



JÖNKÖPING INTERNATIONAL BUSINESS SCHOOL
JÖNKÖPING UNIVERSITY

Export of Pharmaceutical Products

- An analysis of which factors that affects Sweden's export of pharmaceutical products

Master's thesis in Economics

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Jönköping June 2007

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Date:	June 2007
Subject terms:	Pharmaceutical industry, Sweden, Export, Gravity Equation
JEL Codes:	F14, I11

Abstract

The pharmaceutical industry is one of Sweden's most important export industries with 6% of total exports. The purpose of this thesis is to analyse which factors affect Sweden's export of pharmaceutical products. Further, the different pharmaceutical products group Sweden exports will be identified. The modern trade theory, the monopolistic competition model, the product life cycle theory and the gravity equation are used to explain and to understand the problem at hand.

To analyse the problem, data of Swedish export of pharmaceutical products from 1997 to 2003 was used to the 176 destination countries Sweden exported to during the time period. The following factors were used as independent variables; distance, Gross Domestic Product (GDP) /capita, Area, Population, dummy variable for EU-membership, dummy variable for English or Scandinavian speaking countries, dummy variable for bordering to Sweden, dummy variable for same religion as Sweden and a dummy variable for countries that are not land-locked.

The findings coincide with previous studies in the manner that distance and GDP/capita have a major impact on the sales abroad of pharmaceutical products. Also, countries with a larger population are importing more than countries with a smaller population. However, the strong affinities between the exporter and the importing countries found in previous studies were not found in the export of pharmaceutical products. Further, Sweden exports most of the product group that includes medicaments consisting of mixed or unmixed products for therapeutic or prophylactic uses.

Magisteruppsats inom Nationalekonomi

Titel:	Export av Läkemedel – en analys av vilka faktorer som påverkar Sveriges export av läkemedel
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Datum:	Juni 2007
Ämnesord:	Läkemedelsindustrin, Sverige, Export, Gravitationsmodellen
JEL Koder:	F14, I11

Sammanfattning

Läkemedelsindustrin är en av Sveriges viktigaste exportindustrier med 6 % av den totala exporten. Syftet med denna uppsats är därför att analysera vilka faktorer som påverkar dess export. Vidare, de olika exportgrupperna av läkemedel som Sverige exporterar kommer att identifieras. Den moderna handelsteorin, monopolistisk konkurrens, produktcykelteorin och gravitationsmodellen används för att förklara och förstå det uppstådda problemet.

För att analysera problemet så används Sveriges export av läkemedel från 1997 till 2003 för alla 176 destinationer. Följande faktorer används som oberoende variabler; distansen, BNP/capita, arean, folkmängd, dummy variabel för EU-medlemskap, dummy variabel för engelsk- eller skandinaviskspråkiga länder, dummy variabel för gränsande länder till Sverige, dummy variabel för länder som har samma religion som Sverige, samt en dummy variabel för länder som angränsar till vatten.

Resultatet överensstämmer med tidigare forskning att avståndet och BNP/capita har ett stort inflytande av exporten av läkemedel. Likaså länder med ett stort invånarantal importerar mer än länder med ett mindre invånarantal. Däremot, det starka släktskapet mellan exportören och de importerande länderna som funnits i tidigare studier observerades inte i exporten av läkemedel. Vidare, Sverige exporterar mest av produktgruppen som innehåller medikamenter bestående av blandade eller oblandade produkter för terapeutiskt eller profylaktiskt bruk.

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1 Introduction

One of Sweden's most important export sectors is the pharmaceutical industry. The pharmaceutical industry contributed with more than 6% of the total Swedish export in 2003. This share of pharmaceutical products increased from approximately 3.6% in 1997. (SCBk; LIF(b))

The pharmaceutical industry is highly competitive and the companies face strict regulations. Research and Development (R&D) plays a significant role in all product development and is important also for the pharmaceutical companies. The pharmaceutical industry employed nearly 5 000 people only in the R&D activities in 2003. This means that more than 10% of the total numbers of people employed in R&D activities in Swedish companies were working in the pharmaceutical industry. (Karlsson & Olsson, 1998; SCBa; SCBj)

