This paper aims to evaluate the interaction between China’s and Sweden’s revealed comparative advantages (in available sectors, coded according to sni92, from 111 to 9302) within the product cycle theory framework. Revealed comparative advantage (RCA) of China is investigated as a RCA of Sweden with an expected negative dynamic relationship over time due to the shift of production during the stages of product cycle theory, with the other variables like capital intensity and R&D to sales ratio. A part of China’s achievement in trade performance is tried to be explained within product cycle theory by linking it to the flying geese pattern of development. The industrial trade data is tested for the period of 1990 to 2000 with OLS and XTFEVD estimation.

Key words: Revealed comparative advantage, product cycle, flying geese paradigm
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1. Introduction

Trade is one of the redemptive factors for latecomer countries in terms of global competitiveness. When we look at the newly industrialized countries in Asia, trade gains more attention by linking it with their economic performance. China, which is one of the Asian new industrial economies (NIEs) and the concern of this paper, has been considered as the most rapidly growing economy with an average annual growth rate of 10% from 1978 to 2005 after the opening to the world economy (Naughton, 2007). Manufactured exports of China increased by 16.9%, which is greater than the world’s percentage being 6.4%, all developing countries’ (12%) and the rest of the East Asia’s (10.3%), every year for the period 1990-2000 and continued to increase after 2000 (Albaladejo & Lall, 2003). With its relatively rapid trade liberalization in the second half of the 1990s and the WTO accession in 2001, finally China has become the leader exporter in world merchandise trade in 2009, with its 9.6% share (WTO, 2010). This paper also focuses on that stable period (1990-2000) for the empirical analysis that is used as an illustration of a possible dynamic for China’s tremendous exports’ growth within the product cycle theory and “flying geese” pattern of development.

There is a growing literature on the possible factors of China’s achievement. Gaulier et al. (2005) points out; ‘China’s involvement in the international segmentation of production processes’ and ‘integration in Asian production networks’ as the important factors of China’s remarkable trade expansion. The latter, referring to production sharing among East Asian countries is another research topic like Cheang & Dowling (1999) that examines trade patterns of Asian economies within the framework of the “flying geese” pattern of development. Akamatsu introduced the flying geese theory in the 1930s describing how a less developed country becomes exporter of the product which was firstly introduced in that developing country via imports. This theory may be considered to be one step behind the Vernon’s (1966) product cycle theory. The flying geese theory’s first step (introduction of a new product to a developing country via imports from an industrialized country) corresponds to the product cycle theory’s second step (the maturing product stage where relocation of production is likely to occur). This paper seeks

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1 ‘East Asia’ is referred to the economies of Hong Kong, Singapore, Korea, Taiwan, Malaysia, Thailand, Philippines and Indonesia (Albaladejo & Lall, 2003).

2 Total exports of China increased by 7% (WTO, 2003) when the world’s total exports decreased by 4% and the other developing regions lost from their export shares like Latin America (3%), Middle East (7%) and Africa (6%) (Albaladejo & Lall, 2003).
for the relationship between revealed comparative advantages (RCA) of Sweden and China as an indicator for that correspondence and tries to explain China’s trade performance with its trade relations with industrialized countries by taking Sweden as a departure.

‘Made in China’ is becoming a very common phrase on stickers attached to goods of common brands and this situation points out China as a global manufacturing base for those multinational firms. Gaulier et al. (2007) stated that China’s foreign trade to a large extent is the result of the investments of outsourcing foreign firms. They added that about half of China’s foreign trade is fostered by assembly and processing of imported inputs for re-export since the early 1990s. This is served as the reason for China’s rapid diversification from textile to electronics. To assess this diversification of the path, revealed comparative advantage of China is observed for periods; 1974-1999 and 2000-2008. Values larger than one indicate that the country has a comparative advantage for that specific product group.

The specified industries in Figure 1 are picked according to the general first two digits in SITC (Standard International Trade Classification) revision 2, including all related subsectors to be able to provide a correspondence and continuity with the classification of WTO. Again for the consistency between the two sources, sectors coded as ‘75’ and ‘76’ are combined as telecommunication and office equipment in Figure 1. The used SITC codes are:

- 65--: Textile yarn, fabrics, made-up articles and related products
- 67--: Iron and steel
- 75--: Office machines and automatic data-processing machines
- 76--: Telecommunications, sound-recording and reproducing apparatus and equipment
- 78--: Road vehicles (including air-cushion vehicles)

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3 Revealed comparative advantage is used to determine China’s changing situation in terms of trade with respect to rest of the world, in other words world market share of China.

4 To include recent movements in RCA of China, 2000-2008 period was added from another source (WTO) due to the lack of information for that period in the main source, Feenstra et al. in NBER (2005). In addition, since WTO has numerous missing data for the previous years, the figures are divided into two as recent and previous situation. Periods could not be merged due to the different classification of product groups leading data mismatch.
Figure 1: RCA of China with respect to rest of the World for 1974-1999

![RCA (1974-1999) chart](chart1.png)

**Source:** Author’s calculations based on NBER (Feenstra et al., 2005) data.

Figure 2: RCA for China with respect to rest of the world for 2000-2008

![RCA (2000-2008) chart](chart2.png)

**Source:** Author’s Calculations based on WTO data
As it can be seen in Figure 1 & 2, the development of telecommunication and office equipments as a share of world trade is remarkable. Taking the decline in RCA of textiles and clothing into consideration, this paper suggests that the product cycle theory is able to explain some of this shift from labor intensive production to technically more advanced production. The link between revealed comparative advantage and the production is explained in Marconi and Rolli (2008). According to their work, positive and large RCA values are usually related to low unit labor costs in the corresponding domestic activities both in low technology production and in medium and high technology production. Whereas high domestic accumulation of physical capital is shown to be associated with stronger RCA values only in medium and high tech production. In light of this information, how can China’s improvement in medium or high tech industry, like telecommunication equipment industry, be explained when China is considered as a labor-abundant country? The product cycle theory suggests that trade with an industrialized country creates the supply of capital and technological know-how. It describes stages of a product beginning from its entry to the market for the first time. This infant stage is followed by a maturing stage; where less developed countries have access to the product via imports. The standardized product stage, which comes after, corresponds to the period of acquiring production technique for that product in the less developed country to be able to export. This theory proposes the way for a less developed country to shift its trade pattern via importing production techniques. China, in this framework, imports Swedish commodities that Sweden no longer has comparative advantage in and Sweden, shifts production to China that now develops a comparative advantage with having the old level of technology. China is the 10th biggest trading partner of Sweden with 3.1% share of its total exports of goods\(^5\). China’s Zhejiang Geely Holding Group has just signed to own Sweden’s Volvo\(^6\) cars for $1.8 billion in 2010 (Xinhua, 2010). As this enlargement of production network resulted in a negative relationship between engaged parties’ comparative advantage, China becomes capable to make a substantial progress in technologically intensive production.

\(^5\) [http://www.scb.se/Pages/TableAndChart____26637.aspx](http://www.scb.se/Pages/TableAndChart____26637.aspx)

\(^6\) AB Volvo (Aktiebolaget Volvo) of the Volvo Group, which is established in 1927, is a Swedish producer of commercial vehicles like cars, buses, trucks etc. However the Volvo Car Corporation of AB Volvo was sold to the U.S. automaker Ford Motor Company in 1999. AB Volvo is manufacturing trucks, buses, and construction/marine/aircraft equipments and industrial engines now. The Volvo trademark was jointly owned by Volvo and Ford. In 2010 Ford decided to sell the business to China’s Zhejiang Geely Holding Group to focus on its other brands (Fangfang, 2010). According to the news of USATODAY; “The deal also covers further agreements on intellectual property rights, supply, and research and development arrangements between Volvo Cars, Geely and Ford” and Ford “has committed to provide engineering support, information technology, access to tooling for common parts and certain other services for a transition period to smooth the separation” (Jones, 2010).
The dynamics of comparative advantage graduate from labor intensive production to more capital and technology intensive activities with the changes in the pattern of international trade in some other emerging economies like China (Lall 2000, Landesmann & Stehrer 2001, Stehrer & Wörz 2003). In addition, according to Gaulier, Lemoine & Unal-Kesenci’s work (2007), foreign firm affiliates account for 80% China’s total trade, which also reflects China’s selective trade policy promoting processing trade. In other words, these firms have outsourcing strategy attracted by China’s cheap labor after routing to a policy of reform and door opening in the late 1970s. This implies that the role of China in international spatial fragmentation of production process gives opportunity to boost their high tech trade more than its actual domestic capabilities (Gaulier et al. 2007). This situation provides a bounce to China in international competitiveness not only in labor-intensive products but also in some technologically advanced products.

