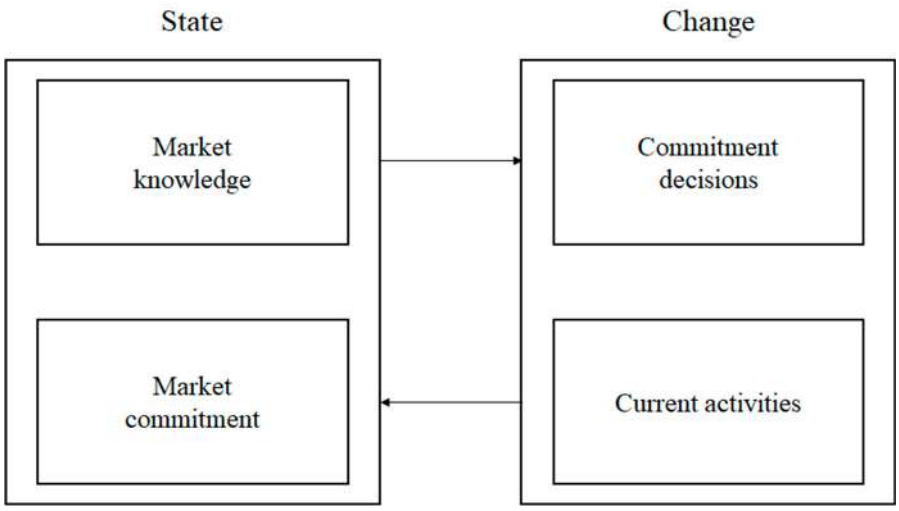

Figure 1. The structure of internationalisation in the Uppsala model. Source: Johanson and Vahlne (1977:26).

The U-model researchers have proposed a dynamic model in which the outcome that one decision influences the next in the process of internationalisation, and analyse its process of SMEs as 'state aspects' and 'change aspects'. They assume that the present state of internationalisation is the factor that drives future change. In the state aspects, 'market commitment' and 'market knowledge' in overseas markets are operated as the important continents. And 'change aspects' are comprised in 'commitment decisions' and 'current business activities' [42]. The detailed description of each element is given below.

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State Aspects

- Market Commitment: the concept of market commitment consists of two components - the amount of resources put into the market and the degree of commitment. The degree of commitment represents the ease with which resources can be transferred from one market to another [76, 77]. The concept of commitment can be also defined as the outcome of the multiplication of the scale of the investment and the degree of rigidity (inflexibility) [78].
- Market Knowledge: it refers to the knowledge and information that the firm retains about its certain markets, competitors, customers, operations and so on [79-81]. Market knowledge is very important in expanding the market globally, and researchers supporting the U-model have found that knowledge of the international market is derived from individual experience. Empirical knowledge is crucial to international activities by providing a framework for recognizing and shaping opportunities and recognizing 'specific' opportunities [76, 77].

Change Aspects

- Current business activities: this serves as a major source of experiential knowledge. Supporters of the U-model thought that as the product became more complicated and specified, the total amount of current business activities and the total market commitment would increase. The best way to quickly acquire and utilise the market experience is to hire a representative, or to merge and/or acquire a company or part of it. Sometimes, however, this type of experience is not an object of sale, so the process of internationalisation may be slowed because it can only be acquired through a long learning process in relation to current business activities [76].
- Commitment decisions: when entering foreign markets, it means deciding where to allocate resources among various alternatives, depending on which alternative. This decision is made at a particular point in time, taking into account the current situation and opportunity. In general, when market uncertainties are large, commitment decisions begin at a lower level. Uncertainty can be reduced if the firm's resources are very abundant, the market conditions are stable, or the firm has lots of similar market experiences [76-78].

There is criticism of the Uppsala model, as well. In a business environment where many industries have been already highly globalised, it may take a considerable amount of time for firms to pursue internationalisation through these steps of U-model. In addition, some steps may be omitted depending on the situation and strategy of an individual firm, and the time required for each step may be significantly different for each company. In such a case, the explanation ability of the Uppsala model may be lowered. Actually, there are studies that explains firms that make a high level of resource investment from the beginning of internationalisation without the sequential process that the Uppsala model cannot explain. In the case of the firms with high levels of resources or product competitiveness, it is possible to start internationalisation through foreign direct investment or penetrating multiple markets. Even if they partially follow a stepwise internationalisation, there is also a way to establish production facilities directly or promote a global strategy through international division of labour without indirect export stage through agency or sales subsidiaries stage [82-83].

2.1.2. The emergence of born globals (BGs)

Basically, the U-model is a gradual stage model of the internationalisation process. However, this internationalisation model has revealed limitations in explaining the internationalisation of venture firms that have rapidly become globalised with advanced technologies since the 1990s when they have started to appear. This type of firm is called 'born global (BG)'[1]. In addition, the emergence

[1] In addition to this born global, firms that are making rapid internationalisation are variously referred to as Infant Multinationals [85], High Technology Start-ups [86], International New Ventures [67], Global Start-ups [40], Instant Internationals [87], Instant Exporters [88], Instant Internationals [89], Born-Internationals [90],

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of a knowledge-intensive BG with an extensive global network from the early stage of establishment has added to the necessity for new theories. Studies of BG's internationalisation have revealed that characteristics of these firms represent technology, knowledge-intensive and discontinuous globalisation patterns [64, 84].

The above model has been treated as an exceptional phenomenon in previous studies (eg. [93]). However, the recent BG model is regarded as one of the important strategies of venture firms, not exceptional, by researchers focusing on studying entrepreneurship. The researchers are emphasising that in the case of BG ventures founded by entrepreneurs with a lot of international experience, they can combine the resources of various countries and respond to the demands of overseas markets through the international experience of them [64, 94].

What capability differences exist between BG and non-BG ventures so that BGs do not follow the existing internationalisation process? Various studies have been carried out to get answers. Many studies have shown that the firms that follow the BG model are new technology-based firms (NTBFs) that are included in technology-intensive industries [95-96]. In the new technology-based industry, the market uncertainty and the competitive intensity is high due to the rapid rate of technology change and short product life cycle [64]. Therefore, the market environment that shortens the product life cycle due to the rapid change of technology leads to the globalisation of the market [70]. In addition, if there is a high level of competition in the domestic market, it may become a strategic alternative to advance into the overseas market. Therefore, the firms exposed to above-mentioned environment tend to pursue rapid internationalisation. Ultimately, for high-tech SMEs, securing their competitiveness at the pace of globalisation is directly linked to the creation of the enterprise's performance and profit [41].

2.2. Internationalisation of SMEs from Diverse Theoretical Perspectives

2.2.1. The drivers of early internationalisation of BGs from resource-based view (RBV)

So what are the drivers that BGs have been able to achieve rapid and early internationalisation? Researches on this topic have also been carried out actively. Fundamentally, a considerable number of contributors to this area chose entrepreneurs as the driver of this early internationalisation. In other words, the firm's entry into the overseas market is determined by the function of the firm's internal capabilities [67, 96-97]. The components of this function are knowledge accumulation, financial resources, organizational learning ability, physical equipment, and so on [63]. Especially, the researchers perceiving the internationalisation of firms from the viewpoint of knowledge-base framework and resource-based view (RBV) regard the presence of overseas experience of the firm as an important variable for determining whether to invest resources in the overseas market or not. Various empirical studies also indicate that firms' overseas experience is an important parameter that accelerates the internationalisation [98-99].

However, it is not easy for SMEs to have knowledge of these internal resources, especially technological and market experience. This lack of internal resources can be a significant impediment to the internationalisation of SMEs [86, 100]. Nonetheless, personal experience can complement organisational experience [101]. In particular, in the case of venture firms that rely heavily on the personal capabilities of entrepreneurs, the more entrepreneur's personal oversea experience, the more likely they are to attempt rapid internationalisation. In previous studies, it is explained that entrepreneurs' knowledge and vision are an important factor which encourages venture firms to seek opportunities for internationalisation actively [102-103].

From the point of view of venture firms, it is possible to develop skills and technologies as a part of the source of competitive advantage because early attempts at internationalisation can provide them with opportunities to improve learning in aspects of organisation and technology [64, 104]. However, venture firm's undergoing the internationalisation process cannot solely promote the

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Micromultinationals [91], and Early Internationalising Firms [92]. These conceptual meanings are almost the same. Thus, in this study, 'born global' is used for the unity of terms.

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acquisition of new knowledge. It depends on the firm's ability to take advantage of opportunities for the internationalisation. In order to successfully exploit external knowledge or skills, the ability to internalise and absorb them, namely absorptive capacity, should be developed within the firm [105]. Therefore, among the venture firms in similar environment, the BG firms have the firm-specific resources such as overseas experience of entrepreneur, the knowledge and information of overseas market, and , in particular, the absorptive capacity.

According to Korbin [106], technology-intensive industries tend to be globalised, because the international activities of firms can be an important source of gaining competitive advantage. In order to have high competitiveness in a globalised market, R&D intensity should be high, and firms with high R&D intensity should focus on 'intelligence gathering' with international scale. In order to meet the enormous cost and cope with the complexity of R&D, therefore, venture firms need to expand their overseas markets rapidly [106-108].

In study of Rialp and Rialp [109], they looked upon the backsight of securing a sustainable competitive advantage as a sustainable export potential, and based on this premise, developed a model of the BGs' nature and performance based on RBV as shown in Figure 2. In this model, they emphasise that what the most crucial and highly relevant determinants for characteristics of BGs is the firm's intangible resources and competencies. They also demonstrated that intangible resources partially influence the nature of BG as an export business through empirical studies aimed at Spanish export companies.

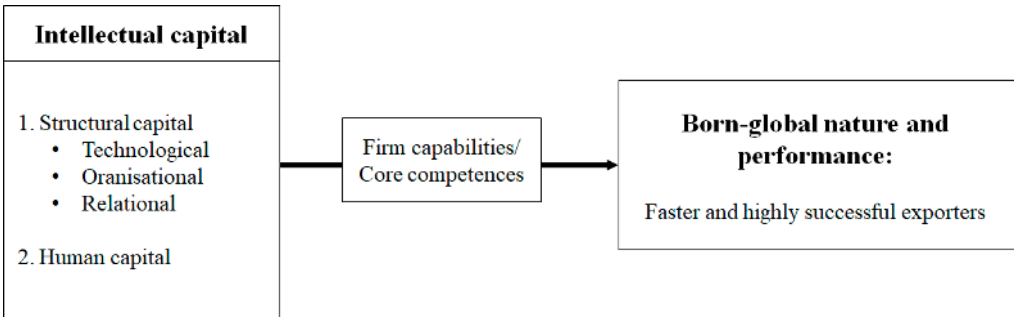

Figure 2. The RBV-based model of the BG nature and performance. Source: Rialp and Rialp (2007: 74)

2.2.2. The rapid internationalisation of SMEs from the network approach

Venture firms that lack the resources to use imitate competitors' strategies or successful implementations [110]. Strategic capabilities, however, are difficult to imitate completely because they consist of complicated the internal business activities and the unique resources. As a result, venture firms are constantly seeking internal development through their R&D capabilities or pursuing cooperation with competitors in overseas markets. Accordingly, it can be a strategy for venture firms belonging to technology-intensive industries to pursue internationalisation rapidly from the beginning of establishment rather than approaching the incremental internationalisation. Also, this can be a better strategic choice for them to open a 'window of opportunity' in the light of the current business environment [111].