In 1997, the Swedish pharmaceutical companies assigned more than 7.1 billion SEK to R&D. That figure increased for every year and in 2003 Swedish pharmaceutical companies devoted 13.1 billion SEK to R&D activities. The money spent on R&D today, will be a pharmaceutical product that will reach the patients in approximately ten years. (EFPIA(a); SCBi)

Sweden's export share of pharmaceutical products compared to the total export of pharmaceutical products in the Organization for Economic Co-operation and Development (OECD) has decreased from around 4.6% in 1997 to 3.7% in 2003. Other major exporting countries of pharmaceutical products in the world are Belgium (14.3%), Germany (12.5%) and UK (10.7%). (OECD, Statistics, 2007)

It is important to identify which factors affect Swedish exports, in order to continue to be a major exporter of pharmaceutical products even in the future. Even though trade in general has been analysed many times, trade in R&D intensive good, as pharmaceutical products, have never been examined. In 1961, Burenstam Linder analysed trade flows between countries. Burenstam Linder claimed that countries with similar GDP/capita tend to trade more with each other than with countries that are much richer or poorer than the exporting country. Distance also has a significant role, since entrepreneurs might not even be aware of market opportunities in countries far away. Several authors (i.e. Sinai, 1970 and Tesar, 1975) find that a country starts to export to countries that are psychologically closest, and then move on to countries that are psychologically further away. Johansson and Westin (1994a) examined how affinities and barriers affect trade flows, based in particular upon the gravity model. They found that countries with closer affinities trade more with each other.

In another paper, Johansson and Westin (1994b) scrutinized which attributes that affected Sweden's exports from 1970 to 1987. The results showed a high degree of explanation¹. Johansson and Westin tested both product- and price competitive products, and came to the conclusion that distance is an important factor. Further, the dummy variable used for testing language effects supported their assumption as well as the common border dummy variable. Hacker and Johansson (2001) found strong trade affinities among different country groups in Europe, especially in Nordic and Baltic-Nordic countries. However, the trade

¹ R-squared from 0.95 to 0.98 in the different estimates, though they had some multicollinearity.

flows they found were not symmetrical, which means that the level of trade was not the same in both directions.

In a study from Hacker and Einarsson (2003), the previous study from Hacker and Johansson (2001) was confirmed. Hacker and Einarsson examined trade among 19 European countries from 1993 to 1996. The result was in line with both previous studies and the theory. They found that export decreases with distance, and increases with all the other variables used, i.e. common border, population and GDP/capita.

Hallak (2006) estimated trade flows between 60 different countries in 1995. His finding was in line with the theoretical prediction; rich countries tend to trade with other rich countries. The other coefficients also had the expected signs, such that distance have a negative effect on trade, while common border, common language, colonial relationship and common colony relationships encourage trade, due to a reduction in the trade costs.

Andersson (2007) analysed what factors affect Swedish export to 150 destination countries. His findings were in line with the theory. The total export increased with GDP and decreased with distance, just as expected. The parameter for GDP/capita was found to be positive, but insignificant. Moreover, he also found positive relations when the country was Nordic, Baltic and/or English speaking. Andersson also founds that a country with no border to the ocean reduces trade, as transport costs are lower when shipped.

As seen, most of the findings are as expected, however, the pharmaceutical industry is special, and therefore, it is important to find out which factors affect the export of Sweden's pharmaceutical industry. The question is whether trade in R&D intensive products as pharmaceutical products for instance, are explained by the same factors as trade of goods in general. The factors that will be examined are distance, GDP/capita, Area, Population, English or Scandinavian speaking countries, countries members of the European Union, countries bordering to Sweden, countries with the same religion as Sweden and countries that are not land-locked over the time period 1997-2003.

The purpose of this thesis is to analyse which factors affect Swedish export of pharmaceutical products.

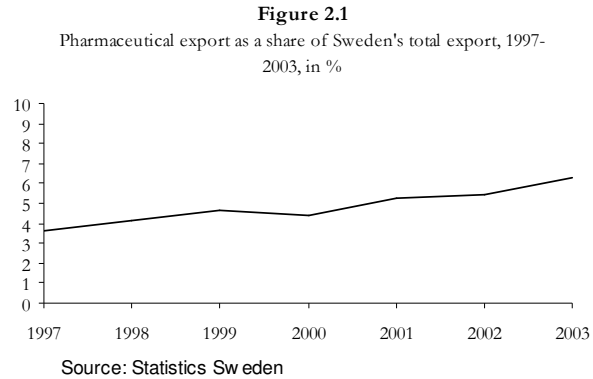
In Chapter 2, a more in-depth background to the problem is given and some necessary concepts are explained. Chapter 3 presents the theories that are necessary for the analysis. Chapter 4 aims at presenting and discussing the data and also analyse the results. In the last Chapter, the conclusions are drawn and suggestions for further studies are given.