From the flying geese theory point of view, which starts by explaining the maturing product stage and thereafter the standardized product stage of the product cycle theory, foreign direct investment (FDI) is one source for the developed countries to ‘recycle’ their comparative advantage to less developed countries (Cheang & Dowling, 1999). This paper will investigate whether Sweden ‘recycles’ its comparative advantage to China. If so, will it be indicated by negative relationship between two countries’ RCAs for same product groups?

The plan of the paper is as follows. The second section overviews the empirical and theoretical literature. Section 3 covers the theoretical background of the analysis consisting of; the product cycle theory, the flying geese pattern of development and how they are related to RCA. Section 4 describes the data and the methodology used. Finally, section 5 gives the model with the results and section 6 concludes.

2. Literature Review

There exist numerous studies analyzing the rapid economic development accompanying the structural changes in Asian economies and usually show international trade and FDI as means for it (Kojima, 1985; Lo et al., 1988; Rana1990; Hirata et al., 1991; Fukasaku, 1992). These kinds of catching-up strategy analyses may be very roughly divided into two types in terms of their conclusions which give rise to predictions about the future
of this rapid development of Asia. The first group predicts that these structural changes may improve and encompass more sophisticated developments like design and related services (Albaladejo & Lall, 2003). The second group finds it unrealistic to expect leapfrogging (i.e. developing countries take market share as a result of moving to advance technologies); because necessary investment for changing industrial structure takes time like education, capital accumulation, technological upgrade, etc. Furthermore, the sustainability of growth is under question. Kwan (2002) may be considered as an example of this group with saying; China’s joining the ranks of advanced nations by skipping the long industrial development process is unrealistic due to the immature export competitiveness with ‘low-value-added products’.

According to Gaulier et al. (2007), China is becoming a major partner in production networks and an export-platform for multinational firms. They analyzed CEPII research work (Gaulier et al., 2005; Gaulier et al., 2006) using the China’s Custom Statistics in order to break down China’s foreign trade flows into Chinese firms, firms with foreign capital and wholly-foreign-owned firms. The results showed that outsourcing strategies of foreign-owned firms account for the largest and the most dynamic part of China’s foreign trade, especially for the trade surplus with the US and Europe (Gaulier et al., 2007).

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7 Export-platform affiliate production (EP) is a phenomenon for exporting a larger amount of output of a foreign affiliate of a transnational corporation rather than selling in the host country (Ekholm et al., 2003). Ekholm et al. (2003) analyzed whether high-cost and large countries shift production to low-cost small countries for any of the three exporting purposes; exporting back to the home-country (home-country EP), exporting to the other large country (third-country EP) and exporting to both (global EP). The results of the study showed that foreign manufacturing affiliates of US multinationals inside North America are mostly engaged with home-country EP and affiliates inside Europe are mostly engaged with third-country EP (Ekholm et al., 2003). According to the their findings, home-country EP and third-country EP occur for the large countries when the trade costs for final goods are higher than the trade costs for intermediates or added fixed costs of fragmentation, supporting the ‘knowledge-capital model’ (Ekholm et al., 2003). The formal theories of multinational firms are grouped into three categories by Blonigen et al. (2002) as; the horizontal model (Markusen, 1984), the vertical model (Helpman, 1984) and the knowledge-capital model (Markusen et al.; 1996, Markusen; 1997). The horizontal model is for the firms engaging in identical production in multiple locations to be close to customer and avoid the trade cost. In the vertical model, firms divide production process and locate in different countries having lower factor costs. The knowledge capital model combines horizontal and vertical model’s assumptions for FDI motivations. The motive of the model is again benefiting from the factor price differences to be able to reduce the cost of production (Blonigen et al., 2002). It assumes “services of knowledge based and knowledge generating activities such as R&D can be geographically separated from production and supplied to production facilities at low cost” and “knowledge based services have partial joint input characteristics that they can be utilized simultaneously by multiple production facilities” (Carr et al., 2001).

8 Centre d’Etudes Prospectives et d’Informations Internationales (CEPII), that was founded in 1978, is an independent French research center in international economics. It provides studies, researches, databases, analyses on the world economy and its evolution with being in connection with other foreign research institutes. The main research areas are competitiveness, specialization, outsourcing, trade negotiations, trade in services, FDI, large emerging economies, EU integration, tax competition, financial globalization, exchange rates and migration (http://www.cepii.fr).
This paper puts emphasis on China’s burgeoning exports, in terms of the changes in its revealed comparative advantage (RCA) in relation with Swedish RCA to reveal whether the product cycle theory has any explanatory power. RCA measure has also been used as an indicator of shares in international trade in studies like; UNIDO, (1986); World Bank, (1994); Laursen, (1998). RCA is used as a measure aimed at determining the dynamics of comparative advantage and trade patterns. Rana (1990) studied the changes in the pattern of revealed comparative advantage of 14 Asian and Pacific countries from 1965 to 1984 and found a certain linkage between changes in the patterns of trade and economic development and stated that RCA can be beneficial in revealing this link. Also Chow & Kellman (1993) used RCA analysis in examining the trade patterns of the four East Asian NIEs for the period between 1960 and 1990. Cheang & Dowling (1999) found that “the shifts in comparative advantage were significant from Japan to the NIEs and the shifts were beneficial in the sense that the gains increased export earnings and promoted economic development in these countries.” According to the analysis of Albaladejo & Lall (2003) referencing China’s export data in the 1990s, even if low technology products have a large share in manufactured goods exports with their labor intensive nature, the structure of exports shifted towards medium and high technology products with a slowing down in the growth of labor intensive textile & clothing industry. They also referred to the machinery sector (medium-tech engineering and high-tech electronics) as the fastest growing sector with the share of $30 billion of engineering products in total medium-tech exports which is $48 billion. They explained the reason for 18% annual growth of engineering exports over the decade as the entry of multinational producers leading an upgrade in local enterprises.

Kesenci & Lemoine (2002) agreed with Albaladejo & Lall (2003) in China’s trade moving into high-tech products. Even if simple assembly constitutes the large part of it, they claim that “there is a considerable deepening of local content and even design and development activity, faster than seen in countries like Malaysia, Thailand or the Philippines” with government support in setting up local R&D facilities. This dynamism within the Chinese economy is studied in line with the product cycle theory in this paper as Cumings (1984) studied Northeast Asia in a similar way. Japan, in his study, was claimed to be the adaptor of foreign technologies with a strong government protection and fits both to the product cycle theory and the flying geese pattern. Textiles, steel, automobiles and light electronics all had the life cycle stages as the new product, the maturing product and the standardized product stages. Then Taiwan and Korea were let to start production in
declining Japanese industries. However, China’s development is taken as fundamentally different then Japan’s and Korea’s by Liu (2007) since China is still relying heavily on imported technology rather than technology developed at home. Similarly Hobday (1995) argued that the flying geese pattern of development cannot capture the different development paths that in China. He explored ‘large local market’ and ‘huge supplies of cheap technical labor’ as other factors besides ‘exporting via foreign multinationals’ and ‘large scale sub-contracting’ that should be taken into consideration in analyzing East Asian path of development. These factors bring different dynamics to China like; global firms moving separate elements of the production process to China which also brings knowledge, big market size, market-oriented innovation, and FDI. Providing technology from the rest of the world is the key for creating a life cycle of a technology system. After that, big local market size gives opportunity to compete with multinationals by aiming low-end and rural markets. Lack of innovation culture, low spending on R&D, few radical innovations also presented as main challenges to suggested market-oriented innovation strategy of China. According to Cao (2008) sustainable development is possible only with the help of the imported technology that will be transported to the new products.

3. Theoretical Background

3.1. Product Cycle Theory

Product cycle theory was developed by Vernon to explain the observed pattern of international trade in 1966. His theory puts less emphasis upon the doctrine of comparative costs and more upon the timing of innovation and the effects of scale economies. However the term ‘product life cycle’ was used for the first time in 1965, by Theodore Levitt in the Harvard Business Review article: "Exploit the Product Life Cycle."