According to Knight and Cavusgil [112], the main contributors to the rapid internationalisation of BGs are: increased trade liberalisation and economic integration, the development of ICT (Information and Communication Technology), particularly the emergence of the Internet and the World Wide Web (WWW), the globalisation of knowledge and the growth of global networks. In the studies of Coviello and Munro [94, 113], they indicated that it is the network they developed to drive the internationalisation process of SMEs. They also found that how companies enter the overseas market and what market they choose are influenced by their network partners. This supports the view of Johanson and Vahlne [114], who conclude that strategic decision-making and networking capabilities play an essential role in entering international markets.

However, there are some limitations in explaining the internationalisation of SMEs by the network approach. According to Young et al. [115], although the network approach provides new insights into the internationalisation of SMEs, it can be seen that the networking is an alternative way

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to overcome resource shortage rather than the actual driving force of internationalisation. This is where the ambiguity of the causality and the order of the incidents occurs. Nonetheless, the network approach can explain much of the internationalisation process of SMEs. The followings are the examples of what the network approach can explain; the interactions between network internal resources, activities and actors, their impact on international activities [90, 116], information on international activities, and so on [22, 117-118]. Empirically, in the study of Loane and Bell [119], they conducted in-depth interviews with 57 companies that were able to demonstrate the network characteristics of the SMEs with less than 250 employees in Australia, New Zealand, Canada and Ireland. Through this, they found that SMEs utilise networking as a means to overcome the deficiencies of resources and knowledge within the enterprise, and these results are consistent with previous studies by Young et al. [115] and Kuivalainen [119].

2.2.3. The role of market-orientation (MO) in internationalisation of SMEs

The market orientation (MO) perspective has been understood in various ways by many researchers. Shapiro [120] saw the MO from decision-making perspective. Kohli and Jaworski [80] introduced a market intelligence perspective on MO as the role to help make strategic decisions at critical stages such as securing market opportunities, making market-penetrating strategies, and developing market.

In addition, Narver and Slater [81] emphasised MO as an organisational culture to deliver better value to customers. In a similar but somewhat different direction, Ruekert [121] approached MOs from a strategic perspective for increasing organisational performance. And now, the definition of these two groups of researchers is regarded as the most prominent conceptualisation.

MO can also be understood from the RBV. In accordance with RBV, MO is seen as an intangible resource that allows the firms to deploy and exploit market information as a means to create better value [122]. According to Armario et al. [123], they counted the company's global MO as a key capability in supporting the market activities of firms in overseas markets. This is because the global MO provides the ability for firms to quickly learn about overseas markets and to build a promptly response system for overseas markets. Therefore, they pointed out that the MO, represented by the market intelligence generation, is the key to promoting international market commitment.

MO as an intangible resource can help to develop an "inside-out" capability that connects internal processes based on firm's internal capabilities with the external environment, providing a framework for self-awareness of internal capabilities simultaneously [81]. Indeed, Day [79] argues that firms' building stronger relationships with customers, distributors and suppliers can increase their competitiveness. MO is the basis for explaining the interaction between BG and various foreign markets. In addition, MO plays an important role in elaborating marketing strategies and enhancing corporate performance based on these interactions [124]. In fact, some studies have shown that MO can provide the requisite information to acquire customer knowledge, develop the host market, and establish appropriate product development strategies, so MO was found to be relevant to the process of establishing appropriate marketing strategies in foreign markets and supporting tactical business activities for firms [22, 125].

As steadily mentioned above, the internationalisation of SMEs is closely related to the export activity and export potential of enterprises. In this regard, studies on between Export Market Orientation (EMO) and export performance have been carried out in various directions. In the area of studying export performance, MO has been attracting attention as a potential major determinant of export performance [126], and many researches have been conducted concerning the relationships between the extent of use of MO activities and export performance and the extent to which exporters accept MO activities [e.g., 127-132]. Accordingly to Cadogan et al. [133], EMO behaviour can be defined as the export-focused activities generating, disseminating, and responding to export market intelligence as parts of the market-oriented activities that a firms carry out in its export markets. Empirically, Cadogan et al. [134] demonstrated that there is an inverted U-shaped relationship between EMO behaviours and export sales performance in export activities unlike the conventional wisdom that there is a linear relationship between them. Namely, they demonstrate that as the market

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dynamics increase, the magnitude of inverted U-shaped relationship is greater, and the optimal value of EMO behaviour decreases with market dynamics increased and increases with the degree of corporate internationalization decreased. Thus, they suggested firms should manage MO behaviours at an optimal level, rather than continually increasing them with the internationalisation process progressed.

2.3. Market-oriented Information Provision of Public Sector for the SMEs' internationalisation

SMEs adopt various corporate strategies and governance systems to manage their relationships with external stakeholders, such as customers, suppliers, distributors, and so forth [135-137]. Indeed, companies cannot be competitive in isolation from the diverse entities, including suppliers within their supply chain [138]. This would be the same in the internationalisation process of SMEs.

As mentioned above, the internationalisation process of SMEs should utilise various external resources. In particular, in order for the high-tech SMEs to achieve the rapid internationalisation, securing resources on network and market-oriented information is the key resources. According to Yeoh [39], start-ups, however, lack the know-how to commercialise, even though they have excellent development capabilities. Therefore, it is necessary for them to acquire information that can capture overseas market opportunities through various channels. And in the same study, firms that relied on information source from individual and quasi-government tend to have higher performance levels, as well as firms that have made efforts to acquire information.

The information, such as overseas market conditions, customer's demands, and regulations (e.g. tariffs), play an important role in making appropriate strategic decisions at a certain point in the internationalisation of a firm [39, 50]. Dhanaraj and Beamish [60] have shown that the ability of an entrepreneur to quickly collect and process information on foreign markets positively affects firm's performance in international markets. However, it is not easy for SMEs entrepreneurs, especially entrepreneurs in emerging economies, to obtain high quality information related to foreign markets [50]. International marketing research has therefore indicated that it is important for governments to provide these SMEs with information on foreign market conditions, trade information, and competition in foreign markets, namely market-oriented information [39, 44, 139].

3. Research Design

3.1. Research Objective

The purpose of this study is to explore the information support system that can facilitate the rapid and efficient internationalisation of SMEs. Among the internal resources of SMEs, the resources required for internationalisation would be market-oriented resources. However, as mentioned above, it is not easy for SMEs to acquire overseas market information [50]. In addition, it is time consuming and costly [140], and it is not easy for SMEs to consume these resources.

KISTI is a government-funded research institute in Republic of Korea and has been providing information on R&D, technology, and industry for innovation growth of SMEs for a long time. According to Jun et al. [141], as a result of conducting research on SMEs in ICT field, R&D planning and technology information support of KISTI led SMEs to increase their R&D investment. It is also pointed out that this increased investment in technology development has a very significant relation to the technical and economic performance of SMEs, regardless of other variables. This prior study can indirectly reveal that KISTI's information support has a substantial impact on SMEs.

This study is an exploratory study to build a system that can provide market-oriented information to SMEs at domestic and overseas in a systematic way. This market-oriented information includes trade information and product supply chain network information. In order to improve the objectivity and reproducibility of the system, the existing data is constructed as a relational database (DB) and the information analysis result is automatically derived through the inter-field network structure in the relational DB.

3.2. Structure of Relational Database

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The purpose of this study is to explore the information support system that can facilitate the rapid and efficient internationalisation of SMEs. Among the internal resources of SMEs, the resources required for internationalisation would be market-oriented resources. However, as mentioned above, it is not easy for SMEs to acquire overseas market information [50]. In addition, it is time consuming and costly [140], and it is not easy for SMEs to consume these resources.

In order to give functions to export market intelligence, the relational DB used in this study consists of multiple DBs in total. It is a relational DB created to systematically provide information on product supply chain network, and trade condition in KISTI, and detailed DB structure is specified in the past researches of the authors [141-142].

Briefly, trade and end products information was based on data from Harmonized System (HS) codes and trade indicators by codes. And information on raw materials and intermediates for each product was obtained from the Chemical Abstracts Service Registry Number (CASRN) data and the patent data corresponding to each CASRN.

The HS code of the tariff nomenclature is the internationally standardized name and numbering system for classifying the products that have been traded [143]. The HS code is a series of six-digit numbers specifying the general product category in the World Customers Organization (WCO). Countries adopting this system additionally set a four-digit number to supplement the product to a more detailed level [144]. Therefore, each merchandise traded globally is typically assigned 10 digits. The total number of HS codes in the relational database is 33,143. Products that assigned individual HS code have quantitative data concerning trade condition such as total product prices and the import or export prices of each product that are traded in the real world.

CASRN is a unique numeric identifier assigned by the Chemical Abstracts Service (CAS) for all chemicals described in the open scientific literature, including organic and inorganic compounds, minerals, isotopes, alloys, and chemicals [145].

In general, chemicals are used in raw materials or intermediates in the process of producing some specific end products. We have matched the HS code and product for the same chemical with CASRN in the relational database. If the product in the HS code database matches the product in the CASRN, it can be considered a raw or intermediate product. In the other case, it can be regarded as a finished product and is assigned to the finished product code consisting of the alphabet 'p' and the 7-digit HS code. Namely, there are also DBs as joints that connect these two DBs. Therefore, these relational DBs automatically represent the structure in which raw materials, intermediate materials, and finished products are interconnected. The overall relational database scheme is shown Figure 3.

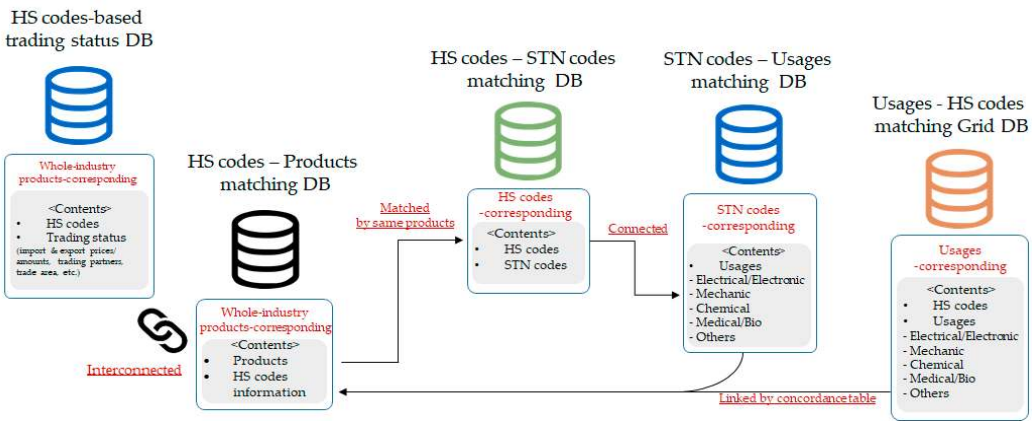

Figure 3. The database structure of market-oriented information system.