2 Background

The intention of this section is to give a more thorough introduction to the subject. The pharmaceutical industry is special in some areas, mainly due to the extensive research phase and the complex products. Also, the pharmaceutical industry is one of Sweden's most important export sectors.

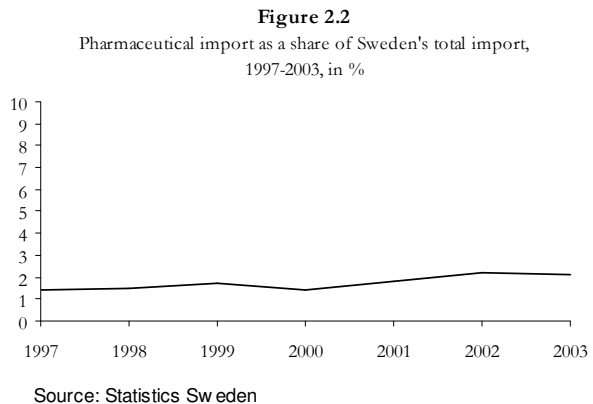
2.1 Pharmaceutical sector

Together with the motor vehicle's industry and the telecom sector, the pharmaceutical industry is one of Sweden's largest export sectors. The pharmaceutical industry stands for almost 6% of Sweden's total exports. In Figure 2.1 one can see the development of Sweden's pharmaceutical export as a share of total exports from Sweden over time from 1997-2003. As can be seen, the pharmaceutical industry increases its share of total export over time, becoming more important for Sweden's exports, starting with approximately 3.6% of total export and increases to more than 6% in 2003. (SCBk)



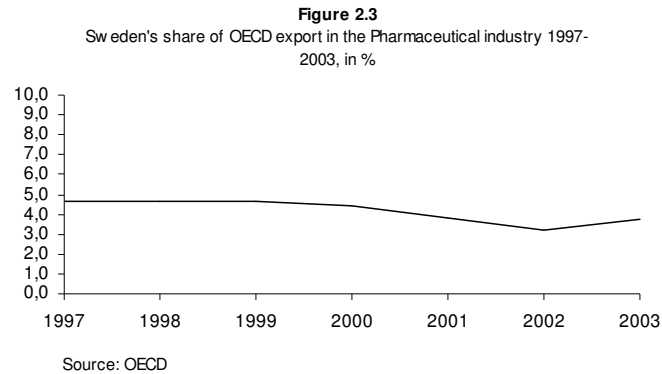
While the pharmaceutical industry increased their share of Swedish exports by approximately 2.5 percentage points, two other important export groups for Sweden, the telecom sector and the motor vehicles' industry, were not growing at the same rates. In fact, the telecom sector decreased their share significantly, while the motor vehicle's sector increased their share of the total exports with less than one percentage point. (SCBd)

Sweden has had a positive balance of trade in the pharmaceutical industry for a long time now. The imports are not increasing as fast as the exports in this sector, therefore the balance of trade increases over time. In 1997, the exports exceeded the imports by 14.7 million SEK. The balance of trade in pharmaceutical products increased to 35.1 million SEK in 2003. Figure 2.2 shows how the pharmaceutical imports have developed over time as a share of Swedish total imports. This import share has been stable over time, fluctuating just a little bit below 2%. (SCBe; LIF(b))



Sweden's share of total exports from the OECD-countries has decreased slightly from 1997 to 2003. In 1997, Sweden exported 4.6% of the total exports of pharmaceutical prod-

ucts of the OECD countries. In Figure 2.3 below one can see how the share has decreased over time. The countries that export the most in the world are Belgium (14.3%), Germany (12.5%) and UK (10.7%). Sweden is the tenth largest exporter of pharmaceutical products. All the top-ten countries are among the richest countries in the world. Among these are nine European countries and the USA. Sweden is said to have a Revealed Comparative Advantage (RCA) of exports of pharmaceutical products compared to the OECD countries. In 1997, the RCA for Sweden's exports of pharmaceutical product was 2.38. As Sweden's share of pharmaceutical export decreased, so did the RCA as well. In 2003, the RCA for Sweden in pharmaceutical products was 1.93, which means that Sweden still has RCA for pharmaceutical products. (OECD, Statistics, 2007)



