Product Cycles for Sweden’s Export of Machinery goods

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Sammanfattning

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Abstract

This thesis analyzes the product cycles of five different product groups within the Swedish machinery export during the time period 1964-2003. The machinery industry is the largest export sector in Sweden, but despite that Sweden’s export shares of OECD’s total export has declined. The export shares are analyzed over time, which reveals connections to general economic fluctuations in Sweden. Diminishing export shares are also caused by industrial movements abroad, imitation by importing countries, increased global competition or by a reduction in comparative advantage. For that reason, the comparative advantage (RCA) for each product group is calculated. This shows that three of the five product groups have experienced an increase in RCA, despite the declining export shares. Hence, this is an indication of increased competition within OECD. Even though Sweden is a preferable region to launch new products and adopt new technologies, according to the product cycle models, the production is approaching a decreasing regional specialization.
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1 Introduction

The machinery industry is currently the largest export sector in Sweden. The machinery industry\(^1\) contributed with 45% of the total export value of 823.8 milliards SEK in 2003. In 1964 the corresponding figure was 34% of the total export value of 19 milliards SEK. (Statistics Sweden) More than half of the goods exported are sold to other OECD-countries\(^2\), which is Sweden’s largest export market (Swedish Trade Council). The competition markets, on the other hand, are low-cost countries, where labor and land are inexpensive. However, also other OECD-countries belong to the competition market, since they take over production because of, for example, comparative advantages\(^3\).

The product cycles of the machinery industry have different characteristics, shorter or longer, depending on the type of product, but nevertheless a similar pattern is apparent. Sweden has lost export shares to OECD the recent decades, which implies a problem for Sweden’s international trade. The export level is stable, but Sweden’s share of OECD’s total export is decreasing. To be able to solve this problem and compete at a superior level with the rest of the OECD-countries, the underlying reason for the diminishing export share must be known.

The export pattern in Sweden is affected by changes in the demand for different types of inputs during the product’s life. In the beginning, when the product requires special skilled labor and a high level of R&D, it is produced in a knowledge intensive area in Sweden and exported to other countries. When the product matures and the production becomes standardized it is possible to move the production to a country or a region with lower production costs, which implies a decline in export. It is also possible that importing countries imitate the product and start to produce it and export it themselves. In other words, products that are net exports become net imports during their life cycle (Posner, 1961).

1.1 Problem formulation

This thesis aims to study Sweden’s export share of machinery goods in order to observe the international\(^4\) product cycles of the product groups and analyze their characteristics. Sweden’s export is analyzed in period 1964-2003 as a share of OECD’s total export\(^5\). The desired result is to be able to explain how the product cycles for Sweden’s machinery export looks like and why. When studying the machinery sector overall, one can see that some product groups have a more unstable pattern and negative development over time.

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1 The machinery industry (SITC 7) includes machineries, appliances and means of transport.

2 Organization for Economic Co-operation and Development

3 When a country is able to produce a good at a lower opportunity cost than another country.

4 There are both intranational and international product cycles (Norton & Rees, 1979).

5 Including: Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.
than others. Of those product groups where it is possible to see a negative development over time, five different product groups\(^6\) are chosen for the empirical analysis.

When observing the export pattern\(^7\) of the five product groups in the machinery industry during the period 1964-2003, a strong trend is noticed. Sweden has lost export shares to OECD, this is most noticeable in product group 74, *general industrial machinery & equipment and parts*. Diagram 1.1 illustrates Sweden’s export pattern of those five product groups, in terms of a percentage share of Sweden’s total export value\(^8\). Three of the product groups have a lower export level now than in 1964 and two of them have experienced an increasing export level since 1964, but Sweden’s share of OECD’s total export has decreased constantly in the same product groups (diagram 1.2). The only exception is product group 73, *metalworking machinery*, where the export share is back at almost the same level as in 1964. Sweden’s export of machinery goods is in a stage of distinct decline, in other words it is the decline phase of the product cycle, which implies a decreasing level of specialization. The competition within OECD has become stronger and other countries have taken over the production and thus increased their shares, at the expense of Sweden. Hence, the problem to analyze is why Sweden’s share of OECD’s total export in these specific product groups has declined since 1964.

![Diagram 1.1: Sweden’s machinery export of product groups 71-74 & 77, as a share of Sweden’s total export 1964-2003. (Author’s calculations based upon SourceOECD).](attachment:diagram1.png)

\(^6\) The product groups examined in this thesis are; 71: Power generating machinery and equipment, 72: Machinery specialized for particular industries, 73: Metalworking machinery, 74: General industrial machinery & equipment and parts, 77: Electrical machinery, apparatus & Appliances n.e.s.

\(^7\) The export is consistently calculated in terms of value.

\(^8\) To avoid inflation, the export value is calculated as a share of Sweden’s total export: Export value product group/Total export value.
Increased competition is one reason for always being one step before. With the knowledge about how the export relates to the dynamics of the product life cycle, it is possible for firms to influence their trade pattern and be prepared to act in the most advantageous way. With this knowledge they can keep their trade balance stable by renewing existing products or introducing new products in the right point of time. Questions that come up are; In which way do the dynamics of the product life cycle affect the export of machinery goods? How does the life cycle for these products look like? Which factors cause the peaks and the downturns in the export pattern of the product groups? Why has Sweden lost export shares? Does Sweden have a comparative advantage in those product groups? These questions will be answered in this thesis, with the aim to explain the relationship between the product life cycle and the export pattern of machinery goods from Sweden.

1.2 Purpose

The purpose with this thesis is to analyze the product cycles for Sweden’s export of machinery goods during the period 1964-2003.

1.3 Outline

Section 2 depicts product cycle theories and earlier research that provides a relevant background for the empirical work in this thesis. The product cycle model is explained from some different angles, as classical theories by Vernon and Posner and a modern approach developed by Andersson and Johansson. Previous empirical criticism made in the field of product cycles and international trade is also presented in this section, with the intention to provide a diverse opinion as well. This is followed by the empirical research together with the analysis in section 3. The thesis is concluded in section 4.