3.3. The Framework of Market-Oriented Information System

The information to be provided by the market-oriented information system designed in this study can be divided into two categories. The first is trade information. In other words, the system is designed to enable SME to easily obtain information about import and export for its flagship products. Trade information includes trade products, trade volume, trading unit prices, and trade

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indices. Second, the system provides product supply chain network information for each product that is generated by linking the HS code with the CAS code. As a result, each company can easily and quickly check various usage information of the certain product. Usage information is based on patent information and is divided into fields such as chemical, mechanical, electrical and electronic, biomedical, and others. The framework of the detailed system is represented in more detail below.

3.3.1. Trade information

Trade information covers trade data for each item from 2013 to 2017. Trade data includes information on total trade volume, total trade volume, and trade unit price by HS code, year, and destination country.

In order to assess the unfavourable trade balance, it is necessary to establish specific criteria. In general, the trade balance, which is unfavourable, is expressed as a trade situation in which exports exceed import volumes and/or costs. Therefore, in this study, UTAB (Unfavourable Trade Amount Balance) is defined as the difference between the amount of imports and the exports as the equation (1). Likewise, UTCB (Unfavourable Trade Cost Balance) can be calculated by subtracting import unit price from export unit price like the equation (2).

$$UTAB = A_{im} - A_{ex} \quad (1)$$

A_{im}: $Import\ amount$

A_{ex}: $Export\ amount$

$$UTCB = C_{im} - C_{ex} \quad (2)$$

A_{im}: $Import\ unit\ price$

A_{ex}: $Export\ unit\ price$

Depending on the combination of the plus and minus signs of each UTAB and UTCB, four types of unfavourable trade balance conditions can be assumed within the quadrant. Initially, let X and Y be the UTAB and UTCB, respectively. If UTAB represents a positive value, it means that the amount of imports is higher than that of exports. In addition, it can be interpreted that the larger UTAB value, the greater the market share of a particular product. Therefore, UTAB can show market power. If UTCB is positive, the products are imported at a higher price than when exporting certain products. In other words, UTCB means price advantage and competitiveness.

In summary, when the X and Y axes are crossed, we can describe each quadrant by UTAB and UTCB as shown in Figure 4.

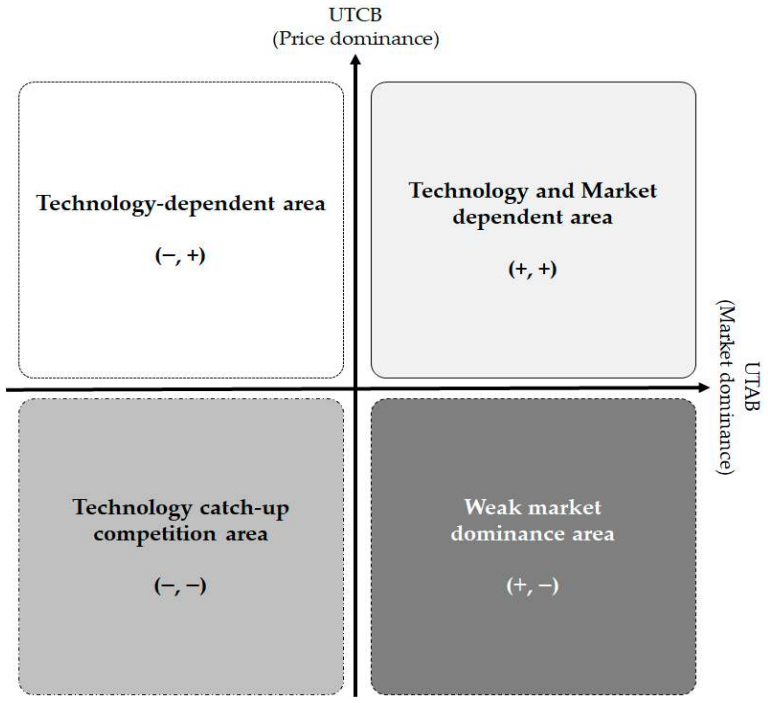

Figure 4. Quadrant configuration representing unfavourable trade status in accordance with the combination of UTAB and UTCB +/− signs.

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- Technology and market dependent area - (+, +) area: the products (groups) which are weak in the domestic market dominance and technology-dependent, and have low price competitiveness
- Technology-dependent area - (−, +) area: the products (groups) which have somewhat strong domestic market dominance similar to that of the imported products, but weak price competitiveness
- Technology catch-up competition area - (−, −) area: the products (groups) which have somewhat strong domestic market dominance and price competitiveness at the same time
- Weak market dominance area - (+, −) area: the products (groups) which have weak dominance in the domestic market, but the price competitiveness similar to that of the imported products

Indicators are provided for each item to determine whether they are import-dependent or export-oriented. Dependence on imports by item is confirmed through Trade Specialization Index (TSI). TSI is an indicator developed by Greenaway and Milner [146], which represents the ratio of net exports to total trade. The equation for obtaining TSI is as follows (3).

$$TSI = \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}} \ (-1 < TSI < 1) \quad (3)$$

X_{ij} : $Exports\ to\ trading\ country\ 'j'for\ year\ 'i'for\ certain\ goods$

M_{ij}: $Imports\ to\ trading\ country\ 'j'for\ year\ 'i'for\ certain\ goods$

TSI has a value between the maximum value of 1 and the minimum value of -1, and the larger the value, the more competitive it is. The closer to 0 (-0.5<TSI<0.5), the lower the import dependence rate. The closer to -1 (TSI ≤ -0.5), the higher the dependence on imports for a particular country, indicating that import diversification is necessary. Conversely, the closer to 1 (TSI ≥ 0.5), the higher the concentration of exports to a particular country, indicating that export diversification is necessary.

RCA (revealed competitive advantage) [147] and SRCA (symmetric revealed competitive advantage) [148] were used as indexes for calculating export intensity. The RCA and SRCA are indices used in the international economy to calculate whether a particular country has a comparative advantage in a particular product or service in trade. The expression of each index is as follows (4) and (5).

$$RCA = \frac{X_{ij} / \sum_i X_{ij}}{\sum_i X_{ij} / \sum_i \sum_j X_{ij}} \ (-1 < TSI < 1) \quad (4)$$

X_{ij} : $Exports\ to\ product\ i\ from\ country\ j$

$$SRCA = 100\tanh(\ln RCA) = 100\frac{(RCA^2 - 1)}{(RCA^2 + 1)} \quad (-100 < SRCA < 100) \quad (5)$$

If SRCA = 0, then the corresponding trade item is that the export specialisation (concentration) with the target trading partner is the average of all domestic trade items. In addition, the value of SRCA between -100 and 0 means that the export specialisation of the trade item with the target trading partner is relatively low. That is, it is lower than the average of all domestic trade items. Finally, if 0<SRCA<100, the trade item means that its export specialisation with the target trading partner is relatively high. That is, it is higher than the average of all domestic trade items.

3.3.2. Product Supply Chain Network Information

The product supply chain network is a useful tool for a holistic view of the overall relevance of all business activity networks, from raw materials to finished goods. The mechanism for embodying the product supply chain networks is based on the relational databases in our study. As mentioned earlier, the relational database constructed in this study is designed with a network structure in which the components are connected to each other via the same product or material within the HS code and CASRN. As shown Figure 5, the first band refers to the relationship between the HS code and the product name. In the same way, the second and third bands are connected from the product name to the CASRN, and from the CASRN to various usages, respectively. The usages are linked back to the HS code with the same commodity name again. As these connections occur in a chain, we can finally derive the same network structure as Figure 6.

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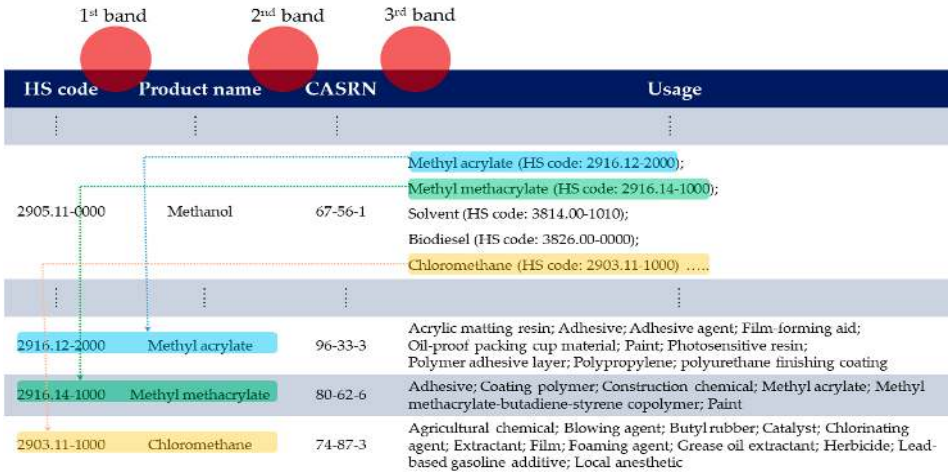

Figure 5. Database-based supply chain network propagation and integration mechanism.

Through this product supply chain network, it is possible for a specific company to identify a variety of usage information for its flagship products. As mentioned above, since this usage information is constructed based on patent information, it is possible to establish more objective business model based on data, and it is easy to diversify business and secure market opportunity through systematic approach. In today's age of knowledge economy, securing such market-oriented information is very costly. Therefore, for SMEs lacking resources, it is not easy to access market-oriented information. However, this systematic approach can enable SMEs to obtain market-oriented information through a clearer way and with lower cost.

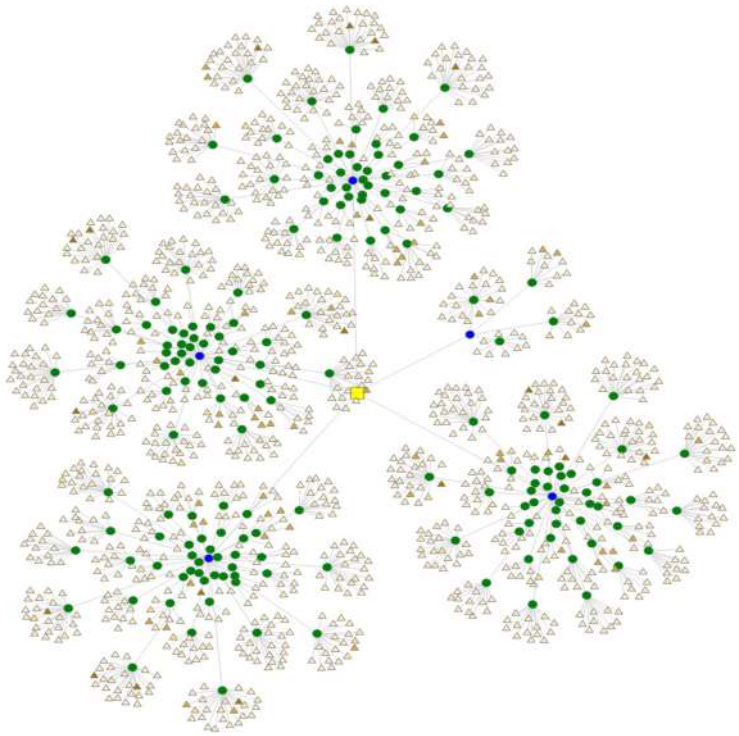

Figure 6. The anticipated supply chain network diagram of the supply chain network based on the relational databases.