The pharmaceutical industry in Sweden is important also because it employs many people, both direct and indirect. Indirect employment can for instance be due to the transport of pharmaceutical products and lawyers the pharmaceutical companies hire. (SCBj)

2.2 Research and Development in the Pharmaceutical Industry

The total amount of person-years² in R&D activities in the pharmaceutical companies in Sweden was 5 053 person-years in 2003. The number of person-year decreased slightly since 1997 when 5 112 person-year was made in the pharmaceutical companies. This figure means that around 10% of the total amount of person-years in R&D in Sweden is done by the pharmaceutical companies. (SCBj)

In the pharmaceutical industry, it is basically two group of investors and two groups who execute the R&D activities. The companies both finance and execute R&D activities. The other investor is the public sector. In 2003, the companies contributed with 74% of the total funding. Most of the money was spent on developing new products and second most in improving already existing products. Together with the companies, the Universities also execute R&D. In 2003, the Universities executed 22% of the total R&D. (SCBb; SCBc; SCBg)

In the year 2000, the European Union (EU) set up the Lisbon Strategy which says that each country in the union should devote at least 3% of their GDP for R&D activities in 2010 and that the companies should contribute with 2% of the 3%. Sweden spent 4% of GDP on R&D in 2003, so Sweden already fulfils the target level. (European Commission, Increase and improve investment in Research and Development, 2007; SCBh)

² A person-year means that if a person for instance works part-time in R&D activities in a year, that person have done 0.5 person-year.

Most of the world's R&D in the pharmaceutical sector take place in the USA, while only 16.67% takes place inside the EU. Studies have shown that it costs approximately 8500 million SEK to develop one new medicine, and that only 30% of the new medicines are so successful in the market, so it can cover its own R&D costs. Therefore exports are extremely important for a relatively small country like Sweden. Most of the new products that enter the market are developed in the USA, while only 40% is discovered in Europe. 30 years ago the figure was about the opposite. (European Federation of Pharmaceutical Industries and Associations (EFPIA)(a))

2.3 Products and Institutional framework

The pharmaceutical industry is somewhat different compared to other industries. This is mainly due to the time it takes to develop a new product and that a new medicine has to be approved by either “Läkemedelsmyndigheten” or the European Agency for the Evaluation of Medicinal Products (EMA) before it can be sold in the market. In USA it is the Food and Drug Administration (FDA) who decides upon which of the new drugs will be approved. This is because the new medicine has to go through several years of testing to minimize its side-effects and control the effect of the new drug. Due to the complexity of new products, only one out of 5 000- 10 000 molecules tested will be approved by the governing institution so it can be sold in the market. The manufacturer must prove that the medicine is safe and fulfils its purpose. Every fifth year, the decisive authority will review its approval of the medicine. A reason for retrieve the approval can be that new previously undiscovered side-effects have been discerned, or that a new and better medicine has entered the market. (EFPIA(a); LIF(a))

A basic patent stretches over 20 years. This means that the average effective patent last only 10-12 years, so the pharmaceutical companies must develop new products in a 10-year cycle. (EFPIA, Did you know that?, 2007) The medicine can receive a so-called Supplementary Protection Certificate which means that the basic patent is extended for a maximum of five years.³ (EFPIA(b))

Developing a new medicine takes several years and extensive research and testing is mandatory. Once a new possible medicine is identified, the preclinical testing can begin. The intention with the preclinical testing is to identify any damage the new medicine can have before human tests begin. (Pharmaceutical Research and Manufactures of America, Research and Development, 2007)

The second step starts with an application to the decisive authority where the results of the preclinical tests are presented and how the further studies will continue. If the application is approved by the authorities the clinical trials can start. The clinical trials involve testing the new medicine on both healthy people and people carrying the disease the medicine is meant to cure. When the clinical testing is finished, a new application has to be approved by the decisive authority, which covers all the information of all the studies. If the authorities once again approve the application, the medicine becomes available for patients. The companies often continue with their research, in order to discover side-effects that appear in the long run. (Pharmaceutical Research and Manufactures of America, Research and Development, 2007)

³ There are some minor differences between the legislation in Europe and USA.