2 Product Cycle Theory and Previous Research
This section includes product cycle theory and a product cycle model, previous research in the field and earlier empirical criticism against the opinion that product cycle dynamics could explain trade.

2.1 Background

For almost one century it has been observed that economic activities and innovations follow a wave-like pattern. Already in 1903 the French sociologist Tarde found that product groups develop in product cycles. Several economists have added their thoughts to Tarde’s notion about product cycles, among others Kuznets (1930) and Schumpeter (1934). All of them agree that products follow a certain pattern in their development. Among later research in the field one can find names as Vernon and Hirsh (1966/1967). They used the product cycle model to explain the Leontief paradox and the fact that the United States exported labor-intensive goods, even though it was a capital-intensive country. The justification was that skilled labor was relatively cheap in the States. These later studies were more comprehensive and revealed that the type of knowledge and inputs change throughout the lifetime of a product or a product group. The basic idea of classical product cycle models is to explain the characteristics of the different stages of a products life. Posner (1961) presents the product life cycle model in a dynamic way and explains that one reason for a declining export level may be imitation by the importing country. The product cycle model developed by Johansson and Andersson (1984) gives a further explanation of how the product moves between different phases. Starting with a high level of research and development in the start-up phase and a lower production cost in the maturity stage. The micro-economic dynamics that affect the mechanisms of the product cycle will in turn affect the trade pattern as well. The classical model of the product cycle has been criticized with the arguments that products are continuously renewed and not following a wave-like pattern and that the model is too schematic in the way it explains economic theory. Nevertheless, it is the framework for an improvement entitled Schloss Laxenburg model of product cycle dynamics, developed by Andersson & Johansson, which is the model framework in this thesis.

2.2 Product and Price Competition in the Product Life Cycle

The product cycle can be seen as a path between product competition and price competition (figure 2.1). In the beginning of its life cycle, the product is characterized by product competition and later on, if the production becomes standardized, the product is identified by price competition. This implies that the tools of competition changes along the product cycle. When a firm introduces a new product or a service, it will gain a “head-start”, which gives a competitive advantage on the market. This kind of dynamic competition can be described as product competition that is recognized by a supply of special made products designed for the customers and low price elasticity. This means that economies of scope are applied, instead of producing long series with standardized products. However, if the companies do not compete with the quality and features of the products, they will instead compete with the price of the products. Karlsson and Larsson (1989) have made some em-

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9 The wave pattern between the different stages that every product experiences can sometimes be characterized by longer fluctuations than what is common within the boundaries of the general cycle. When unusual long periods of up going times is followed by prolonged periods of hard times, it is known as long waves. (van Duijn, 1977)

10 A concept that arises from Johansson (1988).
empirical research in this area, by testing some hypotheses on statistics from the Swedish industry. Some of the main results accomplished by Karlsson and Larsson are following; when investigating the Swedish employment of manufacturing industries, they found out that, in product competition the employment has increased with 36% during the years 1968-84, while in the price competition it has decreased with 34% the same period. Further, the average labor productivity has grown slower in product competition than in price competition during the years 1970-84. Although, during two periods the reverse was true, this can be explained by the increase in R&D investments since the end of the 1970’s. These investments are often connected to industries competing in product competition. They concluded that enterprises involved in product competition cannot be relocated so easily, since the dependence of special-skilled labor, R&D, advanced services and adoption of new technologies. On the other hand, price competition leads to a relocation of production to regions where the price for labor and land are less expensive. Nevertheless, the division between product and price competition is significant and have to be considered further. (Karlsson & Larsson, 1989)

A later study made by Karlsson & Larsson (1990) reveals that there are differences between the periphery and the whole country, regarding product and price competition. The results from this research show that the labor productivity in the engineering industry is lower in the peripheral region than in the whole country, in the case of product competition. In the case of price competition, the opposite is true. This can be explained by the assumption that peripheral regions are more suitable for price-competing products and the country as a whole is more suitable for product-competing products. (Karlsson & Larsson, 1990)

2.3 Phases of the Product Life Cycle in International Trade

A product, or a product group, passes through four different phases during its lifetime. These are the innovation phase, the growth phase, the maturity phase and the decline phase. In this section, the characteristics of those phases will be explained.

2.3.1 Innovation Phase

During the innovation phase the product is highly dependent of special skilled labor and scientific inputs. Therefore it is produced in a small number of places, which have a local

![Figure 2.1: Product and Price Competition in the Product Life Cycle (Karlsson & Larsson, 1990)](image)
advantage in those factors, and exported to other regions or countries. The production is non-standardized, which means that the product is supplied to one or few customers in a limited amount. (Andersson & Johansson, 1984b) The innovation phase of the product cycle is distinguished by high unit costs and a labor-intensive production function. The product is in focus and the development and improvements are maintained, both in product design and production techniques. The production is craftsman like, since special-purpose machinery not is profitable in the first phase. Furthermore, entry to the market is limited by know-how, rather than financial resources. This implies that the costs of information and special-skilled labor are much higher in the innovation phase, than in other stages of the product cycle. (Hirsch, 1967)

The search for knowledge and the access to knowledge strongly affect the localization and trade pattern in the innovation phase of a product. Producers in a certain market are more aware of what kind of new products that can be introduced in that market, than producers in other markets are. This explains why the product most often is produced in the country, which it is developed in, in the innovation phase. All advanced countries have the same availability to scientific knowledge, but it does not mean that this knowledge is used with the same intensity in the creation of new products in all countries. It is often a gap between knowledge and the appliance of it to new products. (Vernon, 1966)

2.3.2 Growth Phase

In the growth stage the demand for the product increase, this leads to standardization. A standardized product is produced in series and delivered to many customers. In this phase special machinery is brought in and the product is made in long production runs. The amount of labor is reduced and the production gets more capital intensive. Another characteristic of this stage is that more competitors enter the market and the risk of imitation appears. Nevertheless, the innovators are somewhat protected by patents and special skills, that the competitors lack. (Hirch, 1967) However, not all products becomes standardized, exceptions are products in industries with short product life cycles and rapid technological change, where the market dynamics reveals much more rapidly than in other industries. (Gruber, 1995)