4. The Cases of Information Support of KISTI for SMEs

In order to evaluate the feasibility and consistency of the relational database constructed in this study and the analysis results implemented based on this database, some products were actually analysed. We analysed the main products of SMEs, who requested the analysis of their main products

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at KISTI and provided the market-oriented information about them through trade and product supply chain network information. For reference, CASRN is mainly a database on chemical substances, and therefore mainly analyses of products of SMEs related to fine chemicals are mainly made. In this study, we present case of analysing hydrazine-related products.

4.1. The Overview of the Hydrazine-Related Products

Hydrazine is a colourless fumed oily liquid with ammonia odour. It produces toxic nitrogen oxides during combustion and is used in rocket propellants and fuel cells. The HS codes associated with hydrazine are shown in Table 1.

The HS codes of products related to hydrazine can be broadly classified into codes starting with 2825.10 and codes starting with 2928.00 Products starting with 2825.10 are hydrazine, hydroxylamine, inorganic salts thereof, other inorganic bases, metal oxides, metal hydroxides, metals and oxides. In particular, products beginning with 2825.10 refer to hydrazine, hydroxylamine and inorganic salts thereof. Also, products starting with 2928.00 means organic derivatives of hydrazine hydroxylamine.

Table 1. HS codes associated with hydrazine and its derivatives.

HS code	Product name	Sub-product name
2825.10-9010	Hydrazine	Hydrazine[1]
2825.10-9020	Inorganic salt of hydrazine	Inorganic salt of hydrazine
2825.10-9041	Hydroxyl ammonium chloride	Hydroxyl ammonium chloride (hydroxylamine hydrochloride)
2825.10-9049	Inorganic salt of hydroxylamine	Inorganic salt of hydroxylamine (except 2825.10-9041)
2928.00-1000	Phenylhydrazine	Phenylhydrazine
2928.00-9091	Organic derivative of hydrazine	Organic derivative of hydrazine (for agricultural chemical) (except 2928.00-1000; 2928.00-9010; 2928.00-9020)
2928.00-9091	Organic derivative of hydroxylamine	Organic derivative of hydroxylamine (for agricultural chemical) (except 2928.00-1000; 2928.00-9010; 2928.00-9020)
2928.00-9020	Methylethyl ketoxime	Methylethyl ketoxime
2928.00-9099	Organic derivative of hydrazine, Organic derivative of hydroxylamine	Organic derivative of hydrazine (except 2928.00-1000; 2928.00-9010; 2928.00-9020; 2928.00-9091), Organic derivative of hydroxylamine (except 2928.00-1000; 2928.00-9010; 2928.00-9020; 2928.00-9091)

4.2. The Trade Conditions of the Hydrazine-Related Products

In order to examine the trade status of hydrazine-related products, we have derived the aforementioned trade-related indicators. First, the trade volume and trading unit price of hydrazine related products starting with HS code 2825.10 and 2928.00 were investigated, and the UTAB and UTCB values of each product line were derived from these trade information (<Table 2> and <Table 3>). The source of all trade data is the information collected from the Korea Customs Service, and the trade volume and trading unit prices are also based on the trade information of the Republic of Korea.

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579 Table 2. Trade condition value of hydrazine-related products starting with HS code 2825.10.

Value \ Year	2013	2014	2015	2016	2017
Export amount (A, kg)	7106407.418	7191525.697	6005403.859	19309.78044	7965848.188
Import amount (B, kg)	1790408.243	2060088.409	2055663.304	1198200.826	3513731.967
UTAB (B-A, kg)	-0.598698034	-0.542935178	-0.465590235	1.792752279	-0.355463396
Export unit price (C, $/kg)	3.37	3.23	3.11	5.01	2.76
Import unit price (D, $/kg)	4.61	4.4	6.84	4.84	3.66
UTCB (D-C, $/kg)	1.24	1.17	3.73	-0.17	0.9

580 Table 3. Trade condition value of hydrazine-related products starting with HS code 2928.00.

Value \ Year	2013	2014	2015	2016	2017
Export amount (A, kg)	916101.0479	956153.0516	683777.284	911448.2813	1406995.435
Import amount (B, kg)	1344779.701	1958856.272	2171989.223	2259516.871	2044186.401
UTAB (B-A, kg)	428678.6536	1002703.221	1488211.939	1348068.59	637190.9662
Export unit price (C, $/kg)	6.68	6.39	8.1	6.4	7.01
Import unit price (D, $/kg)	6.7	8.37	9.65	9.78	12.06
UTCB (D-C, $/kg)	0.02	1.98	1.55	3.38	5.05

581 Based on the trade-related figures shown in Table 2 and Table 3, the trends in annual trade
582 volume and trading unit prices and the changes in the indicators related to the unfavourable
583 condition of trade are shown in Figure 7 and Figure 8, respectively.

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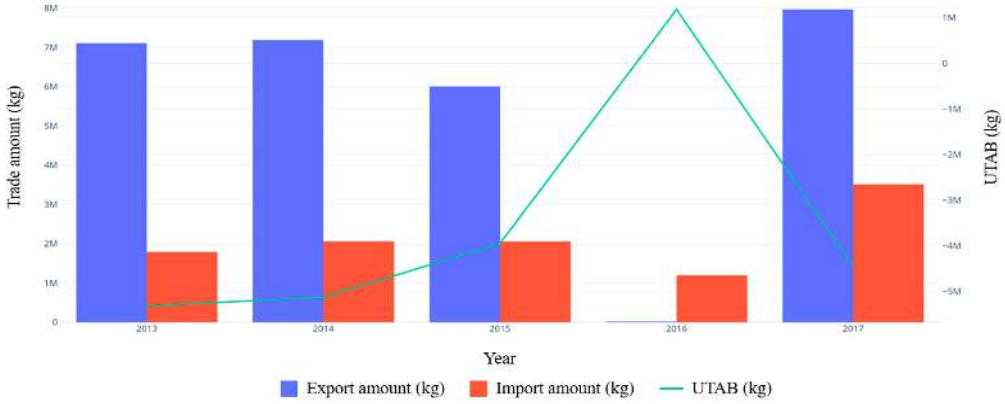
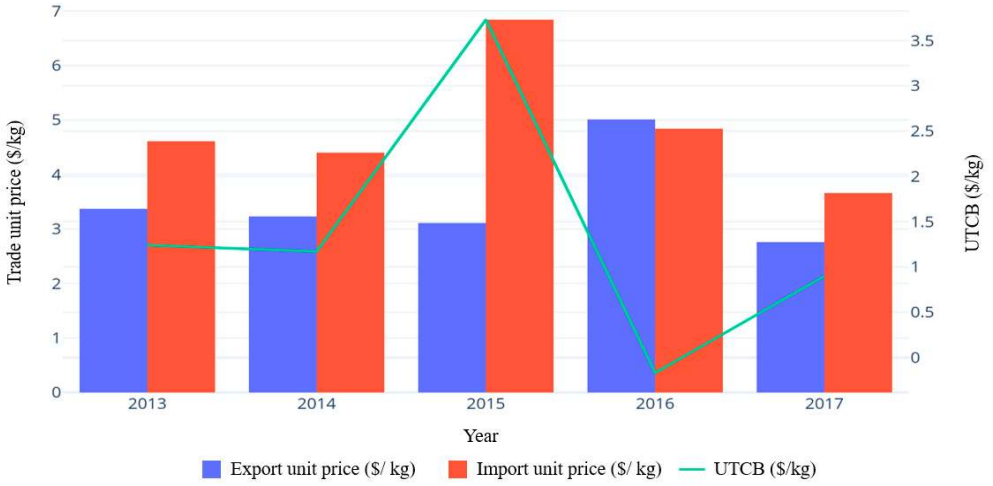


(a)



(b)

Figure 7. Trend in annual trade condition of hydrazine-related products starting with HS code 2825.10: (a) Trends in trade volume and UTAB changes, (b) Trends in trade unit price and UTCB changes

As shown in Figure 7, in terms of trade volume, the export amounts of hydrazine-related products with HS code 2825.10 is generally larger than imports. Accordingly, except for 2016, the UTAB value remains relatively low. On the other hand, in terms of trading unit prices, the unit price of imports exceeded the export unit price as a whole. As a result, it can be seen that the UTCB value shows a positive value except for 2016. In 2016, unlike other years, the trade volume itself is small, so it does not seem to be similar to other years. In summary, for hydrazine-related products beginning with 2825.10, except for 2016, between 2013 and 2017, most UTABs can be considered negative and UTCBs mostly positive. In summary, in the case of hydrazine-related products starting with HS code 2825.10, there is no unfavourable condition of trade volume, but the unfavourable condition of trade unit price is evident.