In the pharmaceutical industry, mergers and acquisitions are not unusual. The two most well-known Swedish companies Astra and Pharmacia have also engaged in this kind of activities. Astra merged with the British Zeneca in 1999 to become AstraZeneca. Now, the head office is located in London, although the head office for the R&D unit is located in Sweden. AstraZeneca has production in several different countries around the world. However, some of their most important production factories are still located in Sweden. (AstraZeneca, Verksamheten i Sverige, 2007; LIF(b))

Pharmacia & Upjohn is a merger of the two companies Pharmacia and Upjohn in 1995. In 2000, Pharmacia & Upjohn merged with Searle and now it was just called Pharmacia. Three years later, it was bought by the USA Company Pfizer, which is the world-leading pharmaceutical company today. (Pfizer, Pfizer växer, 2007; LIF(b))

3 Trade in R&D intensive goods – a Theoretical Framework

The aim of this Chapter is to give the reader a presentation of the economic theories necessary to analyse and explain Sweden's export of pharmaceutical products. The Chapter is divided into three sections. The first section gives a short review of trade theories before dealing with the Modern Trade Theory. The second section of this Chapter deals with the Monopolistic Competition model, while the last section presents the Product Life Cycle Theory.

3.1 From Basic Trade Models to the Modern Trade Theory

The detection that a country can benefit from trade was made by Adam Smith (1776). Then, among others, Leontief, Posner and Vernon, have developed and found that a country do benefit from trade. These researches have resulted in two major theories, David Ricardo's (1817) theory of comparative advantage and the factor abundance model.⁴ The theory of comparative advantage is essential to understand the modern theory of international trade. What Ricardo said was that even if one country has a lower relative cost in producing both goods, trade is beneficial to both countries. What matters is the opportunity cost of producing of good as a measure of how many of the other good that has to be given up. (Bowen, Hollander, Viaene, 2001) The factor abundance model assumes that the two countries are identical, except in their factor endowments. The countries will then produce the good in which they are relative abundant of, so the capital abundant country will export the capital intensive good and the labour abundant country will export the labour intensive good. R&D intensive products requires a high-skilled workforce, therefore the country that are relatively abundant in educated labour will produce the R&D intensive products. (Bowen et al. 2001)

The theories based on comparative advantage have received critique because the empirical research indicates that much of the world trade actually is between countries with similar factor endowments and is between similar products. The modern trade theory was developed because the models based on comparative advantage were not able to explain this trade, known as intra-industry trade. (Krugman, 1981) To measure the extent of intra-industry trade between two countries, the following equation has been created;

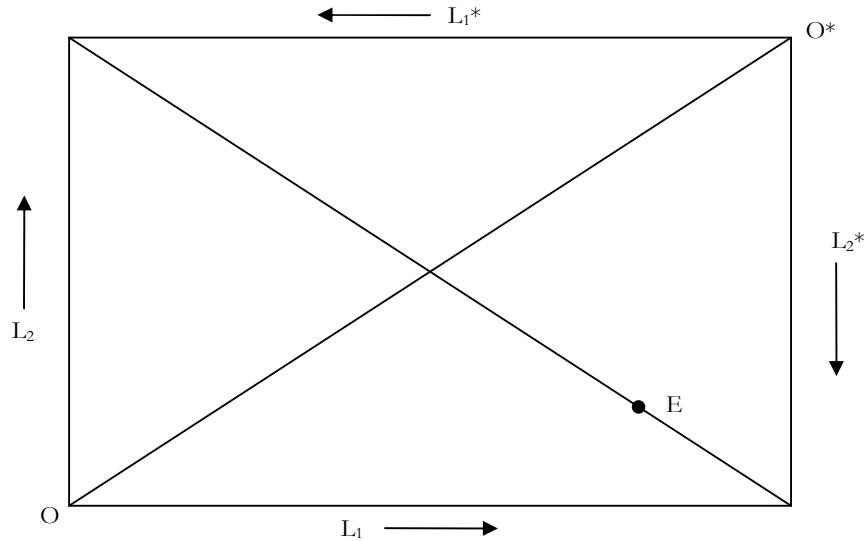
$$I = 1 - (\sum |X_k + M_k|) / [\sum (X_k + M_k)]$$

where X and M is the countries export and import in industry k. If there is trade balance, this index will be equal to 1, and if there is complete specialization, the index will be equal to 0. (Krugman, 1981)