Posner’s model (1961) explains in a two-country economy the introduction of new products and the imitation process, which leads to a decline in export. One of the assumptions underlying Posner’s model is that trade is caused by differences in innovations between different countries11. When a new product is introduced, the demand for the old product will decrease. The introducer of the new product exports it to the other country, further, the competitors in this area will feel a threat when they notice the demand for the new product and realize that other firms are taking over their market. Firms in the importing area will try to imitate the new product and produce it themselves. The more intensive export, the higher risk of imitation. The imitator will start to export the good, in order to gain from a larger market, and hence the innovative country will become the importer. The roles have changed, due to product cycle reasons. However, if the region that introduces the product has a too big lead, the other region may consider changing industry instead, by investing their resources in some other branch. (Posner, 1961)

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11 Thus, if the dissimilarity in tastes is large between the two countries, they will not trade at all.
Imitation can also be discussed in terms of reverse engineering. In this case, the imitator is labeled second comer or reverse engineer. The purpose with reverse engineering is to develop a competing product. The concept reverse engineering is one step in a four-step process for the second comer. The awareness stage is the first and it means that the reverse engineer recognizes that another firm has introduced a new product or service that is worth the cost and time of reverse engineering. Sometimes, this recognition takes a while and others, it comes about very fast. Before the second comer has discovered the product, the introducer has the possibility to invest in R&D and gain market shares. Reverse engineering appears as the second stage and it is very expensive, complicated and slowly. Here, the second comer analyzes how and of what the product is made. Though, the costs will be less than for the introducer of the product, since the reverse engineer does not have to investigate methods and products that do not work. He already knows that the product is successful and that there is a market demand for it, he just has to find out how he is going to imitate it in the most efficient way. After reverse engineering, the implementation stage takes place, where the second comer develops the product and starts to produce it. This stage is very costly and time-consuming, as well. Sometimes he has to go back one step, to the reverse engineering stage, to find a better solution. Finally, the last stage is the introduction to the market, which will lead to competition between the two producers and probably a decline in export for the innovator. (Samuelson & Scotchmer, 2001)

2.3.3 Maturity Phase

After a period of growth, the product enters the maturity phase, where the market is penetrated and the export market is expanded. The price competition leads to that the producers seek for large-scale advantages and larger production volumes. (Johansson & Karlsson, 1991) The product becomes totally standardized, which leads to new localization factors and also a change in the export pattern. It is now possible to gain from scale economies by mass production. Less-developed countries can offer lower production costs. The low cost of labor that less-developed areas offer is attractive for the entrepreneur, when the production is standardized. This is not true for all goods, but for goods that can be precisely described and do not require skilled labor, reliable power or certain spare parts for instance. This derives from the Heckscher-Ohlin theorem, which states that most exports from less-developed countries tend to be labor-intensive goods. Thus, when producing in and exporting from a less-developed country one have to take into account the cost of information and the fact that entrepreneurs not always are inclined to examine markets with unidentified characteristics and promises. Accordingly, if foreign investors have good knowledge about the marketing end of the business and only seek for a low-cost production possibility, they do not have to worry about the market information. Nevertheless, even though capital is a scarce resource in less-developed countries, it will not prevent investments in factories for production of standardized products. The reasons why are firstly, the investment will result in some significant labor inputs in the production and secondly, because a good is capital-intensive, it does not mean that the cost of capital has to be a barrier for investments of this kind. International investors will concern more about their opportunity cost, than the interest rate of capital in the country where they are going to invest. Without relocation, the export will increase in the maturity stage, which will lead to a larger risk of imitation by competitors. Imitation is one reason to why a high export level decreases. (Vernon, 1966)
2.3.4 Decline Phase
The decline phase is the final stage of the product cycle and here the demand for the product decreases. This is a critical phase, where some action is needed if the product shall survive. This stage does not always imply the end for a product, but that it is time to introduce new strategies. These could be new versions of the product, new distribution methods or different prices. Thus, all products finally reach their market ceiling, when the market is saturated. The reason for this is that all products sooner or later will be exposed for competition by substituting products. (Johansson & Karlsson, 1991) The decline period produces the conditions for new innovations and with that new product cycles; these new cycles are not solely random, but occur because their time is there. (van Duijn, 1977)

2.4 Schloss Laxenburg Model of Product Cycle Development

Schloss Laxenburg model (Johansson, Andersson, 1984) is a further development of the classical product cycle model by Vernon and it is also an improvement of an earlier model worked out by the same authors.

2.4.1 Basic Facts and Assumptions in the Model

The Schloss Laxenburg model has been developed in order to formalize the product cycle theory. Market sizes and resource constraints are permitted to change, but transportation distances are fixed and also an important parameter of this model. It is a product cycle model developed by attaching microeconomic dynamics to a combination of five different classical theories;

- The classical theory of comparative advantage with two regions, two goods and two production factors.
- The factor proportions theory, which assumes that technological possibilities are the same in all regions and that production factors have a fixed location.
- Von Thünen’s theory, assuming trading and information networks, location and size of market to be fixed. Free location is assumed in other considerations.
- Schumpeter’s theory (1951) that assumes innovations to be the driving force in the regional specialization process, but he argues that R&D activities are exogenous.
- Product cycle theory, which essential objective is to make R&D activities endogenous.

Knowledge intensity is a key notion in the model. Though, if the products are organized in groups, each group will follow a certain life cycle, if the market is characterized by perfect competition. In other types of markets, like monopolistic or oligopolistic markets, these life cycles can be interrupted. A product differs from other products through place of production, place of transaction and place of consumption. Thus, a product can be identified as an input in the household that is used by different customer groups. This implies that the classification of products and customer groups is significant. Products in the same product group have to some extent the same customer groups. The customers have the possibility to substitute between these products, for example when price or quality change. (Andersson & Johansson, 1984b)

New product cycles are more often initiated in certain regions, than in others. The same is true for imitations in the early stage of the product life cycle. The five most significant
properties for a region that has an advantage for innovation of new products and early imitations are: (Andersson & Johansson, 1984)

- It is important that the region has information channels that keep them informed about all the new innovations around the world. A high level of import will supply them with information of this kind, (import intensity).