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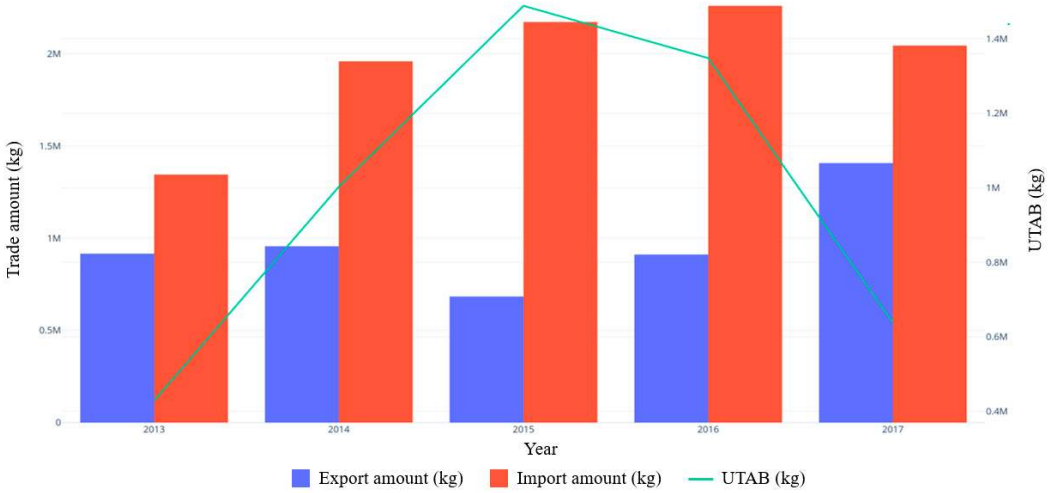
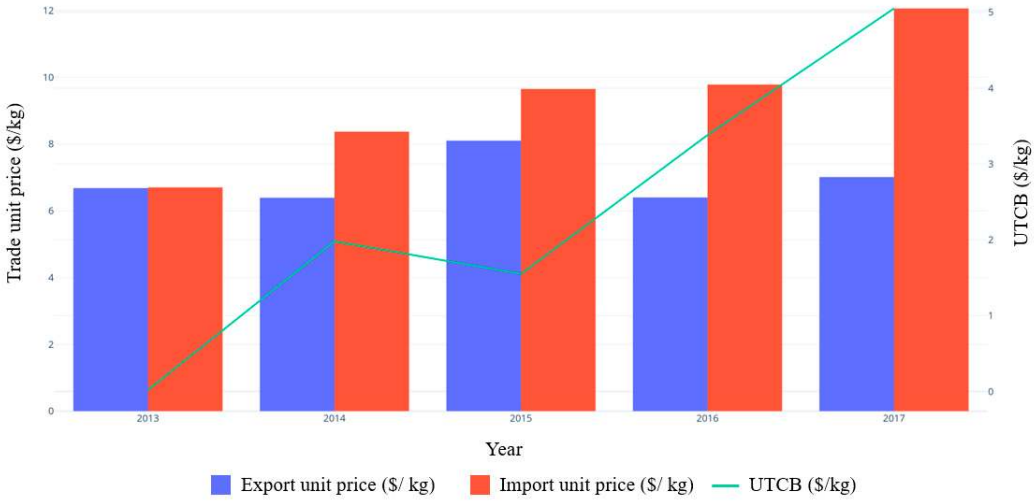


(a)



(b)

Figure 8. Trend in annual trade condition of hydrazine-related products starting with HS code 2928.00: (a) Trends in trade volume and UTAB changes, (b) Trends in trade unit price and UTCB changes

Meanwhile, as shown in Figure 8, the hydrazine-related products starting with HS code 2928.00 show a different pattern. That is, it can be seen that the import volume surpasses the export quantity and the import unit price is higher than the export unit price throughout the year. Therefore, UTAB and UTCB are positive values throughout the year. In particular, UTCB has a characteristic that it is shaped like a straight line in the upward direction as a whole. To sum up, while the unfavourable condition of trade volume appears to be easing off in 2017, the unfavourable condition of the trading unit price appears to be intensifying as the year progresses.

For more in-depth analysis, the UTAB and UTCB values are shown in Figure 9, with the x and y axes respectively. In the case of the hydrazine-related products starting with HS code 2825.10, except for 2016, the coordinate at which the indicators are located is in the second quadrant. In the second quadrant, UTAB represents a negative value and UTCB represents a positive value. The characteristics of the products in this area are that market dominance in the domestic market is similar to or somewhat stronger than that of imported products, but price competitiveness is weak. In other words, a lot of products are exported, but the export unit price is low. Also, the import amounts are small compared to exports, but the products are imported with high trading unit prices. In 2016, it is located in the fourth quadrant, which has the opposite meaning to the second quadrant. However,

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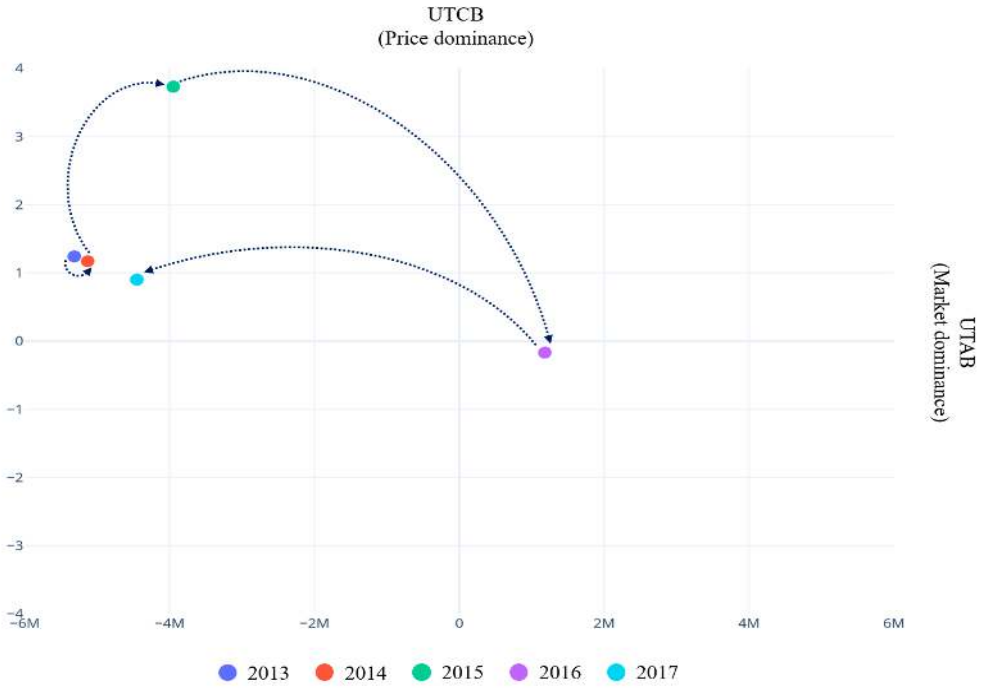
since the amount of trade itself is too small, it can hardly be said to deviate significantly from the trends of the overall indicators.



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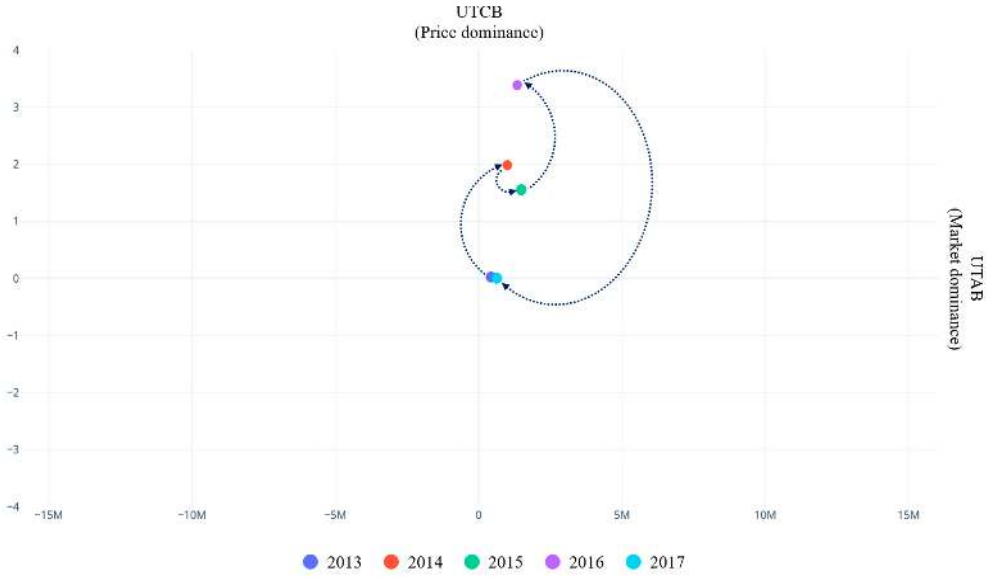

(b)

Figure 9. Changes in the trade indicators of the unfavourable condition by year. The arrows represent the movement of the indicator along the year: (a) the trade indicators of the unfavourable condition of the hydrazine-related products starting with HS code 2825.10, (b) the trade indicators of the unfavourable condition of the hydrazine-related products starting with HS code 2928.00.

In the case of the hydrazine-related products starting with HS code 2928.00, all the indicators are located in the first quadrant. The first quadrant means that market dominance and price dominance are all weak, namely, these products are market and technology dependent. In other words, the products located in this area means that the imports are larger than the exports, and even when importing these products, the trade is done at a high trade price. In terms of the domestic trade situation, it can be said that it means the area to be avoided as much as possible.

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4.3. The Import-Dependent and Export-Oriented Indicators of the Hydrazine-Related Products

The hydrazine-related products were subdivided in accordance with HS code, and each product was divided into import-dependent and export-oriented products. Also, the indicators related to import-dependent and export-oriented were examined by years and target countries of trade.

Table 4 shows information on whether each item showed a tendency to import-dependent or exports-oriented trend by year. These distinctions are divided according to the total amount of money of imports and exports and trade volume. If the trade volume is insufficient or the two characteristics are relatively similar, they are not separately classified.

Table 4. Trade trends of hydrazine-related products by year.

HS code \ Year	2013	2014	2015	2016	2017
2825.10-9010 (Hydrazine)	ID	-	-	-	EO
2825.10-9020 (Inorganic salt of hydrazine)	ID	ID	ID	ID	ID
2825.10-9041 (Hydroxyl ammonium chloride)	ID	-	ID	ID	ID
2825.10-9049 (Inorganic salt of hydroxylamine)	-	-	-	-	ID
2928.00-1000 (Phenylhydrazine)	ID	-	ID	ID	ID
2928.00-9020 (Methylethyl ketoxime)	-	-	-	-	ID
2825.90-1010 (Calcium oxide)	EO	-	-	-	-
2825.50-2090 (Copper hydroxide)	-	-	EO	EO	EO

* ID: Import-Dependent, EO: Export-Oriented.

Most of the products starting with 2825.10 and 2928.00 mentioned above tend to be import-dependent. Products with a HS code of 2825 in a broad category belong to the hydrazine-related product. Therefore, as a result of exploring export-oriented hydrazine-related products in this broad category, it was found that 2825.90-1000 (Calcium oxide) and 2825.50-2090 (Copper hydroxide) showed export-oriented characteristics. So it was investigated together for comparing their demand-supply networks with those of import-dependent products.

For products corresponding to each HS code, the import dependency and export intensity indexes can be used to determine which trade target countries are highly dependent on imports or which countries are main targets of export in the Republic of Korea.

As shown in Table 4, products that were granted HS code 2825.10-9010 were import-dependent in 2013 and exports-oriented in 2017. Table 5 shows the import amounts of money and import dependency indices of this product in accordance with target trade countries and year. In addition, Table 6 shows the SRCA, which means the degree of export-orientation for the same product, and the export amounts of money by trade target countries and year.

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As shown in Table 5, it can be seen that China, Germany, and Taiwan are the main target countries for imports of this product in 2013, and, besides, imported the product from France and Japan. Also, since the whole quantity depends on the import, almost all TSI values represent -1.00.