The period between introduction to the market and exiting from the market for a product is called the ‘product life cycle’. This period is divided into three stages within the framework of this theory as the new product stage, the maturing product and the

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9 The doctrine of comparative costs presented by Ricardo (1817) says; in the long run and under free trade conditions, specialization occurs according to the each country’s comparative advantage in terms of real costs.

10 'New product' was not explicitly defined by Vernon (1966). This matter was raised by Finger (1975) as a critique of the product cycle theory. Hirsch (1967) and Vernon (1966) were referred to ‘most complete versions of the product cycle applied to international trade’ by Finger. Hirsch’s definition of the ‘new product’ is based on two conditions; being produced by unused production methods for the product and based on a
standardized product stage by Vernon (1966). Within the first stage a new product emerges and is developed in local market and exported only to the countries with similar needs, preferences and income. Price elasticity of aggregate demand and aggregate demand itself for the unknown product are low. Cost of production is high and capital intensity is relatively low. After this infant stage, the product becomes more standardized and is produced using mass production techniques with lower costs reflected in lower prices in the maturing product stage. When the domestic market is thick due to increased competition from entry of firms, the location of production facilities are likely to shift in order to lower the cost. If production and transportation costs turn to be lower abroad, relocation of the production becomes less costly than producing at home. As the final (the standardized product) step, product and the production process are all standardized with high capital intensity. Product differentiation is needed in order to compete. Riding the wave of lowering the cost, Vernon (1966) hypothesizes that less developed countries acquire the necessary production technique via importing from the developed country and then eventually become exporters so that standardized production can be done at large scale. The less developed country producing the standardized product for the foreign brand with old level of technology and low labor cost enables the developed country to develop new products or techniques. The different supply and demand conditions among countries yield these stages to occur with the means of trade.

The product life cycle theory is used to analyze various maturity stages of products and industries. This variety is reasoned by the fact that the high-income countries are more capable of invention and development of a new product with their high capital intensity, highly educated labor and technology endowment. Also a high-income society is assumed to have a price inelastic demand for the new product. High demand and the good contact with the market provide necessary conditions for a new product to flourish and communize. Developing countries that are lacking these kinds of opportunities take their place in the international division of labor by producing earlier stages or intermediate products with low cost of labor and imported production technique.

recent invention or unfamiliar developments. Finger criticized this definition due to the misapplication that it would lead with giving examples of products satisfying Hirsch’s conditions of being a ‘new product’ for which the consumption is dominated by imports rather than evolving towards exporting. According to Finger Vernon used the term ‘new product’ for the products “not only technologically new but which are unfamiliar to buyers i.e. which cater to newly realized wants” (Finger, 1975).
3.2. The Flying Geese Pattern of Development

“The linkage between economic development, trade and FDI is described by the flying geese pattern of development.” (Cheang & Dowling, 1999). The phase "flying geese pattern of development" was coined originally by Kaname Akamatsu in 1930s. Cumings (1984) also used Akamatsu’s flying geese analogy within the product cycle theory for East Asian case of development. The flying geese pattern of development is explaining the growth of industries in developing countries within their catching up process of industrialization in line with dynamic comparative advantage. The name comes from the inverted ‘V’ formation of flying geese experienced in East Asian case where Japan was the leader and the dynamic driving force behind industrial development. The Asian newly industrialized economies (South Korea, Taiwan, Singapore, Hong Kong) and the ASEAN4 (Indonesia, Malaysia, Philippines, Thailand) were the followers supplied by Japan with capital and technological know-how through the expansion of trade and FDI. Afterwards, the follower countries exported the commodities that Japan’s comparative advantage did not last usually because of the increasing labor costs (Park, 1989). For the leader to move into more capital intensive production, low productivity production is shifted to the follower countries endowed with old level of technology. This shift continues to the next tier of followers in same manner.

The flying geese model has three aspects in explaining developing countries’ catching-up process of industrialization; intra-industry aspect, inter-industry aspect and international aspect. The first aspect is the counterpart of the product cycle theory’s second and third steps from the developing country point of view. It covers the product’s development in the developing country. The product was first imported and then the production technique was acquired from the developed country and finally the developing country starts exporting. The second aspect is about the development of industries in the developing country by upgrading from simple to complex products. The last aspect points out the relocation of production from leader country to next tier of following countries. Figure 3. shows Kwan’s (2002) illustration of inter-industry and international aspect of the flying geese model for Asia. He observed a typical sequence of shifting comparative advantage from the textiles industry to chemical, steel, automobile and electronics/electrical industries step by step among Asian countries.
Figure 3. Asia’s flying geese pattern of development

Source: Kwan, 2002: 3.

There also exist extensions of the theory combining it with Dunning’s OLI framework to explain FDI flows in East Asia. FDI is suggested as a channel of realization of the development theory. See Damijan & Rojec; 2004 and Barnard; 2008 for detailed information.

Figure 4 shows the cases for developed country and the developing country following the product cycle theory. The general principles of the product cycle theory and the flying geese pattern of development are similar; however the latter gives an additional perspective of the developing country after the introduction stage of the new product and enlarge the theory with similar relationships among developing countries. When domestic production is no longer comparatively advantageous in a developed country, the product is introduced to a developing country to capture the demand that will lead production. This stage is represented by the black area of developing country in Figure 4. After the demand in developing country deescalates, the developing country starts exporting. To reinforce the production, capital goods and techniques are imported which usually follows inward

\[ \text{FDI} = O + L + I \]

where O; ownership advantages (trademark, production technique, entrepreneurial skills, returns to scale), L; locational advantages (raw materials, wages, taxes, tariffs), I; internalization advantages (licensing, joint venture). The multinational firm considers the advantages to decide on operating abroad in order to overcome the cost.

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11 John H. Dunning’s theory, the eclectic (OLI) paradigm of international production, was first mentioned by himself at a Nobel Symposium in Stockholm in 1976, (Dunning, 2001). It is about internalization process for the time of making transactions, is cheaper within an institution rather than the free market for multinational enterprises. OLI model is a further development of the internalization theory with combining other individual theories of foreign direct investment. FDI=O+L+I
FDI. When the standardized product stage is subsequently reached by the developing country, production is relocated to deal with increasing costs faced as a result of decreasing demand. This paper however focuses on the intra-industry aspect of the flying geese pattern of development coinciding with the product cycle theory’s last two steps and runs a simple test to show the relationship between Sweden’s and China’s changing patterns of trade (changing RCAs) as two sides of the same argument.

Figure 4. Production, consumption and trade in the Product Cycle Theory

3.3 Revealed Comparative Advantage

“As a country moves up the economic development ladder, the composition of its exports is altered to reflect changes in the ranking of its industries by comparative advantage. A rapidly changing ranking of industries implies an inherent dynamism in a country’s economy. RCA index assumes that ranking industries by their export performance represents their ranking by the country’s comparative advantage” (Kreinin, 1966).
RCA index is defined as the share of commodity ‘i’ in country ‘j’’s total exports relative to the commodity’s share in total world exports. This index was developed by Balassa (1965). A number of assumptions underlying this approach have been questioned but the measures are used frequently as an informative index (see Kreinin; 1966, Yeats; 1985).