- The enterprises in the region should have high accessibility to the labor market, which should be characterized by education and competence, (knowledge intensity).

- The R&D competence in the region should be high and of high accessibility for the firms, (R&D intensity).

- The region should offer a high accessibility to customers that are willing to test new products, (customer intensity).

- Finally, the region should have a high accessibility to suppliers of parts and services that are necessary in the development and renewal of products, (supplier intensity).

2.4.2 Possible product cycle paths

Figure 2.2 shows the stylized picture of product cycle paths. A new product starts in point I and shifts step by step to point IV. Nevertheless, a number of different product cycle paths can be likely, for example; (I-II), (I-III), (I-II-IV), (I-III-IV) or (I-IV). The latter three are identified as ordinary product cycle paths. The variables used in the graph are standardization ($\theta$), on the x-axis, and a technique-vintage index ($\tau$), on the y-axis. With standardization, it is meant in this model that a larger number of firms are capable to supply the same good. When a product has matured, the production is standardized and the index is equal to 1. A completely new or special made product has standardization equal to zero, which implies $0 \leq \theta \leq 1$. The technique-vintage index stretches along the same interval, with 0 for a new and non-routinized vintage and 1 for a established and totally standardized product.

![Figure 2.2 Product cycle paths (Andersson & Johansson, 1984b)](image)

2.4.3 Level of Specialization

Figure 2.3 illustrates the product cycle patterns in an initiator’s region and in an imitator’s region. It is demonstrated how the leader moves from a high level of specialization to a low
level of specialization and vice versa for the follower. $dS/dt$ is the rate of change in specialization level a specific period.

Figure 2.3 Product Cycle patterns of the initiator (left) and the imitator (Andersson & Johansson, 1984b)

Figure 2.4 shows the aggregated product cycle paths, where $S$ symbolizes the specialization level in the region and $S^*$ is the specialization level for a product group. Each product cycle will generate a regional specialization pattern, which will change in a methodical way over time. It is possible to use several different measures to calculate the specialization level and it is the availability to statistics that determine which one is appropriate in each case. Andersson & Johansson apply two measures in their discussion of specialization, location intensity and self-sufficiency ratio. The first weighs a sole region against a multiregional context and the second compares the intraregional delivery in a region with the total delivery to the region. (Andersson & Johansson, 1984b)

Figure 2.4 Aggregated Product Cycle Paths (Andersson & Johansson, 1984b)
2.5 Empirical Criticism towards Posner’s Imitation Theory

Gagnon and Rose (1992) have investigated the dynamics in the American and Japanese trade flows that are connected to product cycles. They found out, in contradiction to Posner (section 2.3.2), that most goods that are net exports in the beginning of a study still are net exports in the end of the study. During the 27 years period of their study, it was difficult to find a good that turned from being a net export to a net import. They impose a completed product life cycle in a developed economy and analyze how it affects the trade pattern. They found out that a product undergoing a product cycle can be expected to have the following trade pattern; 1) the product starts out its product cycle with an undersized trade balance, 2) the product come into a period of trade balance surplus; 3) this is followed by a period where the trade balance declines and goes into a shortage in the trade balance. To sum up, their basic result is that changes in the trade flow are characterized by sluggishness, implying that the product cycle phenomena basically are irrelevant for the aggregate trade flows. (Gagnon & Rose, 1992)

Gagnon and Rose extended their empirical work in 1995 with a study of dynamics in trade flows, particularly those caused by product cycles. The dynamics that exist are small and follow the sluggish behavior of the trade pattern, predicted by the Heckscher-Ohlin theorem. Their main conclusion is that there is an absence of important dynamics in the trade flows of the individual good. Instead they relate to static trade theory, as the factor proportions theory\(^\text{12}\). The purpose with their work is to move the line of thoughts towards the opinion that product cycle dynamics not are important for the characteristics of the trade pattern. (Gagnon & Rose, 1995)

2.6 Summary & Conclusions

The preceding section has described a products development phase by phase. Starting with the innovation phase, when the availability to research, knowledge and capital is crucial for the product to develop and approach the next phase. Further on to the growth phase, where the risk of imitation by importers is high, which could in turn decrease the innovative country’s export. When the product has matured the competition is more characterized by price than quality and it is a possibility that the producing country move the production to a low cost country. This will also lead to a reduction in the export value. Finally, the product enters the decline phase with a lower demand. This phase is critical and if the product is going to survive it is time for some action. New innovations, with new product cycles, starts off in this stage, because their time is there.

Moreover, the model framework for the empirical analysis has been presented. The Schloss Laxenburg model of product cycle development (Johansson, Andersson, 1984) is a further development of the classical product cycle model by Vernon (1966). The assumptions in the model are built upon several different trade theories, which help to explain the properties for a region that has an advantage for innovations and early imitations. The focus is on different levels of specialization that the product life cycle passes through.

\[^\text{12}\] Each national industry uses the same production factors in the same proportion. The production factor used is the one that is abundant in the nation.
As a final point, some empirical criticism made by Gagnon and Rose (1992) was presented. Their opinion is that product cycle dynamics are irrelevant for the aggregate trade flows. Their empirical observation indicates that most goods that are net exports in the beginning of the study, still are net exports in the end of the study, in contradiction to Posner's (1961) claim that net exports become net imports due to product cycle dynamics.

One could assume Sweden's decrease in export shares to be dependent on several of the issues above. Both imitation and industrial movements abroad are assumed to cause a reduction in export shares. Furthermore, Sweden is expected to have a low level of specialization, according to the declining export shares and this will be analyzed in different schedules of the Schloss Laxenburg model.

3 Empirical Analysis
In this section, the business cycles and product cycles for Sweden’s export shares are analyzed. This will reveal the trade pattern in Sweden and why Sweden’s share of OECD’s export has decreased. Further, the analysis will also clarify which product group that have the highest revealed comparative advantage (RCA) and how it is related to the export share. The slope of the declining trade pattern is determined by a regression analysis and compared between the product groups.

3.1 Analyzing the Business Cycles

The analysis of the business cycles is based upon Sweden’s export share of OECD’s total export (diagram 1.2 in chapter 1). In this section the small fluctuations are analyzed and not the overall trend.