Further, a measure to determine how similar the two countries are according to their respective factor endowments has also been constructed. This can be seen in Figure 3.1. The two countries will be identical except that the relative size of their labour forces will be different. (Krugman, 1981)

⁴ This model is also called the Heckscher-Ohlin-Samuelson model and the 2-2-2 model. The model is developed by Heckscher (1919) and Ohlin (1933) and also by Samuelsson in the 1950s. It is called the 2-2-2 model because it is two countries, two goods, and two factors of production (labour and capital)

Figure 3.1 Relative distribution of labour and economic size



Source: Krugman

The labour will be divided in the following way between the two sectors and the two countries, thus

$$\begin{aligned} L_1 &= 2 - \bar{z} & L_2 &= \bar{z} \\ L_1^* &= \bar{z} & L_2^* &= 2 - \bar{z} \quad (0 < \bar{z} < 1) \end{aligned}$$

where the * denotes the foreign country. This means that the two countries are just mirror images of each other. If $\bar{z}=1$ the two countries will have the exact same factor endowments. (Krugman, 1981)

The O and O* origins represent home and foreign endowments respectively. The diagonal line between O and O* represents the situation when the factor proportions are equal in the two countries. The downward-sloping diagonal line on the other hand represents economic size, which are equal for the two countries along that line. The \bar{z} -variable decides where on the line one will be, from the corner of the Edgeworth box to the centre of it. (Krugman, 1981)

Krugman assumes that there is no transportation costs and that the symmetry of the model assures that the wage rate will be equal in both industries and in both countries, hence $w_1 = w_1^* = w_2 = w_2^*$. He also assumes tastes and technology to be similar in the two countries. The individual firms are profit maximizing and because Krugman assumes free entry and exit of firms, all firms will earn zero profits in the long run. This will determine the size of the firm, which will be the same in both industries in both countries, due to the assumed symmetry. (Krugman, 1981)

Further, the condition of full employment in both industries and both countries will conclude how many firms that will produce. The firms will never produce exactly the same product. This is because the firms can at no cost differentiate their products. Krugman argues that this will lead to an equalization of factor prices. Moreover, Krugman declares that everyone will spend an equal amount on both products within an industry and allocate equal shares of expenditure to both industries. (Krugman, 1981)

The income, Y , is assumed to be equal in the two countries as well. This means that the following equations will be true;

$$X_1 = \frac{1}{2} Y * [(2 - \alpha) / 2]$$

$$X_2 = \frac{1}{2} Y * (\alpha/2)$$

$$M_1 = \frac{1}{2} Y * (\alpha/2)$$

$$M_2 = \frac{1}{2} Y * [(2 - \alpha) / 2]$$

Where X_1 is the countries export of commodities produced in industry 1 and X_2 is the countries export of commodities produced in industry 2. The M stands for import of the respective industry. (Krugman, 1981)

This means that the home country will export $X_1 + X_2 = \frac{1}{2} Y$ to the foreign country. The foreign country will import $M_1 + M_2 = \frac{1}{2} Y$ from the home country. The consumers in both countries will gain because of the “love of variety” effect. They now have more varieties to choose from. (Krugman, 1981)

Krugman found that countries will produce the goods in which the home demand is relatively high. This is known as the home-market effect and the reason for this is that there is positive transport costs in the real world which the firms wants to minimize, and that the countries are not of equal size, hence different size of the markets. Therefore, the firms will locate in the country where the demand for the product they produce is the highest. This means that countries will have positive trade balance in the products they produce, and a negative trade balance in the products they import. The crucial assumption for this to hold is that there is increasing returns of scale. (Krugman, 1980; Brakman, Garretsen, & van Marrewijk, 2001)