The earlier comparative advantage analysis based on the Ricardian and the Heckscher-Ohlin (H-O) international trade theories\(^\text{12}\) is widely accepted, but comparative advantage is a concept defined in terms of relative autarkic prices which are not observable in the real world. Balassa (1965) finds it problematic to analyze comparative advantage and H-O theory because of this reason and says that comparative advantage is ‘revealed’ by the observed trade patterns. Revealed comparative advantage is a kind of application of the earlier comparative advantage theory within the post trade situations determining weak and strong sectors of a country. Unlike the comparative advantage, RCA is an immediate determinant of the trade pattern. RCA uses actual trade statistics only for empirical analysis to reveal underlying pattern of comparative advantage in commodity specific degree. RCA also shows the shifts in comparative advantage, therefore revealed patterns of trade can be beneficial in adjustments of production structures. Thus inferring comparative advantage from observed data is named as ‘revealed’. Balassa (1965) derives an index called ‘Balassa index’. A sector with values above one in the Balassa index indicates that the sector has revealed comparative advantage. However, before Balassa, Liesner (1958) proposed simple measure of RCA which is:

\[
RCA = \frac{X_{ij}}{X_{nj}}
\]

where \( X \) represents exports, \( i \) is country, \( j \) is commodity and \( n \) is a set of countries. An advanced measure of RCA was presented by Balassa (1965) afterwards:

\(^{12}\text{Ricardo’s (1817) comparative cost advantage theory analyzes international trade in terms of differences in relative opportunity costs to measure relative productivity in the lines of production. It is based on relative productivity differences. The theory suggests that countries should specialize in the goods that they can produce relatively most efficiently rather than trying for self-sufficiency. H-O theory (developed by Eli Heckscher;1919 and Bertin Ohlin; 1933) is built on David Ricardo’s theory of comparative advantage by predicting patterns of commerce and production based on the factor endowments of a trading region. The model states that countries will export products that utilize their abundant and cheap factor(s) of production and import products that utilize the countries’ scarce factor(s) (Leamer, 1995). The differences in factor endowments are the cause for trade. For one of the failures of the Heckscher-Ohlin theory see Trefler’s (1995) “missing trade” argument basically saying that observed trade in embodied factor services lies far below the levels predicted by cross-country differences in relative factor endowments.}\)
\[ RCA_2 = \left( \frac{X_{ij}}{X_{it}} \right) / \left( \frac{X_{nj}}{X_{nt}} \right) \]

where again \( X \) represents exports, \( i \) is a country, \( j \) is a commodity (or industry), \( t \) is a set of commodities (or industries) and \( n \) is a set of countries. \( RCA_2 \) measures a country’s exports of a commodity relative to its total exports and to the corresponding export performance of a set of countries (in this paper; the world). It compares the specified country’s export structure with the global export structure. If \( RCA_2 > 1 \) then the sector is said to have revealed comparative advantage with having a higher percentage share than the global average. The industry having revealed comparative advantage is said to be specialized by that country and vice versa if RCA is below 1.

This index has been criticized for being biased because of not including imports in the formula (Greenaway & Milner, 1993). There are also further studies to measure RCA at the global level (Vollrath, 1991). Balassa’s analysis only concerns bilateral trade between two countries or trading partners. RCA is seen unlikely to be fulfilled in the real world but as the sample size increases the identification of comparative advantage by the RCA index gets larger (Fukasaku, 1992). There are more RCA indexes and stability/consistency concerns of alternative measures of RCA which are out of this paper’s scope (for example see, Balance et al. 1987, Yeats 1985, Hinloopen & Van Marrewij 2001).

4. Data and Methodology

For the estimation of Sweden’s revealed comparative advantage on China’s revealed comparative advantage, industry specific data was needed to determine specific trade relationship between Sweden and China. The industrial grouping was realized by annual four digit SITC (Standard International Trade Classification) revision 2 used in Feenstra et al. (2005). China’s and world’s total export data were extracted from NBER source for years between 1990 and 2000 to be able to use it with the industrial data for Sweden from Statistics Sweden (1973-2002)\(^{13}\) (see Appendix for all variables). Data is in nominal thousands of US dollars. The merged data is cut off for the years 1990-2000 since in Statistics Sweden’s data industrial code is classified according to sni69 (Swedish

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\(^{13}\) Assoc. Prof. Patrik Karpaty, the thesis advisor, used his remote control to create a map for the industry data for years 1973-2002 with the help of his access to MONA at Statistics Sweden. I would like to thank him for all of his contributions, patience and helpful guidance.
Industrial Classification codes) instead of the revised version, sni92, before 1990. In the process of matching two data source for estimation, it was not possible to convert sni69 codes to sni92. Converter key for SITC codes to sni92 exists and have been used to be able to synchronize Sweden’s and China’s data. For that reason, the number of observations is reduced from 18870 to 1849 for the matching period of 1990-2000. There exist few missing observations among them due to unmatched classification codes.

The factors determining the pattern of comparative advantage are numerous, but this paper uses mainly capital and R&D intensity according to availability of data. The model, as a result of it, is considered as incomplete. The aim is, though, to reveal the direction of the specified relationships. R&D intensity is found positively related with US exports performance by Gruber et al. (1967) and with competitiveness by Fagerberg (1997). Fagerberg (1997) also focused on the importance of knowledge acquired by R&D as a result of trade and reflected in the export performance. Gustavsson et al. (1996) added that R&D efforts improve competitiveness by creating technology gaps. They also emphasized the global spillovers of knowledge created by R&D that can be acquired from foreign firms. This makes R&D a very crucial factor in explaining Sweden’s pioneer position in line with product cycle theory. Investment in R&D affects exports twice as much as an investment of similar size in physical capital (Fagerberg, 1997). Besides direct R&D, purchase of capital goods and intermediates also provides R&D having a significant, positive impact on competitiveness (Gustavsson et al., 1996).

Moreover, Sterlacchini (1999) showed positive relationship between capital stock and firms’ export performance. According to the author; “firm’s export performance depends significantly on its innovative efforts and the ‘quality’ of its capital stock”. In light of these, it can be said that in the industrialization process to be a pioneer and develop an internationally segmented industry, capital accumulation and technological development are required. The capital intensity variable for Sweden in the estimation is measured by adding ongoing capital stock, machines, buildings and land and then dividing them by total employment. Rising capital intensity is assumed to the increase the productivity of labor due to the assumption that labor becomes more effective with the usage of more machinery. Research and development intensity\textsuperscript{14} is measured as R&D expenditures

\textsuperscript{14} An outlier (7.3378882) in the data for R&D intensity variable (RS) is dropped due to the outrageously larger number than the previous and following years for that industry group without any other change in the other variables. The RS variable became significant without the outlier.
divided by total sales. The intensity measure is used for both variables in order to disregard individual characteristics of the industries.

An additional energy variable is needed because Sweden’s advantage from nuclear and hydro power use has changed after the liberalization of electricity market in 1996. The integration with the other Nordic countries has affected the prices in Sweden by introducing competition to the electricity market. Considering the continuing high demand in Sweden, the increase in electricity prices is taken into consideration even if the relationship is possibly not significant. Since, according to the product cycle theory when costs are higher than abroad, production will be shifted by moving separate elements or entire industries of the production process to lower cost locations. Concerning this link, the variable was constructed by adding energy costs of the industries for relevant years and dividing it to the average number of employees in order to determine the overhead.

In addition to the year dummies constructed to include overall effect of the individual year, another dummy variable for product group sni92 coded; 2000 (manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials) is created. Since, Swedish export competitiveness was also determined by domestic forest raw materials according to Carlsson & Ohlsson (1976), but raw materials’ impact on competitiveness is known to lessen in time in capital intensive countries like Sweden. More detailed information can be acquired by including more dummies like this to assess that specific country’s exact current situation but it requires additional time.

Telecommunication equipment industry’s rapid development was observed in Figure 1 & 2 for China. According to International Center for Materials Research’s (ICMR) case study ‘Ericsson in China’ (2004), China has the fastest growth rate in telecom and IT (information technology) industry in the world and Ericsson has influence on it as a provider of the main equipment. Moreover, this study claimed that “from the late 1990s to the early 2000s, Ericsson shifted the procurement and supply side of its wide range of business to China”. In the late 1970s, Ericsson started selling AXE stations (electronic switching system) to China. In 1985 Ericsson opened its first office in Beijing (however, trade relations between Ericsson and China go back to 1892, Zhang & Pearce, 2006). In 1992 a joint venture, Nanjing Ericsson Panda Communication was established by China Putian Information Industry Group (one of the largest technology companies in China),
Nanjing Panda Electronics Company, Yung Shing enterprise and Ericsson, to produce AXE-10 mobile phones and exchange equipments (Zhang & Pearce, 2006). Ericsson (China) company’s establishment came after in 1994.

Ericsson’s investments in China add up to 0.6 billion dollars until 2000 (Liu, 2007) with the opportunities gained by the big market of China. In 1995, China was the third globally biggest market of Ericsson with the growth of the Chinese economy (Zhang & Pearce, 2006) and in 2002 China has become one of the biggest supply hubs of Ericsson with full-line production capacity located in Beijing, Nanjing and Chongqing (ICMR, 2004).