3.1.1 Up going Business Cycles

When observing the business cycles for all five product groups simultaneously, one can see some patterns that coincide for all products. Those short-wave or long-wave fluctuations are the business cycles for the Swedish production of these commodities. The cycles are characterized by product competition in the first phase (Figure 2.1 in chapter 2) and along the curve this will change to price competition when the goods are standardized, which can be assumed that Swedish machinery goods will become after the innovation phase.

Some up going periods seem to coincide for the product groups during the time period 1964-2003. There are three significant peaks, even though the overall trend is negative. The first peak is rather prolonged, compared with the following two, and it occurs in 1970-1976. This long wave of good times in the business cycle paths happens during an extended expansion in the Swedish economy. This expansion took place during 1953-1976 (Edvinsson, 2005); consequently the end of it pushed the production and export upwards within the observed products of the machinery industry. In this point of time, Sweden had started up its industrial production, by importing production techniques from the United States, since there was a technological gap between the States and Europe after the World War II (Encarta Encyclopedia, 2005). Sweden, which managed to avoid the war, had an advantage in building up its industry. In this period one can argue that Sweden gained a headstart in introducing new products, developed by the new techniques from the States. Hence, second comers were the other countries in Europe, which imitated the products when the production was standardized in Sweden. The industry grew, at the expense of the agriculture and this in turn increased the productivity, since the industrial sector had a higher productivity than the agricultural sector (Regeringskansliet). Another explanation for the up going product cycles this period was the introduction of the forerunners to the European Union, and with that the elimination of trade barriers. The international trade became less complicated and less expensive, which gained both Sweden and other countries.

The second period of increasing export shares occurred in 1985-1988. This era, as well, was synchronized with an expansion in the Swedish economy, which took place in 1981-1990 (Edvinsson, 2005). This economical expansion was an effect of the boom in the real estate industry during the 1980’s. The real estate industry does not affect the machinery industry directly, but note that there is a connection between every expansion in the Swedish economy and the up going business cycles of the machinery industry. The third up going period, in 1995-1997, is the shortest one and it is possible to make connections to the general ex-

---

13 Short time fluctuations are defined as business cycles and the long term trend is the product cycle.
pansion that the Swedish economy experienced 1993-2000 (Edvinsson, 2005), probably because of the enormous growth in the telecom industry, which increased the total productivity in the country. The growth in Sweden during these years was a lot higher than in other European countries.

Another cause of business fluctuations in the Swedish machinery export is the importing countries GDP. Since the importers’ investments are reflected in the GDP, this will in turn affect the export level in Sweden. Increasing GDP in importing countries will lead to a higher export level in Sweden, and vice versa.

### 3.1.2 Down turning Business Cycles

Between the periods of business cycles in the growth stage and the maturity phase, there are also declining business cycles. The down turning cycles of the different product groups coincide somewhat, as well. Consequently, they follow Swedish economy fluctuations, but other aspects are also relevant, for instance industrial movements abroad discussed in section 3.1.3. Referring to Posner (1961), the downturn after the first peak could be explained by imitation by other European countries. Since Sweden was one of the initiators after World War II, it exported large quantities of goods to the rest of Europe. However, when these countries realized how profitable the products were, they started to imitate the products and hence, Sweden’s export level decreased. If this is true, Posner’s imitation theory is accurate to explain the Swedish path from being a net exporter to becoming a net importer, thus in a rather extreme way. However, the train of thoughts agrees to some extent with Sweden’s machinery industry situation that period of time.

In the beginning of the 1990’s Sweden experienced a very deep recession (Edvinsson, 2005), which obviously affected the productivity within the machinery industry. After the second peak in the late 80’s comes a long-lasting decline phases in each product group. The obvious trend since the beginning of the 1990’s is that the business cycles flatten out more and more. The growth phases are not that strong and the decline phases are longer, before any new business cycle enters. All the product groups has experienced a declining export share since 1964 and current figures shows export shares between one and three per cent of OECD’s total export. The same product groups showed figures up to five per cent in 1964. A present problem within the Swedish export market is the dominance of the United States as an importer (SourceOECD). The dollar is falling, which affects the export prices from Sweden to the States. This will of course affect the export share in a negative way, since the calculations are made in terms of value.

### 3.1.3 Industrial Production Moves Abroad

The main observance from the preliminary investigation is that Sweden has lost export shares to OECD constantly during the time period 1964-2003. One reason that affects the product cycles in such a way is that companies move their production abroad, which is a significant problem within the industrial sector in Sweden. Enterprises that wish to profit-maximize start up production in low-cost countries and mainly R&D-intensive production stay in Sweden (Dagens Industri, 2005). However, it is not only low-cost countries that attract Swedish companies; other EU-countries and the United States are also attractive regions for starting up production (Statistics Sweden). Some large machinery industry enterprises, as ABB and Electrolux, have as a main goal to move the production to low-cost countries. In addition to that, the movements abroad have been confirmed during the recent years; 100 000 employments within the industrial sector have disappeared during
2001-2003 because of movements abroad and 500,000 more are calculated to depart in the nearest future. (Huldschner, 2005) Therefore, the decline in Sweden's export shares could to some extent be justified by industrial movements abroad. To be able to investigate the problem further, section 3.2 will analyze calculations of Sweden's comparative advantages in each product group.

3.2 Revealed Comparative Advantage

Revealed comparative advantage is the calculated measure of a country's comparative advantage in producing a certain good.

3.2.1 Method & Major Results

As mentioned in the theory background about product cycles, the pattern of goods exported and imported is determined by many factors, one of them is comparative advantage. Further, the Schloss Laxenburg Model takes the classical theory of comparative advantage into consideration. The trade pattern will be analyzed by calculating the revealed comparative advantage (RCA), which is the empirical measure of comparative advantage (Bowen, Hollander & Viaene, 1998). The RCA index is calculated as:

\[
RCA = \frac{X_{sj}/X_{oj}}{X_s/X_o}
\]  

where \(X_{sj}\) represents Sweden's export of product group \(j\), \(X_{oj}\) denotes OECD's export of product group \(j\), \(X_s\) is Sweden's total exports and \(X_o\) is OECD's total exports. When the RCA index exceeds 1, Sweden has a revealed comparative advantage in that product group.