Table 5. Trends in import and export value and import dependency index by target trade countries of HS code 2825.10-9010 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	28,400	0	113,760	0	0
	Export ($)	0	0	0	0	0
	TSI	-1.00	0	-1.00	0	0
France	Import ($)	0	107,680	0	0	0
	Export ($)	0	0	0	0	0
	TSI	0	-1.00	0	0	0
Germany	Import ($)	259,200	0	5,107,620	0	363
	Export ($)	0	0	0	0	0
	TSI	-1.00	0	0	0	-1.00
Japan	Import ($)	0	1,667	0	0	0
	Export ($)	0	0	0	0	0
	TSI	0	-1.00	0	0	0
Taiwan	Import ($)	2,945	4,025	0	0	0
	Export ($)	0	0	0	0	17
	TSI	-1.00	-1.00	0	0	1.00
United States of America	Import ($)	0	0	0	0	54
	Export ($)	0	0	0	0	0
	TSI	0	0	0	0	-1.00

Table 6. Trends in export-related values and export-orientation index by target trade countries of HS code 2825.10-9010 products for each year.

Target country \ Year	2013	2014	2015	2016	2017
Domestic total exports ($)	559,632,433,795	572,664,607,063	526,756,503,366	495,425,939,637	573,694,420,540
HS code 2825.10-9010 total exports ($)	43,681	0	454	20,875	889

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Iran	Total exports ($)	0	0	0	3,716,566,540	0
	Certain product exports ($)	0	0	0	20,860	0
	SRCA	0	0	0	99.99	0
Jordan	Total exports ($)	1,316,642,875	0	0	0	0
	Certain product exports ($)	3,191	0	0	0	0
	SRCA	99.79	0	0	0	0
Pakistan	Total exports ($)	0	0	790,066,789	0	1,006,764,208
	Certain product exports ($)	0	0	454	0	751
	SRCA	0	0	99.99	0	99.99
Turkmenis-tan	Total exports ($)	0	0	0	0	130,922,876
	Certain product exports ($)	0	0	0	0	75
	SRCA	0	0	0	0	99.99
Venezuela	Total exports ($)	442,904,911	0	0	0	0
	Certain product exports ($)	40,490	0	0	0	0
	SRCA	99.99	0	0	0	0

As shown in Table 6, the products that were granted HS code 2825.10-9010 were mainly exported to developing countries. Also, when we check the SRCA values, we can confirm that it shows 99.00 or more. This means that products that are granted HS code 2825.10-9010 are products with a high level of export concentration in trade with the target country.

Through this information, SMEs dealing with hydrazine-related products will be able to know the past trade conditions in detail, which will help them to establish strategies for entering the trading market and securing trading partners. Information on import dependency and export centricity for the other HS codes shown in Table 4 is specifically included in Appendix A.

4.4. Analysing the Supply Chain Network of the Hydrazine-Related Products

A product supply chain network was embodied to identify usages of the import-dependent HS code items and export-oriented practical. As mentioned above, the supply chain network implemented in this study is systematically based on relational DB.

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Six of the eight HS codes presented in Table 4 were import-dependent and two were export-oriented. If the usages of each product are identified through the supply chain network, then the trade status and objective of each item can be verified from a macro perspective. It is also possible to identify firms handling such items through patent information that is the basis of the information on the usages. Furthermore, based on the above results, it can be analysed whether the current unfavourable condition of trade that the Republic of Korea has been undergoing in relation to the hydrazine-related products is advantageous or disadvantageous.

The supply chain network for the six products listed in Table 8 is shown in Figure 10, Figure 11 and Figure 12. In the case of HS Code 2825.10-9010, it is an exceptional case that changed from import dependency to export dependency over time (<Figure 10>), and 2825.10-9020, 2825.10-9041, 2825.10-9049, 2928.00-1000 and 2928-00-9020 were all imported Dependent products (<Figure 11>). Conversely, 2825.90.1010 and 2825.50-2090 are export oriented products (<Figure 12>). As shown in Figure 11, import-dependent products have complex supply chain networks with diverse usages, while export-oriented products have only slightly simpler applications as shown in Figure 12. For more detailed applications, the specific usages of HS code 2825.10-9010, which has changed from an import-dependent item to an export-oriented item, is shown in Table 7. Also, Table 8 and Table 9 detail CASRNs and their usages that match import-dependent HS codes and export-oriented HS codes, respectively.

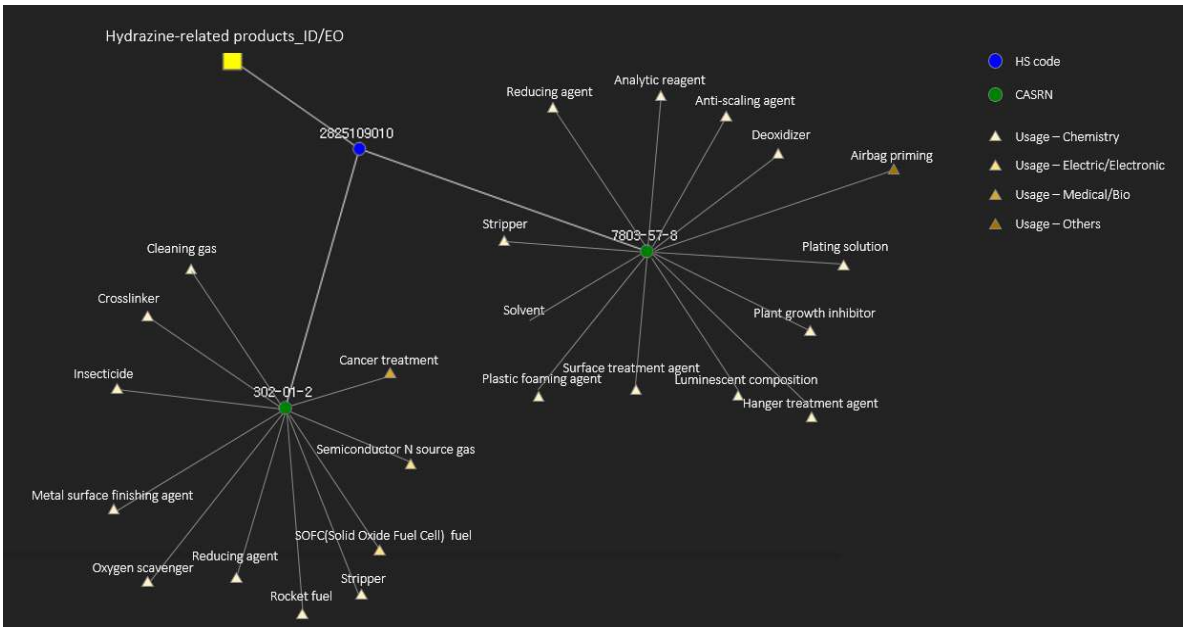

Figure 10. Supply chain network of hydrazine-related products starting with HS code 2825.10-9010.

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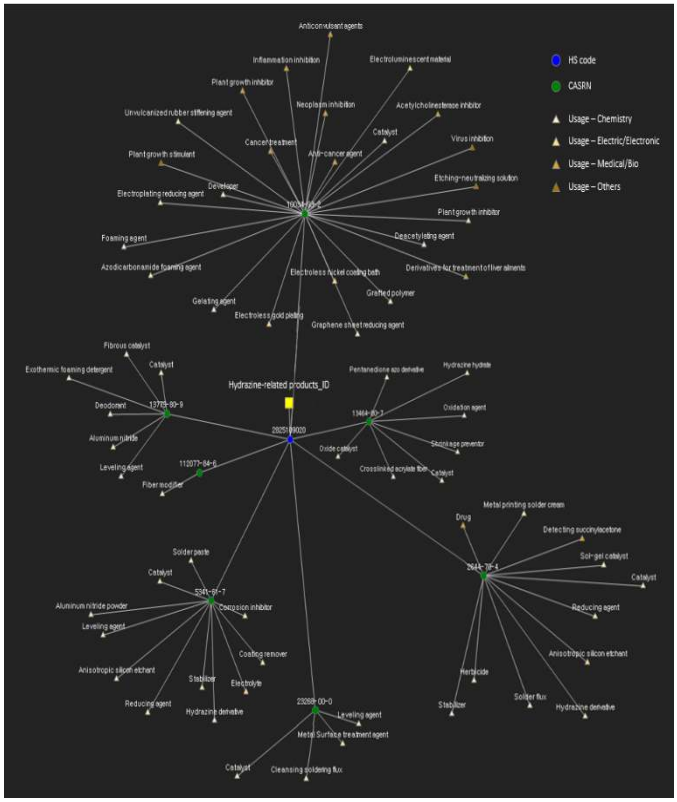
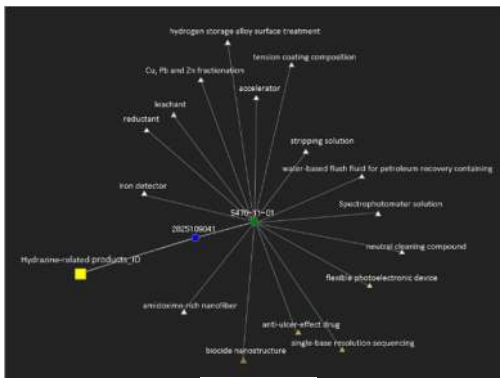
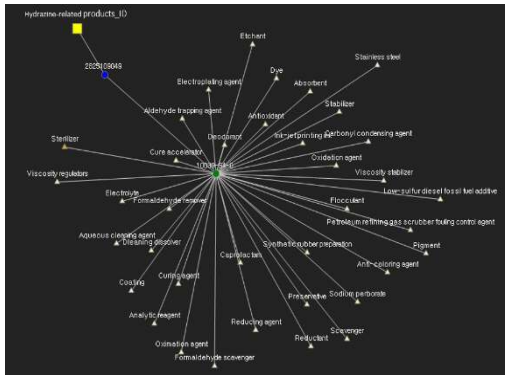


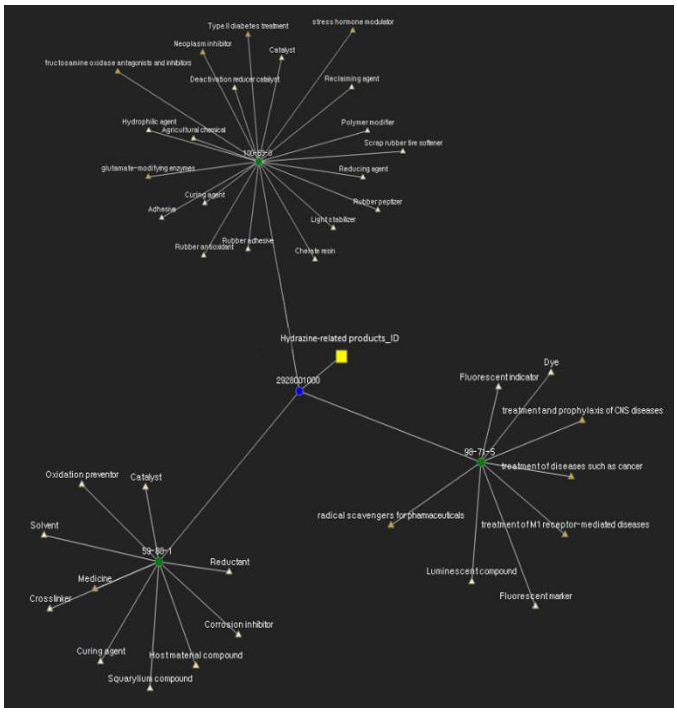
(a)



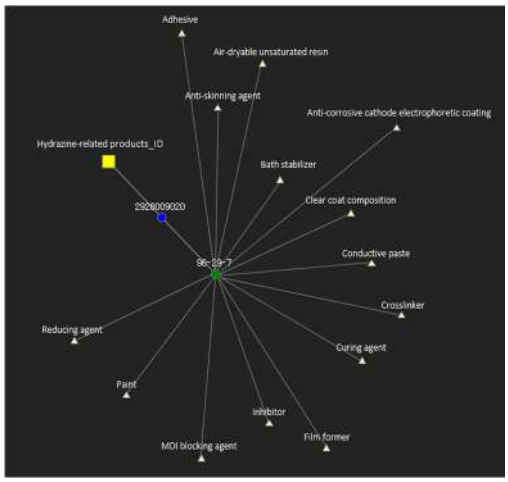
(b)



(c)



(d)



(e)

Figure 11. Supply chain networks of hydrazine-related products which belong to import-dependent products group: (a) HS code 2825.10-9020, (b) HS code 2825.10-9041, (c) HS code 2825.10-9049, (d) HS code 2928.00-1000, (e) HS code 2928.00-9020.