There exist 26 representative offices, 16 joint ventures and 4 wholly-owned companies of Ericsson in China by August 2003 (Zhang & Pearce, 2006). Among them, Nanjing Ericsson Communication Company produces inexpensive mobile phones for local Chinese market. Ericsson’s history in China started with the production shift, reinforced with the investment flow and giving opportunity of production using the old technology to respond China’s maturating demand. This is in accordance with the product cycle theory’s stages and the flying geese paradigm’s corresponding intra-industry aspect. This paper drives the benefit from the flying geese pattern of development’s previous stages as continuation of the product cycle theory in the developing country. It facilitates determination of the relationship between the developed and the developing countries’ shifting comparative advantages due to the trade in between. The mature stage and the following stages of this theory are out of the scope of this paper.

The fixed phone switches demanded especially in rural area can be mentioned as an example suited for the flying geese pattern of development. China imported digital program switch controller from Japan to upgrade the technology level to be able to respond to the high demand in 1982 (Liu, 2007). In 1984 Shanghai Bell was opened as a joint venture for production in China. In the 1990s, competition increased with new brands entering the market for switches. With spillovers\textsuperscript{15} from FDI, the Chinese counterpart of the joint venture acquired production, assembling, maintaining, managerial and service knowledge except the key technology which multinationals do not prefer to transfer (Liu, 2007). In 1999, Ericsson established Management Consulting Ltd. in Shanghai and Mobile

\textsuperscript{15} The term ‘spillover’ (in global level) is used for involuntary transmission of knowledge to the other country for free. Coe & Helpman (1995) argued that there exist spillovers from current R&D activities to future R&D activities and in global level foreign countries’ costs are declined by spillovers, as well as the home country’s costs. The level of the interaction depends on the economic relationship between the parties like volume of trade (Coe & Helpman, 1995).
Multi Media Open Laboratory in Beijing. After this step, local companies were opened in order to respond demand from the rural and semi-urban markets where multinationals do not have a role in. Exporting back to the developed countries -as the product cycle theory suggests for internationally large scale production- did not occur after the flourishing of the local companies, since developed countries had already moved to higher technology products. As a result of that, local companies traded with less developed countries demanding the old technology.

Another example is CDMA (Code division multiple access) market, which is not as developed as mobile phone standards. Sony Ericsson withdrew from the US market to focus on new GSM technology, as well. Chinese firms Huawei and ZTE managed to enter the market with the aid of spending on development and government support and in 1999 ZTE obtained a small share in a project with Motorola (Liu, 2007).

In other telecommunication equipments like phone digital switches, domestic companies had a chance to catch-up the multinationals by aiming the low-end market. However, the wireless telecommunication market is constituted only by multinationals. Motorola (36%), Siemens (15%), Nokia (14%) and Ericsson (13%) had the biggest shares in 1999 (Gao, 2004). Multinationals built all of the telecommunication infrastructures and domestic companies could not enter to the market. In this case the intermediate products that are produced in China by multinationals are exported back to the founders’ market in accordance with the product cycle theory. According to ‘Chinadaily’ news, Sony Ericsson has started to build a new plant for manufacturing mobile handsets and assembling surface mounted circuit boards in Beijing after taking control of Beijing Suohong Electronics (BSE) (74.5% share) (that is outsourcing the assembly of printed circuit boards for Sony Ericsson) and Beijing Se Putian Mobile Communications (BMC) (51% share) (Xinhua, 2007). “BMC represented roughly one-third of Sony Ericsson’s global manufacturing volume with direct shipment to 119 countries and regions” as a spokesperson for Sony Ericsson China stated in Chinadaily-Europe news. Roger Ericsson, president of BMC, also declared that this new factory building is a move for making Beijing the Sony Ericsson’s global manufacturing base. Considering this numerically significant relationship supporting the product cycle theory between Sweden and China, another dummy variable named ‘dum’ is constructed for the product group sni92 coded; 3220 (manufacture of radio, television and communication equipment and apparatus). An interaction term is created to capture China’s RCA’s impact
on Sweden’s RCA via that product group \((\text{inter} = \text{RCA}_C \text{* dum})\). Table 1. gives descriptive statistics for the variables used in the estimation.

Table 1. Descriptive Statistics for merged data (1990-2000)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA_S</td>
<td>1849</td>
<td>1.086902</td>
<td>1.268465</td>
<td>.0001985</td>
<td>8.261857</td>
</tr>
<tr>
<td>E_L</td>
<td>1849</td>
<td>74.43005</td>
<td>211.3694</td>
<td>0</td>
<td>3647.782</td>
</tr>
<tr>
<td>RCA_C</td>
<td>1849</td>
<td>1.27636</td>
<td>1.686985</td>
<td>1.99e-06</td>
<td>17.21038</td>
</tr>
<tr>
<td>K_L</td>
<td>1849</td>
<td>341.0568</td>
<td>462.391</td>
<td>0</td>
<td>12021.33</td>
</tr>
<tr>
<td>RS</td>
<td>1849</td>
<td>0.152318</td>
<td>0.0313241</td>
<td>0</td>
<td>.3245084</td>
</tr>
<tr>
<td>inter</td>
<td>1849</td>
<td>0.0086576</td>
<td>0.112354</td>
<td>0</td>
<td>1.651064</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables</th>
<th>Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCA_S: Revealed comparative advantage of Sweden</td>
<td>(dependent variable)</td>
</tr>
<tr>
<td>K_L: Capital Intensity</td>
<td>(+)</td>
</tr>
<tr>
<td>RS: Research and Development intensity</td>
<td>(+)</td>
</tr>
<tr>
<td>E_L: Energy cost per average employee</td>
<td>?</td>
</tr>
<tr>
<td>RCA_C: Revealed comparative advantage of China</td>
<td>(-)</td>
</tr>
<tr>
<td>Inter: Interaction term ((\text{RCA}_C \text{* dum}))</td>
<td>(-)</td>
</tr>
</tbody>
</table>

Ideally, in explaining RCA, which reflects relative trade performance, the independent variables should be in relative terms to be theoretically correct. Modelling specialization in international trade theory was initiated with the theory of absolute advantage by Adam Smith (1776) and extended by David Ricardo (1817) with comparative advantage. Both absolute advantage and comparative advantage theories are based on efficient production but the reference to the efficiency differs. In the theory of absolute advantage efficiency is referred using fewer real resources during the production process for a certain good. The theory is based on ‘absolute’ productivity differences. The comparative advantage theory’s concern, on the other hand, is being ‘relatively’ more efficient in producing that specific good with relatively lower opportunity cost, than producing another one. However relative production costs are not easy to measure.
Concerning the comparative advantage theory’s ‘relative’ point of view, the variables used in explaining Sweden’s RCA should ideally be weighted with the OECD (Organization for Economic Cooperation and Development) average. Unfortunately the data was very limited. OECD’s structural analysis database (STAN, updated in 2011) for 32 countries, was investigated for the variables; capital intensity and R&D intensity for Sweden in relation to the OECD average. Sweden’s intensity measures relative to the OECD average were expected to significantly explain Sweden’s comparatively advantageous situation in trade for certain goods. However, only 18 industry groups were continuously available for the concerned variables for the estimation period 1990-2000. To calculate the OECD average the same industry level data for the other countries was needed, but only 5 countries’ data were available in those product groups.

**Methodology**

Assuming a linear relationship which is additive between dependent and independent variable, linear regression is used as the first step for this paper’s attempt to see whether Sweden’s RCA and China’s RCA are related to each other with other additional variables. The product group ‘3220’ is chosen as an example to see whether we find any support for the product cycle theory regarding Sweden and China. A negative relationship is expected between RCA_S and RCA_C in correspondence with the product cycle theory and the flying geese paradigm. *Figure 5* below shows the very recent situation of the expected negative relationship for the previously mentioned telecommunications equipment industry\(^\text{16}\).

*Figure 6* is for the period examined in the regression analysis which does not have a trend like *Figure 5* due to the earlier years of the foreign investment. Including the period of 2000-2008 in the estimation would be more appropriate because of the obvious negative relationship between Sweden and China. However, other variables such as R&D and capital intensity in the estimation are only available until 2000.