3.2 Monopolistic competition

The monopolistic competition model examined with international trade was first developed by Krugman (1979; 1981) and Lancaster (1980). Helpman (1981) later developed the model further. In a monopolistic competition situation, there are several firms in the market that are producing differentiated products that the consumers see as close substitutes. The products will be produced with increasing returns to scale technology. Each firm will behave as if they had monopoly power. New firms will enter the market when previously non-existing products are introduced by a firm. The monopolistic competition model is a combination of a monopoly (one single producer) and perfect competition (many producers with an identical product). (Hummels & Levinsohn, 1995)

The demand for a product depends on its own price and of all the other varieties prices. Therefore, the single firm takes other firms production in to account when deciding its own quantity to produce. The price a firm can charge depends on how differentiated the products are. If the products are more or less identical, it will be a pricetaker, hence it will charge the same amount as the other firms’ charges. On the other hand, the more the single firm can differentiate its product, the more of a monopoly type of power it will have. (Jehle & Reny, 2001; Varian, 2003)

Even though a firm has a patent on their product, so other firms can not produce exactly the same product, it is still possible for other firms to produce similar product, i.e. in the pharmaceutical industry. (Varian, 2003)

The profit for a firm depends also on the prices of all the other varieties, as well as the cost of course. In the short run, the firms can enter either positive or negative profits. However, because of free entry and exit, all the firms will earn zero profit in the long run. (Jehle & Reny, 2001)

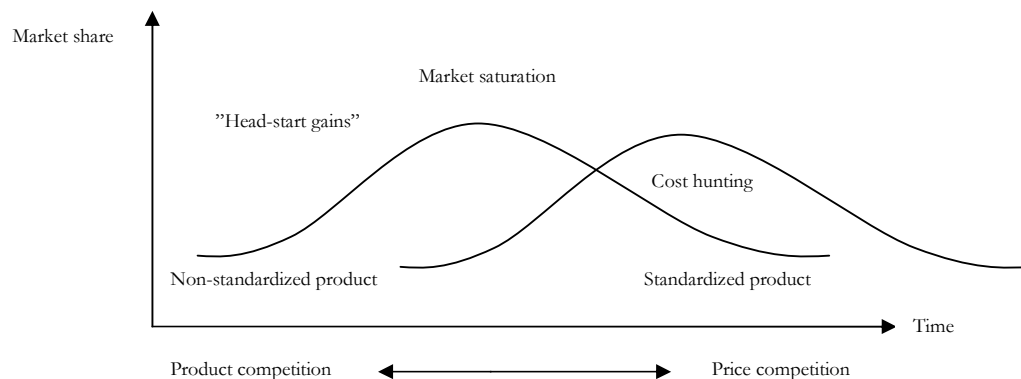
3.3 Product Life Cycle theory

The product life cycle theory was first developed by Kuznets (1929) and Schumpeter (1939). The theory was later further developed by Vernon (1966). The product life cycle theory follows a wave-like pattern over time and consists of five different stages; (i) initial development, (ii) growth, (iii) maturity, (iv) decline and (v) obsolescence. (Daniels and Radebaugh, 1995)

According to Andersson and Johansson (1984), the theory of comparative advantage and the product life cycle theory can explain the development of world trade. These two theories explain why economies are specializing and the international pattern of activity locations. The product life cycle theory, they claim “attempts to capture the dynamic aspects of change” (Andersson & Johansson, 1984, p.8)

In Figure 3.2, one can see that in the beginning of the cycle, the companies are competing with the attributes of the product, while the price of the product plays a more significant role the further the cycle goes. The labour productivity is higher in the product competition than in the price competition. Therefore, the companies are in general also having higher gross profits as well as a higher average wage level in the early stages of the product cycle than in the later phases (Karlsson and Larsson, 1983). The company who develop the new

Figure 3.2 Product Life Cycle Theory



Source: Based upon Karlsson & Larsson, 1989:3 and Johansson, 1993

product has an advantage over the other companies in the beginning. In the pharmaceutical sector, this is also due to the fact that a basic patent stretches over 20 years (Johansson, 1993; EFPIA(b)).