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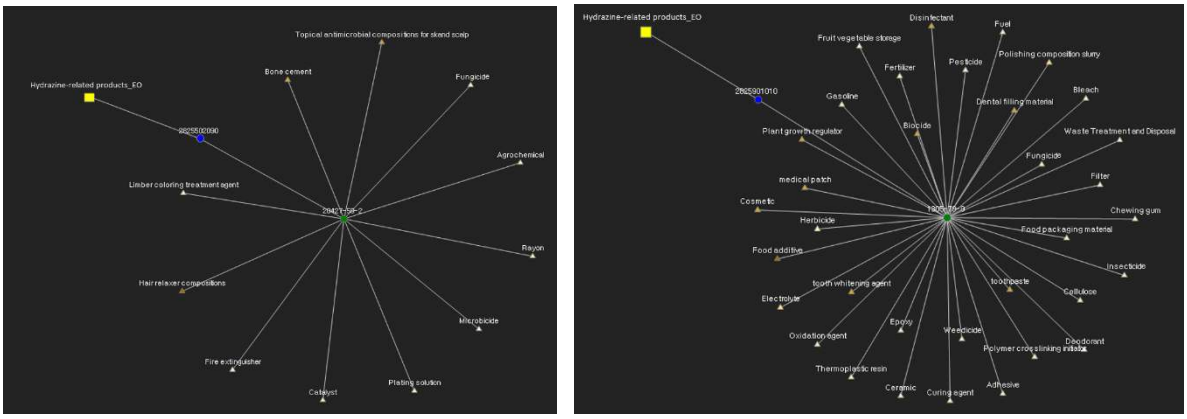

(a) (b)

Figure 12. Supply chain networks of hydrazine-related products which belong to export-oriented products group: (a) HS code 2825.50-2090, (b) HS code 2825.90-1010.

As can be seen in Table 7, the usages of HS Code 2825.10-9010 include many of the high-tech industries. For example, all types of usages for production, intermediate and consumer goods can be identified such as metal surface finishing agents, solid oxide fuel cell (SOFC) fuel, rocket fuel, cancer treatment, semiconductor N source gas, airbag priming, deoxidizer, luminescent composition, and so on. Most of these usages are high value added and require high technology. The fact that such high value-added items have been import-dependent in the past, but recently, they become export-oriented items can allow SMEs dealing with hydrazine-related products to establish appropriate business strategies.

Table 7. The CASRNs and the specific usages associated with HS code 2825.10-9010.

HS code	CASRN	Usages _Chemistry	Usages _Electric/ Electronic	Usages _Medical/Bio	Usages _Others
2825.10-9010 (Hydrazine)	302-01-2 (Hydrazine)	Cleaning gas; Crosslinker; Insecticide; Metal surface finishing agent; Oxygen scavenger; Reducing agent; Rocket fuel; Stripper	SOFC(Solid Oxide Fuel Cell) fuel; Semiconductor N source gas	Cancer treatment	-
	7803-57-8 (Hydrazine ($1H_2O$))	Analytic reagent; Anti-scaling agent; Deoxidizer; Hanger treatment agent; Luminescent composition; Plant growth inhibitor; Plastic foaming agent; Plating solution; Reducing agent; Reductant; Solvent; Stripper; Surface treatment agent	-	-	Airbag priming

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725 Table 8. The CASRNs and the specific usages associated with the import-dependent products.

HS code	CASRN	Usages _Chemistry	Usages _Electric/ Electronic	Usages _Medical/Bio	Usages _Others
2825.10-9020 (Inorganic salt of hydrazine)	10034-93-2 (Hydrazine sulfate)	Azodicarbonamide foaming agent; Catalyst; Deacetylating agent; Developer; Electroplating reducing agent; Foaming agent; Gelating agent; Grafted polymer; Graphene sheet reducing agent; Plant growth inhibitor; Unvulcanized rubber stiffening agent	Electroless gold plating; Electroless nickel coating bath; Electroluminescent material	Acetylcholinesterase inhibitor; Anti-cancer agent; Anticonvulsant agents; Cancer treatment; Derivatives for treatment of liver ailments; Inflammation inhibition; Neoplasm inhibition; Plant growth inhibitor	Etching-neutralizing solution; Plant growth stimulant; Virus inhibition
	112077-84-6 (Hydrazine carbonate)	Fiber modifier	-	-	-
	13464-80-7 (Dihydrazine sulfate)	Catalyst; Crosslinked acrylate fiber; Hydrazine hydrate; Oxidation agent; Oxide catalyst; Pentanedione azo derivative; Shrinkage preventor	-	-	-
	13775-80-9 (Hydrazine monohydro-bromide)	Aluminum nitride; Catalyst; Deodorant; Exothermic foaming detergent; Fibrous catalyst; Leveling agent	-	-	-
	23268-00-0 (Hydrazine dihydrobro-mide)	Catalyst; Cleansing soldering flux; Leveling agent; Metal Surface treatment agent	-	-	-
	2644-70-4 (Hydrazine monohydro-chloride)	Catalyst; Herbicide; Hydrazine derivative; Metal printing solder cream; Reducing agent; Sol-gel catalyst; Solder flux; Stabilizer	Anisotropic silicon etchant	Detecting succinylacetone; Drug	-
	5341-61-7 (Hydrazine dihydro-chloride)	Aluminum nitride powder; Anisotropic silicon etchant; Catalyst; Coating remover; Corrosion inhibitor; Hydrazine derivative; Leveling agent; Reducing agent; Solder paste; Stabilizer	Electrolyte	-	-

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726

Table 8. (continued).

HS code	CASRN	Usages _Chemistry	Usages _Electric/ Electronic	Usages _Medical/Bio	Usages _Others
2825.10-9041 (Hydroxyl ammonium chloride)	5470-11-01 (Hydroxyl ammonium chloride)	iron detector; reductant; leachant; Cu, Pb and Zn fractionation; hydrogen storage alloy surface treatment; tension coating composition; accelerator; stripping solution; water-based flush fluid for petroleum recovery containing; Spectrophotometer solution; neutral cleaning compound; amidoxime-rich nanofiber	flexible photoelectronic device	anti-ulcer-effect drug; single-base resolution sequencing;	biocide nano-structure
2825.10-9049 (Inorganic salt of hydroxylamine)	10039-54-0 (Hydroxyl-amine sulfate)	Absorbent; Aldehyde trapping agent; Analytic reagent; Anti-coloring agent; Antioxidant; Aqueous cleaning agent; Caprolactam; Carbonyl condensing agent; Coating; Cure accelerator; Curing agent; Deodorant; Dleaning dissolver; Dye; Electrolyte; Electroplating agent; Etchant; Flocculant; Formaldehyde remover; Formaldehyde scavenger; Ink-jet printing ink; Low-sulfur diesel fossil fuel additive; Oxidation agent; Oximation agent; Petroleum refining gas scrubber fouling control agent; Pigment; Preservative; Reducing agent; Reductant; Scavenger; Sodium perborate; Stabilizer; Stainless steel; Synthetic rubber preparation; Viscosity regulators; Viscosity stabilizer		Sterilizer	

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727 **Table 8.** (continued).

HS code	CASRN	Usages _Chemistry	Usages _Electric/ Electronic	Usages _Medical/Bio	Usages _Others
2928.00-1000 (Phenylhydrazine)	100-63-0 (Phenylhydrazine)	Adhesive; Agricultural chemical; Catalyst; Chelate resin; Curing agent; Deactivation reducer catalyst; Hydrophilic agent; Light stabilizer; Polymer modifier; Reclaiming agent; Reducing agent; Rubber adhesive; Rubber antioxidant; Rubber peptizer; Scrap rubber tire softener	-	fructosamine oxidase antagonists and inhibitors; glutamate-modifying enzymes; Neoplasm inhibitor; stress hormone modulator; Type II diabetes treatment	-
	59-88-1 (Phenylhydrazinium chloride)	Catalyst; Corrosion inhibitor; Crosslinker; Curing agent; Oxidation preventor; Reductant; Solvent; Squarylium compound	Host material compound	Medicine	-
	98-71-5 (Phenylhydrazine-p-sulfonic acid)	Dye; Fluorescent indicator; Fluorescent marker; Luminescent compound	-	radical scavengers for pharmaceuticals; treatment and prophylaxis of CNS diseases; treatment of diseases such as cancer; treatment of M1 receptor-mediated diseases	-
2928.00-9020 (Methylethyl ketoxime)	96-29-7 (Methyl ethyl ketone oxime)	Adhesive; Air-dryable unsaturated resin; Anti-corrosive cathode electrophoretic coating; Anti-skinning agent; Bath stabilizer; Clearcoat composition; Conductive past; Crosslinker; Curing agent; Film former; Inhibitor; MDI blocking agent; Paint; Reducing agent	-	-	-

728 Import-dependent hydrazine-related products are also found to have a variety of usages in the
729 fields of fine chemicals, medical and life sciences, and it is noteworthy that there are most of the high
730 value-added intermediates and consumer goods that require high technology. This suggests that the
731 hydrazine-related items are in the same context as the above-mentioned results, i.e. these products
732 are in trade unfavourable conditions, and the related-technology is not sufficiently advanced or
733 domestic market power associated with these products is weak.

734 **T**able 9. The CASRNs and the specific usages associated with the export oriented products.