\(^{16}\)Telecommunications equipment in WTO classification corresponds to the product group 7641 in NBER source of the data according to SITC4. SITC4/7641: Telephone sets, including telephones for cellular networks or for other wireless networks; other apparatus for the transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network), other than transmission or reception apparatus of groups 726, 751, 761, 762 and 764.
Figure 5. Revealed Comparative Advantage of Sweden and China for the telecommunications equipment industry for period 2000-2008

Source: Author calculations based on WTO data.

Figure 6. Revealed Comparative Advantage of Sweden and China for the telecommunications equipment industry for period 1990-2000

Source: Author calculations based on NBER data.
For Figure 6, it should be noted that 1990s are generally the years for which several multinationals have just started setting up affiliates in China. For instance; Motorola opened its own company in 1992, Ericsson in 1994 as mentioned earlier. 1994 is also the year for GSM introduction to the Chinese market. From 1996, Ericsson’s sales of both mobile systems and telephones increased by almost 50% and Ericsson experienced a boost according to Ericsson’s website (Wickman, n.d.). It is also stated that, in 1999, a R&D center jointly by Ericsson and the China Academy of Telecommunications Technology and also a research center for mobile communication by Beijing Institute of Technology were established. These are referred to China’s transition from existing digital mobile network to the third-generation mobile systems with the help of Ericsson (Wickman, n.d.). Due to the telecommunications crash at the beginning of 2000, Ericsson experienced a massive decline (17% decline in consumer products sale) and in 2001 merged with Sony Corporation (Japanese consumer electronics company) to manufacture mobile phones. The decline continued in 2002 and in 2003 until both countries injected money to cover some of the losses (Wickman, n.d.).

Besides linear regression with the observed variables, individual impact of unobserved variables, which are possibly correlated with the chosen variables, are taken into account with the panel fixed effects with vector decomposition (XTFEVD) method that is the second estimating procedure. The possible harmful effect of omitted variable bias and the unobserved heterogeneity among industry groups are tried to be controlled by that way. XTFEVD method was chosen over standard fixed effect procedure to be able to distinguish the rarely changing variables’ effects from the unobserved variables’ effects in the regression analysis. This differentiation is not possible with standard fixed effect procedure which does not estimate time-invariant variables (Woolridge, 2002).

The article “Efficient Estimation of Time-Invariant and Rarely Changing Variables in Finite Sample Panel Analyses with Unit Fixed Effects” by Plümper and Troeger (2007) introduces XTFEVD estimation procedure which has three stages:

- **First Stage**: Unit effects are obtained with standard fixed effect regression which excludes time-invariant variables.
- **Second Stage**: The unit effects are divided into two parts by OLS as; explained by the time-invariant (regressors with a ‘within variance’ of 0) and/ or rarely changing
variables (regressors with a smaller positive ‘within variance’) part and the unexplained part which is the uncorrelated error term.

- **Third Stage:** It includes the decomposed unit effects to the estimation, first stage is reestimated by pooled OLS.

At the end, both time-varying and time-invariant variables captured by the residual will be included in the estimation which is an efficient one with minimum sampling variance of the estimator. Fixed effect estimation is suggested to be inefficient by Plümper and Troeger (2007) reasoning of the ‘within transformation’ ignoring the between variation. This situation creates inefficient use of available information. Unlike fixed effect estimation, the explanatory power of the rarely changing variables is used in the panel fixed effects with vector decomposition method.

According to Plümper & Troeger (2007), time invariant variables can be determined by the difference between their ‘between’\(^{17}\) and ‘within’\(^{18}\) variation. Small ‘within variance’ with large ‘between variance’ point out the time-invariant variable. In this case using XTFEVD method leads to ‘more efficient and probably less biased point estimates’ (Plümper & Troeger, 2007). In this analysis capital (\(\sigma_{\text{within}} = 303,8734; \sigma_{\text{between}} = 504,6876\)) and R&D intensity (\(\sigma_{\text{within}} = 0,0137409; \sigma_{\text{between}} = 0,0271432\)) are treated as rarely changing variables.

### 5. Model and the Results

\[
RCA_S_{it} = \alpha_0 + \alpha_1 (K_L)_{it} + \alpha_2 (RS)_{it} + \alpha_3 (RCA_C)_{it} + \alpha_4 (dum)_{it} + \alpha_5 (inter)_{it} \\
+ \alpha_7 (skog)_{it} + \alpha_6 (year)_{it} + \epsilon_{it} 
\]

\( (i=111,\ldots,9302 \ t=1990,\ldots,2000) \)

---

\(^{17}\)Between variation: Suppose \((X)\) is a categorical (nominal) variable and \((Y)\) is an interval-scaled variable and \(X\) is grouped into \(k\) categories. In this case, distribution of \(Y\) among the \(k\) categories of \(X\) is also needed to be considered to determine the interrelationship between \(X\) and \(Y\). The sum of squares between groups (BSS) measures the variation between the group means around the grand mean (UNESCO, n.d.).

\(^{18}\)Within variation: The sum of squares within groups and quantifies the spread of values within groups.

\[
\text{WSS} = \sum_{j=1}^{k} \sum_{t=1}^{n_j} (y_{jt} - \bar{y}_{jt})^2 \\
\text{TSS} = \text{WSS} + \sum_{j=1}^{k} \sum_{t=1}^{n_j} (\bar{y}_{jt} - \bar{y})^2
\]

The total variation is split into two as within groups’ variance and between groups’ variance. \(\text{TSS} = BSS + WSS\) where \(TSS\) is the total variation in \(Y\) over the sample (UNESCO, n.d.).
where ‘\(i\)’ is the index for industry codes, ‘\(t\)’ is the index for the year. The model is very basic considering a number of specific cases with the dummy variables:

- ‘\(skog\)’ taking value 1 for the industries ‘manufacturing wood and of products of wood and cork, except furniture; manufacturing articles of straw and plaiting materials’ and 0 otherwise.
- ‘\(dum\)’ taking value 1 for the industries manufacturing electronic valves and tubes and other electronic components and 0 otherwise.
- ‘\(inter\)’ is the interaction term for the variable ‘\(dum\)’ and revealed comparative advantage of China (\(RCA_C\)) due to the assumed product cycle relationship between Sweden and China on the telecommunication equipment industry.
- ‘\(year\)’ is the dummy variable for considered years from 1991.
- ‘\(\varepsilon\)’ is the error term.

Table 2 gives OLS and XTFEVD estimates for the model. First estimations (indicated with (1)) are without the variables; \(RCA_C\), \(dum\), \(inter\) which are the key factors of investigated relationship between Sweden and China. The difference between the first and the second estimations (indicated with (2)) is roughly to assess the product cycle’s separate effect on Sweden’s RCA. As a result, coefficients of determination (\(R^2\)) of second estimations are higher without any major disturbances on the other variables. This is interpreted as a support for the relationship between China’s and Sweden’s RCAs. Adding the variables for China improves the model for explaining Sweden’s RCA, as the product cycle theory suggests.

Robust option is used in OLS estimation with concern of heteroscedasticity and the VIF (variance inflation factor) values measuring the impact of multicollinearity among the independent variables were found as less than two detecting no serious multicollinearity (also for the correlation between variables see Appendix B).
Table 2. Results from the merged data for the period 1990-2000