The calculations show that in 2003 Sweden has a comparative advantage in product groups 71 and 74, thus rather low values slightly over 1. This implies that Sweden can produce these goods to a lower opportunity cost, or with a higher quality, than countries without a comparative advantage in those goods. The comparative advantage arises from the fact that elementary factors, which determine supply and demand differs between countries. Summing up the major results, the comparative advantage has increased in product groups 71, 72 and 73 (Diagram 3.2, 3.3 & 3.4) since 1964, but product groups 74 and 77 (Diagram 3.5 & 3.6) shows a decline in RCA.

Could Sweden's loss in export shares be explained by a lack of comparative advantage or by decreasing comparative advantage? To clarify this possible explanation, the change in export shares will be put in relation to the RCA index in section 3.2.2.

3.2.2 The Change in Export Share put in Relation to RCA

In this section each product group will be examined and analyzed carefully from the beginning of the time period in 1964 until the end in 2003. The variables analyzed are Sweden's export share of OECD's total export and Sweden's revealed comparative advantage in those product groups.

3.2.2.1 Power Generating Machinery and Equipment (71)

The analysis in this section is based upon calculations illustrated in diagram 3.2.

Product group 71 shows a rather constant RCA during the time period. The RCA index is approximately 1 all the years, especially during the 1980's and the beginning of the 1990's, where it hardly moves from the 1-level. This implies that Sweden do not have a compara-
tive advantage in producing these commodities during the observed years. On the other hand, Sweden is rather neutral in its production of these goods, referring to the RCA value 1. Furthermore, the RCA has increased to some extent during the period, even though it is only a small difference (0.09) between 1964 and 2003. This means that since the late 1990's Sweden has a small comparative advantage in this product group, since the RCA value now is a bit above one. Despite the increasing RCA, Sweden has lost export shares in this product group. In 1964 the export share was 3.7% of the total OECD export and in 2003 the share had declined to 3.0%. When ignoring all the small business cycles, it is obvious that the product cycle is a negative curve throughout the time period. However, it is possible to observe fluctuations in this declining pattern. One can observe strong connections with the Swedish economy overall in this product group, as well as in other groups. In the beginning of the 1970’s the inflation in Sweden was high (Regeringskansliet), which resulted in a decrease in the general competitiveness that can explain the fall in RCA. However the price increases also implies a higher export share in terms of value, which is obvious in diagram 3.2, where one can see a substantial growth phase that results in the highest peak during this period. Furthermore, the collapse of the Bretton Woods-system\textsuperscript{14} in 1973 can also be connected with this growth phase. Right after the devaluations in 1976-77 and 1981-82 the export share decreases somewhat, before it rise again. Generally, during 1976-1980 the trend was negative, which could possibly be an effect of the oil crisis that took place during these years. This could be justified by that the production of these type of commodities is rather energy consuming. In 1992 the Swedish Riksbank let the Swedish crone float and after that one can observe a huge growth phase in the Swedish export share. It seems like the export share is on its way towards a new peak, since it started to increase rapidly in 2002. The comparative advantage (RCA) in these products is also increasing, which produces good possibilities for this product group in the future.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{Diagram.png}
\caption{Diagram 3.2 Product group 71, Sweden’s export share and corresponding RCA. (Author’s calculations based upon Source OECD).}
\end{figure}

\textsuperscript{14} The western world currencies was connected to the US dollar, which in turn had a fixed price in gold (Swedish Riksbank).
3.2.2.2 Machinery Specialized for Particular Industries (72)

The analysis in this section is based upon calculations illustrated in diagram 3.3.

Product group 72 is characterized by a more unsteady RCA between 1964 and 2003, than the previous product group. The RCA follows the same pattern as the export share, it drops when the export share is falling and rise when the export share increases. Sweden lacks comparative advantage in this product group too and this has been the case during almost all the years. The export share starts off in 1964 with a tiny growth period which is followed by a deep and long lasting decline phase. What is remarkable here is that both the export share and the RCA increases during the oil crisis in the late 1970’s. The reason could be that this kind of products are less energy dependent in their production. After the devaluation in the early 1980’s there is a strong growth phase. The risk with using devaluation as a tool for kicking off the industry is that quite soon the industry will be characterized by price competition, instead of product competition. This is confirmed by the following long-lasting and steep decline phase, in both export shares and RCA.

However, even for this product group it looks bright for the future since both the export share and the RCA started to increase in year 2000. Thus, it is important to note that despite this promising growth period coming, Sweden has still lost export shares (0.5%) to OECD since 1964, but the RCA index has increased with 0.1 during the period.

![Diagram 3.3 Product group 72, Sweden’s export share and corresponding RCA. (Author’s calculations based upon Source OECD).](image)

3.2.2.3 Metalworking Machinery (73)

The analysis in this section is based upon calculations illustrated in diagram 3.4.

Product group 73 starts off with a sharp increase in export shares that last until the late 70’s and thereafter the pattern declines until 2003. The export ends up at almost the same level as in 1964, but it never reached the same high level as in the 70’s again. One possible explanation is that the oil crisis affected this branch of the machinery industry that much. Another justification could be that the devaluations 1976-77 started a long lasting price competition. The comparative advantage in these products has increased with 0.23 since 1964, but this improvement took place between 1964 and 1970. Either in this product
group, Sweden has any comparative advantage and have never had, throughout the observation period.

![Diagram 3.4: Product group 73, Sweden's export share and corresponding RCA. (Author's calculations based upon Source OECD).](image)

### 3.2.2.4 General Industrial Machinery & Equipment and Parts (74)

The analysis in this section is based upon calculations illustrated in diagram 3.5.

With an almost 2 percentage points decrease, this product group is the most significant example of loss in export shares. Despite that, it is characterized by the highest RCA index, but it has declined by 0.27 since the beginning of the period. Thus, it seems strange that the product group with the highest comparative advantage has lost most export shares of all product groups to OECD. This could of course depend on the fact that the OECD-countries have an even higher RCA in these commodities.