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HS code	CASRN	Usages _Chemistry	Usages _Electric/ Electronic	Usages _Medical/Bio	Usages _Others
2825.50-9020 (Calcium oxide)	1305-79-9 (Calcium peroxide)	Adhesive; Bleach; Cellulose; Ceramic; Chewing gum; Curing agent; Deodorant; Epoxy; Fertilizer; Filter; Food packaging material; Fruit vegetable storage; Fuel; Fungicide; Gasoline; Herbicide; Insecticide; Oxidation agent; Pesticide; Polymer crosslinking initiator; Thermoplastic resin; Waste Treatment and Disposal; Weedicide	Electrolyte; Polishing composition slurry	Biocide; Cosmetic; Dental filling material; Disinfectant; medical patch; Plant growth regulator; tooth whitening agent; toothpaste	Food additive
2825.10-9049 (Inorganic salt of hydroxylamine)	20427-59-2 (Copper (Ⅱ) hydroxide)	Agrochemical; Catalyst; Fire extinguisher; Fungicide; Limber coloring treatment agent; Microbicide; Plating solution; Rayon		Bone cement; Topical antimicrobial compositions for skin and scalp	Hair relaxer composi-tions

Conversely, when we look at the usages of the export-oriented hydrazine-related products, a relatively large number of usages were related to necessities among consumer goods. Of course, not all usages have low value-add, but there are a number of usages where the added value is considered relatively low when compared to the usages of the import-dependent products. Ultimately, when we examine the above information in a comprehensive manner, the hydrazine-related product market in the Republic of Korea can be concluded that high value-added products are dependent on imports from abroad while low value-added products, especially kinds of daily necessity, are exported overseas.

These market-oriented information can help SMEs handling domestic hydrazine-related products to help them make decisions to expand into overseas markets, and also provide a basis for securing their technological capabilities and the market entry strategy.

5. Discussion

Globalisation of SMEs was one of the big issues in academia. Indeed, many international researchers have agreed that SMEs' participation in internationalisation should be revitalised in the era of globalisation [5-17]. Nevertheless, globalisation of SMEs has problems such as constraints on available resources, lack of infrastructure, lack of know-how, and so forth, when compared with MNCs [26-29]. Therefore, studies related to the globalisation of SMEs have been limited to analysing the phenomena such as Uppsala model, BGs, etc.

From a RBV, a network viewpoint, and an MO viewpoint, it was knowledge, or market-oriented information, that played one of the key roles in the globalisation of SMEs. It is a reality for SMEs that it is not easy for SMEs to get information on their current status of trade, import and export data, potential competitors, and partners who can establish friendly relations in entering the global market. Thus, such information needs to be strategically provided to SMEs to support them at the government level [39, 44, 139].

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Therefore, in this study, we have studied the system that can effectively communicate market-oriented information to SMEs from the government's perspective. In other words, we have studied how SMEs can obtain market-oriented information related to their products more easily and quickly, and devised a systematic and automatic method as the solution by using various DB links.

To do this, we constructed an optimal relational DB by linking information related to trade and patent information. We also used various indices for the trade condition to identify actual market-oriented information and designed relational DB to embody the product supply chain network. Thus, a systematic basis is established to derive various market-oriented information corresponding to the HS code or CASRN of the product. In addition, we have presented the results of our research as an example of the data provided by KISTI in the request of actual SMEs dealing with hydrazine-related products.

This study is an exploratory study, and it has studied how government agencies can actually support the internationalisation of SMEs on a practical level. For governments, the most direct way to help SMEs is by subsidising or giving them projects directly. However, SMEs that can benefit from these methods are limited. On the other hand, government support through information is advantageous in that it can be used variously according to the discretion of the user as long as the infrastructure is equipped, and it can be highly effective against the investment. Especially, in the knowledge-based economy society, the asymmetry of information between large corporations and SMEs can be alleviated or somewhat solved, so the social value is also quite high, in terms of reducing polarisation. In addition, support for SMEs through information has the advantage of providing fundamental and long-term support, rather than temporary support, in terms of expanding the level of knowledge and capability of SMEs themselves. Therefore, it can be said that the information support system can change the constitution of SMEs with limited resources so that more competitive SMEs can be raised at the national level in the era of globalisation.

Limitations of this study include the followings. First, there is a lack of research on how the information provided in the relational DB used in this study actually benefited SMEs. This can be achieved by obtaining data on the responses and performance of SMEs who have received actual information support. So, we are preparing a follow-up empirical study about this. In addition, the information provided in this study focused more on the information that real data could provide, rather than tailored to the needs of SMEs. Therefore, it is necessary for SMEs to further explore the information they need when entering the global market. Finally, the data provided in this study is centred on Korea trade data. Therefore, it is necessary to build richer and more practical market-oriented information by securing international trade data for the internationalisation of SMEs. For this purpose, data expansion and linking with existing data are being discussed internally, and future research is under way.

Appendix A

Table A1. Trends in import and export value and import dependency index by target trade countries of HS code 2825.10-9020 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	0	13,068	6,712	0	7,870
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	0.00	-1.00
Germany	Import ($)	0	0	0	261	191

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	Export ($)	0	0	0	0	0
	TSI	0.00	0.00	0.00	-1.00	-1.00
India	Import ($)	0	0	0	1,974	112
	Export ($)	0	0	0	0	0
	TSI	0.00	0.00	0.00	-1.00	-1.00
Japan	Import ($)	18,983	20,545	12,567	14,163	11,281
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United Kingdom	Import ($)	0	140	185	433	868
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	-1.00	-1.00
United States of America	Import ($)	0	240	76	0	0
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	0.00	0.00

Table A2. Trends in import and export value and import dependency index by target trade countries of HS code 2825.10-9041 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	77,455	77,694	49,513	113,186	101,121
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
Germany	Import ($)	63,750	148,750	63,750	85,010	106,405
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
Japan	Import ($)	3,545	4,678	5,093	4,278	4,680
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
	Import ($)	105	307	583	1,671	2,688

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United Kingdom	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United States of America	Import ($)	6	11	0	10,113	206
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	0.00	-1.00	-1.00

Table A3. Trends in import and export value and import dependency index by target trade countries of HS code 2825.10-9049 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	981,508	1,018,461	806,342	865,671	386,909
	Export ($)	0	0	4,269	0	0
	TSI	-1.00	-1.00	-0.99	-1.00	-1.00
France	Import ($)	0	14	49,600	0	0
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	0.00	0.00
Germany	Import ($)	54,083	189,350	348,826	151,466	361,339
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
Japan	Import ($)	505,644	20,243	30,954	178,735	36,829
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United Kingdom	Import ($)	0	38	68	0	4,408
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	0.00	-1.00
United States of America	Import ($)	0	4	236	219	0
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	-1.00	0.00

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Table A4. Trends in import and export value and import dependency index by target trade countries of HS code 2928.00-1000 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	0	168	6,128	279	1,383
	Export ($)	539	0	0	0	0
	TSI	1.00	-1.00	-1.00	-1.00	-1.00
India	Import ($)	0	0	0	341	548
	Export ($)	0	0	0	0	0
	TSI	0.00	0.00	0.00	-1.00	-1.00
Japan	Import ($)	28,112	109,775	80,585	111,697	89,889
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United Kingdom	Import ($)	158	4,474	3,472	112	307
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United States of America	Import ($)	190	1,061	50	0	0
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	0.00	0.00

Table A5. Trends in import and export value and import dependency index by target trade countries of HS code 2928.00-9020 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
China	Import ($)	106,064	177,073	416,912	575,516	251,900
	Export ($)	10,520	9,176	12,170	7,007	3,743
	TSI	-0.82	-0.90	-0.94	-0.98	-0.97
India	Import ($)	0	16	0	0	42,408

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	Export ($)	1,883	1,260	1,075	496	2,879
	TSI	1.00	0.97	1.00	1.00	-0.87
Japan	Import ($)	193,940	918,500	1,146,495	692,187	427,333
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	-1.00
United Kingdom	Import ($)	0	52	119	24	37
	Export ($)	0	0	0	0	0
	TSI	0.00	-1.00	-1.00	-1.00	-1.00
United States of America	Import ($)	227,814	441,828	101,961	19,317	0
	Export ($)	0	0	0	0	0
	TSI	-1.00	-1.00	-1.00	-1.00	0.00

Table A6. Trends in export-related values and export-orientation index by target trade countries of HS code 2825.90-1010 products for each year.

Target country \ Year		2013	2014	2015	2016	2017
Domestic total exports ($)		559,632,433,795	572,664,607,063	526,756,503,366	495,425,939,637	573,694,420,540
HS code 2825.90-1010 total exports ($)		839,670	1,212,419	1,462,039	581,015	585,129
China	Total exports ($)	145,869,498,273	145,287,701,213	137,123,933,893	124,432,941,239	142,119,999,703
	Certain product exports ($)	327,224	610,499	834,422	127,816	107,244
	SRCA	38.18	59.51	65.56	-13.18	-29.25
India	Total exports ($)	11,375,792,024	12,782,490,256	12,029,586,768	11,596,285,824	15,055,543,131
	Certain product exports ($)	53,487	71,144	112,492	118,447	131,792
	SRCA	81.52	74.72	83.81	97.40	97.32
Japan	Total exports ($)	34,662,290,114	32,183,787,734	25,576,507,270	24,355,036,459	26,816,141,106

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	Certain product exports ($)	298,434	261,877	183,726	0	4
	SRCA	94.11	87.32	74.02	-99.99	-99.99
Slovakia	Total exports ($)	4,406,986,422	4,298,747,961	3,543,446,832	2,926,364,831	2,772,780,155
	Certain product exports ($)	68,145	97,910	190,933	147,489	142,697
	SRCA	98.13	98.29	99.47	99.89	99.92
United States of America	Total exports ($)	62,052,487,604	70,284,871,834	69,832,102,801	66,462,311,986	68,609,727,326
	Certain product exports ($)	3,176	41,491	65,342	48,103	28,139
	SRCA	-99.77	-85.57	-79.59	-44.84	-72.16

808 809 **Table A7.** Trends in export-related values and export-orientation index by target trade countries of HS code 2825.50-2090 products for each year.

Target country \ Year	2013	2014	2015	2016	2017
Domestic total exports ($)	559,632,433,795	572,664,607,063	526,756,503,366	495,425,939,637	573,694,420,540
HS code 2825.50-2090 total exports ($)	0	0	633,546	214,232	114,171
Australia	Total exports ($)	0	0	0	0	19,861,647,344
	Certain product exports ($)	0	0	0	0	51
	SRCA	0.00	0.00	0.00	0.00	-99.97
Italy	Total exports ($)	0	0	0	3,163,432,701	0
	Certain product exports ($)	0	0	0	150	0
	SRCA	0.00	0.00	0.00	-97.62	0.00
Japan	Total exports ($)	4,662,290,114	32,183,787,734	25,576,507,270	24,355,036,459	26,816,141,106

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	Certain product exports ($)	0	0	633,546	213,817	113,136
	SRCA	0.00	0.00	99.53	99.52	99.56
Taiwan	Total exports ($)	0	0	0	12,220,455,254	14,898,397,854
	Certain product exports ($)	0	0	0	265	943
	SRCA	0.00	0.00	0.00	-99.50	-81.63
Thailand	Total exports ($)	0	0	0	0	7,467,041,220
	Certain product exports ($)	0	0	0	0	41
	SRCA	0.00	0.00	0.00	0.00	-99.85

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