<table>
<thead>
<tr>
<th></th>
<th>OLS(1)</th>
<th>OLS(2)</th>
<th>XTFEVD(1)</th>
<th>XTFEVD(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RCA_S</td>
<td>RCA_S</td>
<td>RCA_S</td>
<td>RCA_S</td>
</tr>
<tr>
<td>RCA_C</td>
<td>------</td>
<td>-0.154***</td>
<td>------</td>
<td>-0.0345***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-9.72)</td>
<td></td>
<td>(-5.95)</td>
</tr>
<tr>
<td>K_L</td>
<td>0.000471* (2.45)</td>
<td>0.000399* (2.32)</td>
<td>0.000446*** (21.05)</td>
<td>0.000437*** (20.77)</td>
</tr>
<tr>
<td>RS</td>
<td>5.572*** (4.32)</td>
<td>1.787* (2.18)</td>
<td>5.666*** (18.37)</td>
<td>2.733*** (8.19)</td>
</tr>
<tr>
<td>Dum</td>
<td>------</td>
<td>13.96*** (4.67)</td>
<td>------</td>
<td>13.48*** (9.37)</td>
</tr>
<tr>
<td>Inter</td>
<td>------</td>
<td>-7.621*** (-3.75)</td>
<td>------</td>
<td>-7.402*** (-7.53)</td>
</tr>
<tr>
<td>E_L</td>
<td>-0.000184 (-1.84)</td>
<td>-0.0000709 (-0.56)</td>
<td>-0.0000415 (-0.89)</td>
<td>-0.0000459 (-0.99)</td>
</tr>
<tr>
<td>Skog</td>
<td>1.271*** (5.83)</td>
<td>1.227*** (5.89)</td>
<td>1.278*** (22.77)</td>
<td>1.250*** (22.65)</td>
</tr>
<tr>
<td>Year dummy</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>_cons</td>
<td>0.895*** (8.78)</td>
<td>1.153*** (10.90)</td>
<td>0.812*** (24.20)</td>
<td>0.893*** (26.13)</td>
</tr>
<tr>
<td>N</td>
<td>1849</td>
<td>1849</td>
<td>1849</td>
<td>1849</td>
</tr>
<tr>
<td>R²</td>
<td>0.0728</td>
<td>0.1383</td>
<td>0.9054774</td>
<td>0.9088168</td>
</tr>
</tbody>
</table>

Robust t-statistics reported in parentheses. ***, **, * significant at the 1, 5 and 10 percent level respectively.

First of all, significance of rarely changing variables (K_L and RS), which have positive effects on the revealed comparative advantage as it is expected, is considerably increased in the XTFEVD estimation due to the decomposition of the time-invariant effects into the explainable and unexplainable parts. By using this method, the possible bias caused by the correlation between relatively time-varying variables and unobserved industry characteristics is reduced, unlike the OLS estimation. XTFEVD estimation’s performance is also reflected in higher R² than the OLS estimation.

All of the variables’ effect on RCA of Sweden is significant except E_L. It was not expected to have a direct significant effect on RCA from the beginning but the sign of the relationship is informative. Electricity became a traded good and it was opened to competition in 1996. With the increasing prices in the energy market after the deregulation, Sweden has lost certain part of its advantageous situation based on the usage of nuclear power (Swedish Energy Agency, 2005). Increasing input prices increase the cost of the production. The product cycle theory suggests that shifting production to the developing countries with low labor cost reduces the cost of production. Exporting the
production techniques and importing the finished products are reflected through the trade statistics as increasing imports of capital intensive goods from the developing country. This leads a decline in RCA of the developed country. The negative sign of the relationship between $E_L$ and $RCA_S$ is interpreted as the shift of production from the less energy consuming industries to the more R&D intensive industries. In concordance with, expenditure on R&D in Sweden during the period 1997-2007 is increased from 78 billion to 110 billion SEK in 2007 prices as declared by Statistics Sweden. Moreover, Sweden’s R&D expenditure was 3.6% of GDP in year 2007, highest among all OECD countries (Statistics Sweden, 2010).

The total electricity usage in manufacturing, on the other hand, decreased by 11% in 2009 (Statistics Sweden, 2011). In relation with the model’s ‘skog’ variable, pulp and paper products industry decreased its electricity usage by 7% (Statistics Sweden, 2011). However our limited analysis could not trace its effect on RCA. The positive and significant coefficient of the related industry’s dummy variable indicates that the pulp and paper products industry still has a more significant effect on the revealed comparative advantage of Sweden than the other sectors.

The positive and significant coefficient of the dummy variable for the telecommunication equipment industry, ‘dum’ alone, indicates that for the period 1990-2000, telecommunication equipment industry remarkably reinforces Sweden’s RCA which can also be followed from Figure 6. The expected decrease in RCA of Sweden for this product group as a result of the shift of the production in this industry, became apparent for the period after 2000 (Figure 5). FDI inflow for this specific industry mainly started from the middle of the 1990s (1994 for Ericsson as mentioned) and took several years to be visible in the trade pattern. Furthermore, FDI flow to the region accelerated after 2000. For the period 2000-2009 Swedish FDI increased most in Asia, from 1,4% of total direct investment assets of Sweden, to 4,5% (Statistics Sweden, 2009). In China, particularly, Swedish direct investment assets increased from 5 billion SEK to 27 billion SEK from 2000 to 2009 (Statistics Sweden, 2009). Among Swedish direct investment assets abroad, engineering (including steel and metal production, production of metal products, machines, electric and optic products, telecommunication products, precision instruments and vehicles) has the largest share with the increase from 400 billion SEK to 609 billion SEK for the period 2000-2009 (Statistics Sweden, 2009). When the interaction term is
considered, ‘inter’s negative and significant coefficient provides information supporting the product cycle theory. The negative relationship between RCAs of Sweden and China is reinforced in telecommunication equipment industry. Moreover, joint significance test for the variables ‘dum’ and ‘inter’ gives p-value=0 interpreted as statistically significant effect of telecommunication industry in explaining Sweden’s RCA with China’s RCA for the both estimation methods. In accordance with the product cycle theory, the conclusion drawn from these results is that Sweden’s RCA in the telecommunication equipment industry started a shift to China.

A Spearman test is conducted for \( RCA_S \) and \( RCA_C \) to assess the association. The values for the both variables are lined up in ranks \( (\text{RCA}_S, \text{RCA}_C) \) and are correlated with each other. Spearman’s coefficient of rank correlation is the degree of the association and denoted by \( r_s \). The formulation is,

\[
r_s = 1 - \left( \frac{6 \sum_{i=1}^{n} d_{R_i}^2}{n(n^2-1)} \right), \quad \text{where } d_{R_i}^2 = (\text{RCA}_S - \text{RCA}_C)^2
\]

Spearman’s coefficient of rank correlation is equal to +1 or -1 if there is perfect positive or negative association between two series of RCAs and 0 indicates no relationship at all. Higher values of the correlation coefficient indicate either strong competition for export market if the countries have similar conditions or catching up with the developed country. The higher the correlation coefficient, the faster the shifts in comparative advantage occur due to the catching-up process. In our case, the high values of RCA of China are considered as a result of the outsourcing from Sweden and the correlation coefficient is interpreted in that way. The null hypothesis is; \( H_0 \): there is no outsourcing association between \( RCA_S \) and \( RCA_C \). The result suggests that correlation coefficient is -0.2941 and significant with \( p \)-value= 0.000. Spearman test also confirms the regression’s results showing negative and significant relationship between RCAs of Sweden and China. The interpretation is likely to be valid for the other developed countries shifting production to China in similar industries with the motive of lowering production costs or other advantages.
6. Conclusion

This study tried to analyze China’s rising comparative advantage in the commodity groups that are capital and technology intensive like telecommunication equipment and decreasing comparative advantage in labor intensive product groups like textile. This seems to contradict the H-O international trade theory that basically says that countries produce and export goods that intensively use the abundant factor of production and import the scarce-factor intensive products. The product cycle theory was used as a framework to analyze the dynamics of RCA behind recent pattern of international specialization, since as a labor intensive country; China needed an outside intervention to be able to change its trade pattern towards capital and technology intensive products. The product cycle theory suggests that this intervention occurs via shifting of production from developed countries in order to reduce their production costs. The aim of this paper was to analyze China’s involvement in the international division of labor as an assembly country. It investigates the export performance (revealed comparative advantages used to derive world market shares) of China in relation with Sweden following up the product cycle theory. Ericsson is considered as an example for the theory, following the steps with being initiated in the Swedish market then exported to the other developed countries and finally affiliated to China. This shift fostered the increase in China’s RCA in telecommunication equipment industry creating a paradox according to H-O theory.

To assess the interaction between Sweden and China, 1990-2000 industrial data of Sweden was merged with the calculated ‘revealed comparative advantage’ values for Sweden and China to be able to seek a simultaneous negative relationship in between. The relationship indicates a shift in comparative advantage due to China’s integration in international division of labor. Despite all the limitations of the model and the data, the negative relationship between the two countries’ RCAs was found significant especially for the telecommunications industry by using OLS and XTFEVD estimation. Likewise, Ernst (2004) stated that Asia became a manufacturing hub especially for the electronic industry with its increased share in global exports of parts and components. The flying geese pattern of development is suggested to constitute a reasonable story behind Asia’s role in international production sharing. Even if the Chinese case differs from the earlier Asian experience, the flying geese paradigm can still be traced for some product groups. In addition since it has a counterpart for the product cycle theory from the developing
country’s point of view, it is used as a background for the regression analysis associating two countries’ RCAs.