One explanation of the high RCA could be that raw material and inputs for producing goods in group 74 is less expensive in Sweden and hence it has an advantage in producing these commodities. Another reason could be that these types of goods requires superior technology, which is available in Sweden. Sweden has a comparative advantage in R&D-intensive goods and capital intensive goods, since capital is rather cheap, relatively to labor. This means that goods where Sweden has a high RCA index should be capital intensive in their production, if this assumption is true. Moreover, a high RCA may reflect economies of scale. This is also true for Sweden, where machinery industry goods are produced in long series.

Once again, one can see the connection between a decline phase and the oil crisis in the 1970’s and after the devaluation in the early 1980’s there is a weak growth phase. Otherwise, the stylized product cycle during the time period is decline-growth(with a peak)-decline.
Diagram 3.5 Product group 74, Sweden’s export share and corresponding RCA. (Author’s calculations based upon Source OECD).

3.2.2.5 Electrical Machinery, Apparatus & Appliances n.e.s. (77)

The analysis in this section is based upon calculations illustrated in diagram 3.6.

The export of product group 77 can be described with, in general, a growth phase until 1976, when the oil crisis started and devaluation was made, and then a decline phase until year 2003. Even though this decline includes small up going business cycles, the trend is negative and it is obvious that Sweden has lost export shares in these goods as well. Two of the following sharp decline phases coincide with the next devaluation, in the 1980’s and the deep recession Sweden experienced in the 1990’s. The RCA has been almost 1 some years, but it has never reached that level, which implies that Sweden never have had any comparative advantage in producing these commodities. In fact, the RCA is even lower in 2003 than in 1964. The low comparative advantage is justification enough for the decrease in export shares.

The low RCA can be enlightened with that the production of these products may require cheap land or labor if, for instance the products are more labor intensive in their production, and thereby Sweden lack comparative advantage in this product group. Both land and labor are relatively expensive in Sweden, compared with other countries.
3.2.3 Change in RCA quotients

To provide a deeper comprehension of the RCA-index and its movements, the quotients that it is based on will be further analyzed. The RCA formula (2) is based on two different quotients, Sweden’s relative export share of a product group and Sweden’s relative total export share, in relation to OECD. The denominator illustrates Sweden’s share of OECD’s total export and this variable is the same in all calculations. In 1964 Sweden’s total export share was 3.21% and in 2003 it had declined to 2.02%. This implies that, if the export share of the product group has been constant, or increasing over time the RCA should have increased. However, the export shares of the product groups have decreased over time (Diagram 1.2) and hence, they must decrease less than the total export share to have an increasing RCA.

As a result, it is possible to conclude that in product groups where RCA has increased (71, 72, and 73) during the period, the export shares of these product groups must have decreased less than Sweden’s total export share. Consequently, in product groups where RCA has decreased (74, 77), the export shares of these product groups must have decreased more than the total export share.

3.3 Schloss Laxenburg Model Approach

In this section the empirical results are analyzed within the Schloss Laxenburg model framework.

The Swedish machinery industry is characterized by a competitive market and the Schloss Laxenburg model argues that in this type of market, product groups will follow certain life cycles. Sweden is a preferable region to launch new products, since it meets the requirements for a region that has an advantage for innovations and early imitations. It is a knowledge and R&D intensive country, which are the main issues according to the Schloss Laxenburg model. Further, since it is a highly developed country with a relatively high-educated population, people are interested in, and can afford, testing new products. The import intensity is high, the import value is equal to approximately 75% of the export value.
(Swedish Trade). This will contribute with information about new innovations around the world.

The introduction of new products and production methods should be equally likely in Sweden as well as in other OECD countries, since they all are highly developed. Therefore, Sweden is assumed to be one of the initiators in the machinery industry development and hence, low-cost, less-developed countries should be the imitators. Hence, the empirical observations and the analysis in this thesis reveal that this is not true for Sweden. The machinery product cycles moves from a high level of specialization to a low level of specialization, as illustrated in figure 2.3 (Chapter 2). Sweden starts with a high specialization level, connected with the entry of new or modified products, where the rate of change in specialization over the time period is higher than zero. This stage is the product cycle’s innovation phase, which later on develops into the growth phase, where the specialization level still is high, but the rate of change in specialization is less than zero. Further, the product cycle enters the maturity phase and with that a low level of specialization. Finally, in the decline phase, the specialization level is still low, but the rate of change is back on more than zero. Contrary, figure 2.3 also illustrates how the imitator’s product cycle develops. Assuming that less-developed countries are the imitators, those countries moves from a low level of specialization with a rate of change of more than zero to where it finally become less than zero, but the specialization is back on a low level.

In general, the Swedish production of these product groups is on its way towards a decreasing regional specialization, using one of the measures suggested in the Schloss Laxenburg model, when a sole region is weighed against a multiregional context, in this case OECD. Figure 2.4 (Chapter 2) shows the aggregated product cycle paths. The product groups analyzed is placed in the lower, right square of the figure. Here, the specialization of the product group is larger than the regional specialization and the product cycle is in a decline phase. This stage in the model is characterized by a distinct decline. If the product cycles will continue like this, Sweden will enter a political protection phase, according to the Schloss Laxenburg model.

The different types of product cycle paths (Figure 2.2 in Chapter 2) can be observed in the empirical studies of the product cycles. Product cycle I-II-IV is characterized by product competition and product cycle I-II-III illustrates price competition, (see also Figure 2.1). Disregarding from small fluctuations during the research period, Sweden’s machinery production seems to generalize a pattern of predominantly price competition during the period 1964-2003, referring to the slope of the product cycles. To increase the export shares, the focus has to be on product competition. R&D, knowledge and labor with specific knowledge are important factors in this concept.

3.4 Regression Analysis

To find out which product group that has the steepest decline over time, a regression analysis was made.

The independent variable is time, i.e. all the years 1964-2003. The dependent variable is each product group and by running a regression, (Ordinary Least Squares, OLS), one could analyze the slope over time. To be able to do a linear regression, the regression model has to be linear and therefore the independent variable is logged, making it a Log-Lin model.

\[ \ln \left( \frac{f}{1-f} \right) = a + bt \]  
(The regression model)  
(3)
where \( f \) = Sweden’s share of OECD’s export each year and \( t \) = each year. The intercept (a), which is a constant, and the slope (b) will be estimated by the regression.