As cited in the Ericsson’s official website, Ericsson’s largest joint venture (having nearly half the market for mobile systems), the Nanjing Ericsson Panda Communication Company is in China and cited as Ericsson’s Flow Control Centre for the Asia Pacific Region. Ericsson also invested in R&D in China like opening technology licensing business in 2002. In 1997 Ericsson Communication Software R&D Center (Asia’s first software research and development center) and Ericsson China Academy of Telecommunications Technology were established to assist in absorbing technology by developing and providing application software products (Wickman, n.d.). In 2002 Ericsson Chief Academy of Research and Development was established and in 2003 R&D analyses for Ericsson’s Asia-Pacific market region are undertaken by Ericsson Putian Telecommunication Company (Zhang & Pearce, 2006). These are followed by the establishments of Ericsson Wireless Technology Company, which is a R&D center specialized for the wireless base station products, in 2004 and Ericsson Data Application Technology Research and Development Center, Ericsson TD-SCDMA (Time Division Synchronous Code Division Multiple Access) R&D Center, a cooperative R&D center with Beijing Telecommunication University in 2005 (Zhang & Pearce, 2006). About the later development, the sustainability of China’s growth with the help of these kinds of production shifts and acquiring the necessary production technique is being questioned. According to Hobday (2010) "Sweden and other leading nations need to maintain and accelerate their technological/product leads in areas of local advantage, complementing and benefiting from Asian growth trajectories". Holst and Weiss (2004) approached to the subject from the Asian perspective and found that ASEAN economies have already lost market share in the US and Japanese markets because of the Chinese exports, for the period 1995-2000. The upgrade to the more sophisticated products’ export remains doubtful but there exists protection from the government of the domestic market for new industrial Chinese firms to flourish. Zhang and Pearce (2006) suggested that Chinese market have potential to develop local innovation with R&D support from multinational enterprises (MNEs), however for the Ericsson case, “the potential interdependencies of the technological progress of China and MNEs’ are in its early stages”. Further research is needed to observe recent development.

The countries that the multinational companies like Ericsson assembling in (for instance; India, Mexico, Brazil etc.) could be observed, like this paper’s work on China, for
sufficiently long period of time and a larger scaled picture of product cycle scheme can be taken. A global cycle network can be revealed with further analysis. Furthermore, if the process after experiencing the product cycle is investigated in developing countries, it will be possible to see whether/in which ways that process helped their catching up process of industrialization in long term.

7. Limitations of the Analysis

Most importantly the analysis is limited by the lack of data for the period 2000-2010 where the investigated negative relationship between the two countries’ RCAs is clearer and the Swedish direct investment accelerated towards China. Concerning FDI, it is better to be included in a product cycle analysis since; FDI is the mean for relocation of production from developed countries to the developing ones. Capital accumulated with FDI coming with forward and backward linkages with other industries, is the dynamic behind the shift of the comparative advantage. Especially for China, its openness to FDI unlike the earlier East Asian experience, attracted FDI and gave the opportunity of accessing technology with its spillover effect. FDI ratio (FDI in host country in industry i / total FDI in host country) or its ratio in GDP could be added to the analysis.

Other good instruments that could not be used due to the lack of data are; education expenditure, openness to trade and availability of skilled human resources, import penetration measure as an outsourcing measure (imports/ (total sales + imports) to capture the effect of imported intermediate goods in production in Sweden with an expected positive sign in RCA analysis. However, distinguishing the national content and the imported intermediate parts is a complex task. It is known that relocation of production is usually realized by offshoring\(^\text{19}\) in developing countries. As Grossman & Rossi-Hansberg (2006) draw attention to international organization of production processes and increasing participation in global supply chains with the help of improving technology, offshoring has become a common option to benefit from specialization in trade. It is possible to make

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\(^{19}\) Offshoring is the term for relocation of business or the production process across countries usually to reduce the cost with benefiting from the ‘different factor endowments and different linkages to related activities’ (Venables, 2006). Other possible reasons to offshore are; entering a new market, avoiding governmental regulations, etc. The difference between ‘outsourcing’ and ‘offshoring’ is that, in addition to the foreign sourcing, it also includes the migration abroad of multinational firms’ activities (Grossman & Rossii-hansberg, 2006).
separate tasks of the production done in several places. They developed a new paradigm to model trade in tasks in order to capture the effect of offshoring (Grossman & Rossi-Hansberg, 2006). According to the model, firms offshore tasks according to cost-benefit analysis and this allows home to focus on the tasks that they are more productive in performing. This breaking-up of the production process adds another aspect to the Vernon’s (1966) hypothesis about the ‘considerable shift in location of production facilities’. In Varian’s (2007) analysis on Apple Company outsourcing the entire manufacture of iPod in several countries, China’s contribution is found as 1% (4$) of the total value of an iPod while the final export is recorded as 150$ to China-US bilateral trade accounts. However, Toshiba, the Japanese company who adds 73$ value to iPod, also makes most of its hard-drives for iPod in Philippines and China (Varian, 2007). Moreover, unaccounted parts and labor costs in making the iPod having 299$ retail value, is sum up to 110$ (Varian, 2007). There exists a very complex picture of the global economy with increasing offshoring possibilities bringing disintegration of the production processes. US Bureau of Economic Analysis has a work for determining the sectoral source of the intermediate inputs but it is unable to differentiate foreign and locally produced inputs (Grossman & Rossi-Hansberg, 2006). More detailed value-added analysis is needed to specify China’s separate contribution on its exports.

In addition, the classification differences among different sources put this analysis away from the exact product group analysis and caused data mismatch for few observations. Furthermore, merging different periods was not possible since there is no unique trade data resulted in the data dependency on the estimates.

The test used in this paper is simple with all its limits. Besides, the Swedish variables’ counterparts for China (like the capital and R&D intensity in China for the same industry) would be more ideal to use for product cycle relationship.

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APPENDIX

A. Variables’ explanation

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<th>Variable name</th>
<th>Variable label</th>
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<td>sni92_4</td>
<td>The Swedish industrial classification_4 digit</td>
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<tr>
<td>energycosts7396</td>
<td>Energy costs between years 1973-1996</td>
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<tr>
<td>average_employees</td>
<td>Average number of employees</td>
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<td>Energy costs between years 1997-2002</td>
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<td>tot_sales</td>
<td>Total sales</td>
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<tr>
<td>cap_stock_ong~g</td>
<td>Capital stock (ongoing)</td>
</tr>
<tr>
<td>cap_stock_mac~s</td>
<td>Capital stock (machines)</td>
</tr>
<tr>
<td>cap_stock_bui~s</td>
<td>Capital stock (buildings)</td>
</tr>
<tr>
<td>cap_stock_land</td>
<td>Capital stock (land)</td>
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<tr>
<td>RandD</td>
<td>Research and Development</td>
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<tr>
<td>total_employees</td>
<td>Total number of employees</td>
</tr>
<tr>
<td>Cap_stock</td>
<td>Capital stock= cap_stock_ong<del>g+ cap_stock_mac</del>s+ cap_stock_bui~s+ cap_stock_land</td>
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<tr>
<td>K_L</td>
<td>Capital intensity= cap_stock/ total_employees</td>
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<tr>
<td>RD</td>
<td>Research and Development intensity= RandD / tot_sales</td>
</tr>
<tr>
<td>energy</td>
<td>Energy cost= energycosts7396 + energycosts9702</td>
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<tr>
<td>E_L</td>
<td>Energy cost per av. Emp.= energy / average_employees</td>
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<tr>
<td>dum</td>
<td>Telecommunication equipment industry dummy</td>
</tr>
<tr>
<td>skog</td>
<td>Wood and wooden products industry dummy</td>
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<tr>
<td>inter</td>
<td>Interaction term= dum * RCA_C</td>
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<tr>
<td>RCA_C</td>
<td>Revealed comparative advantage of China</td>
</tr>
<tr>
<td>RCA_S</td>
<td>Revealed comparative advantage of Sweden</td>
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Sorted by: sni92_4
B. Correlation between independent variables

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<th>$RS$</th>
<th>$E_L$</th>
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<td>0.0969</td>
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