The variable that the logarithmic function provides is linear and it is now possible to estimate the model, (3), with the OLS-method. A linear regression is made for each product group, over the time period (Table 3.4). This allows us to see the speed of decline for each product group. The result is that product group 74 has the steepest slope and rather steep is also the slopes of 72 and 77. These product groups will most likely approach a significant reduction in export shares, if the slope is constant.

<table>
<thead>
<tr>
<th></th>
<th>71</th>
<th>72</th>
<th>73</th>
<th>74</th>
<th>77</th>
</tr>
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<tbody>
<tr>
<td>a</td>
<td>10,06</td>
<td>21,95</td>
<td>8,68</td>
<td>34,63</td>
<td>28,94</td>
</tr>
<tr>
<td>t-value</td>
<td>(3,1)</td>
<td>(7,2)</td>
<td>(3,0)</td>
<td>(13,2)</td>
<td>(9,2)</td>
</tr>
<tr>
<td>b</td>
<td>-0,007</td>
<td>-0,013</td>
<td>-0,006</td>
<td>-0,019</td>
<td>-0,017</td>
</tr>
<tr>
<td>t-value</td>
<td>(-4,2)</td>
<td>(-8,4)</td>
<td>(-4,2)</td>
<td>(-14,5)</td>
<td>(-10,5)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0,32</td>
<td>0,65</td>
<td>0,32</td>
<td>0,85</td>
<td>0,74</td>
</tr>
</tbody>
</table>

*Table 3.4 Regression Results*

Using Klein’s rule of thumb\(^{15}\) for the t-test significance, all the t-values indicate that the parameters are statistically significant at the five per cent significance level. The \( R^2 \)-values shows that between 32% and 85% of the variation can be explained by the regression model.

### 3.5 Summary

The machinery industry in Sweden approaches a declining level of regional specialization, which implies that the product cycles are in their decline phases. In two of the five product groups, Sweden has a small comparative advantage, but still the export shares are decreasing. The overall trend during the analyzed time period is that the export level has declined in all product groups observed and the revealed comparative advantage has increased in three of the product groups and decreased in two of them. Several large Swedish machinery producers have, or planning to, move their production abroad, which decreases the export level in Sweden. The regression analysis shows that the speed of decline is rather high in three of the product groups, but they all have a negative slope. If this speed of decline is assumed to be constant, product groups 72, 74 and 77 are in the risk zone.

Several economic events in the Swedish history have affected the product cycles, more or less. The oil crisis in the late 1970’s is one of the incidents that negatively influenced all the product groups. Hence, despite several devaluations and one depreciation during the time period, the pattern has not changed. The product cycles show a declining trend, which is a large problem for Sweden. A country where the machinery sector is the largest export source and a country which historically has been a leader within machinery industry.

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\(^{15}\) With degrees of freedom more than 20 and a significance level of 5%, the null hypothesis, \( b=0 \), could be rejected if the t-value exceeds 2 in absolute value. (Gujarati, 2003)
4 Conclusions & Suggestions for Further Research

The purpose with this thesis was to analyze the product cycles for Swedish machinery export 1964-2003. The empirical research reveals that Sweden has lost export shares within the machinery industry to other OECD-countries since 1964. Five different product groups were examined and all of them show a decrease in export shares, mainly General Industrial Machinery (74), which has declined with almost two per cent during the analyzed time period. Despite that, this product group has the highest revealed comparative advantage (RCA), even though it has declined some since the beginning of the research period. The lost Swedish export shares could depend on the fact that OECD countries have an even higher RCA in these commodities. This implies that the competitiveness in OECD is very strong and it is difficult for Sweden to compete on the global market of machinery industry.

There is no clear relationship between a decreasing export share and a decreasing RCA. It is obvious that the RCA follows a similar wave pattern as the change in export share, but in some product groups the RCA has increased since 1964 even though the export share has decreased during the same period. Hence, it is not likely to state that a declining RCA alone could explain Sweden’s decreasing export shares. In product groups with a high comparative advantage, which has risen during the period, the export share has declined anyway.

However, possible explanations for Sweden’s loss in export shares could be industrial movements abroad. It is an obvious problem that Swedish industries move their production to low-cost countries, to minimize production costs, or to other OECD-countries, to minimize transportation costs for instance. When the production moves abroad, Sweden’s export will automatically decrease. The machinery industry is one sector that is threatened by those movements of production, since large producers, as ABB and Electrolux, already have or planning to move their production to low-cost countries.

A third, thus theoretical, reason for the declining export pattern is imitation by importing countries. One could assume that successful products exported by Sweden are threatened by imitation in their growth phases. The early imitators are highly developed countries, as other OECD and the late imitators are less developed countries. It is important that the Swedish machinery industry produces new product cycles, to avoid a deep decline phase. Through new innovations and product modifications it is possible to keep up in the global competition. The Swedish machinery production of the examined commodities is approaching a decreasing regional specialization. To avoid this, the vision has to be product competition and the tools for that are knowledge and innovation.

The general economic situation in Sweden seems to affect the trade pattern as well. Economic expansions are followed by increasing export shares and recessions bring along declines in the export shares. Furthermore, devaluations and currency structure changes appear to have some effect on the trade flows too. The steepest decline phases of the product cycles are synchronized with the oil crisis in the late 1970’s and the deep recession in the early 1990’s. During those periods, Sweden lost in both export shares and comparative advantages in the product groups examined.

However, these fluctuations are rather insignificant for the trade balance, since the trade will always be affected of the economic situation in the country. The dilemma for Sweden is that the export shares of OECD’s total export in those product groups have decreased over time and do not recover, which is an interesting problem for further research. A research question that would be motivating would be to calculate the RCA of other OECD-
countries; do they have a higher revealed comparative advantage than Sweden in those goods? In addition to that, it would be interesting to statistically examine if the industrial movements abroad do have a large effect on these specific product groups. A third topic in this field of research that would be appealing to study is the price levels of the product groups, in order to see their path from price driven to quality driven competition.
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