The product life cycle theory says that the product eventually will enter the most developed regions in the world. This will happen after the product has gone through the first stage which involves R&D of the product. Normally, the products are produced in countries with a comparative advantage in R&D, because in the first stage the necessity of a skilled

workforce and R&D possibilities is the highest. The innovating company has a monopoly position in the beginning of the cycle, while it has problems of competing later in the cycle due to the higher wage level. This will happen when the product has been standardized and production is taking place in developing countries. (Andersson & Johansson, 1984; Daniels & Radebaugh, 1995)

The second phase is characterized by an increase in export from the innovating country. The R&D intensity declines as well as the labour intensity. The firm will face more competition and therefore starts some production in a foreign country, to eliminate transport costs. (Andersson and Johansson, 1984; Daniels and Radebaugh, 1995)

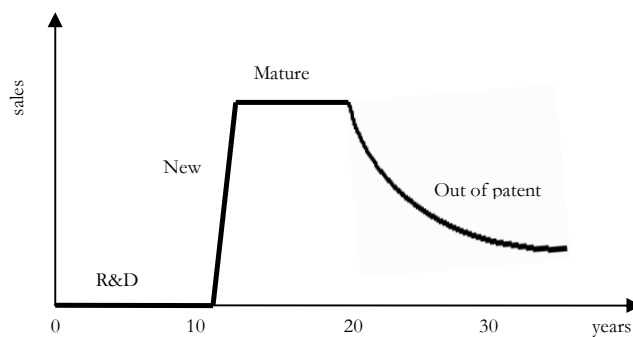
In the maturity phase, the product is being more capital intensive and standardized. Therefore, the innovating country's export declines, and production starts in less developed countries. (Lotz, 1996; Daniels and Radebaugh, 1995) The company invests in other production techniques in an attempt to minimize the costs. The high knowledge intensity is gradually decreased throughout the cycle due to the growth in production. The innovating firm does no longer have an advantage of its head-start, since technologies are known all over the world. (Johansson, 1993; Andersson and Johansson, 1984)

The second to last phase are characterized by a high concentration of the production in countries where labour cost is relatively low. The innovating country now becomes a net importer of the same product. The product now exclusively competes with its price in the market. (Daniels and Radebaugh, 1995; Johansson, 1993)

The last phase means that the product disappears from the market. New and better products have entered the market and the old product is obsolete. The company has two options then; either it can close down the production, or it can enter a new market and try to decrease the cost of production even further.

The product life cycle for a medicine is somewhat special. A basic patent for a medicine is 20 years. However, it takes 10-13 years after R&D have begun before the product can be sold in the market, so the effective patent is only around 10 years. In Figure 3.3 the life cycle for a medicine can be seen. In the early stage, the development process takes place. When the product is approved by the pharmaceutical authorities, it is allowed to enter the market. The new medicine will then gain market shares until it run out of its patent. After the patent expired, the company will start to lose market shares as other companies are allowed to enter the same market. Eventually the product will be obsolete. (EFPIA(b); Association of the British Pharmaceutical Industry, The Pharmaceutical Business, 2007).

Figure 3.3 The Life Cycle for a new medicine



Source: Based upon Association of the British Pharmaceutical Industry (ASBI)

3.4 Summary: Reasons for trade in R&D intensive products

From the above Sections, the complexity of trade in R&D intensive products have been described and the previous research have been presented, which lack research of trade in R&D intensive products. So to analyse which factors that affect Sweden's export of pharmaceutical products becomes even more complex. To give the reader an overview of the theories and the previous research, this Section will summarize the most important parts of Section 3.1, 3.2, 3.3 and the previous research in the Introduction.

The Modern Trade Theory explains why trade takes place between countries with similar factor endowments and between similar products. The country that is relatively abundant of a high-skilled labour force will produce R&D intensive products and the capital abundant country will produce the capital intensive good. (Bowen et al. 2001)

The pharmaceutical companies face a monopolistic competition situation, were several firms are competing in the market producing differentiated products. The products are produced with increasing returns to scale, and two firms will never produce exactly the same product, because they can differentiate the goods at no cost. Each firm will behave as monopolists and when previously non-existing products are introduced by a firm, new firms will enter the market. (Hummels & Levinsohn, 1995)

The product life cycle theory says that the companies are competing with the attributes of the products in the beginning of the cycle, while the price of the product plays a more significant role the further the cycle goes. The innovating country has an advantage over the other companies in the beginning of the cycle. In the pharmaceutical sector, this is also due to the basic patent that stretches over 20 years. (Johansson, 1993; EFPIA(b).

The first stage of the product cycle involves R&D of the product. The products are therefore often produced in countries with a comparative advantage in R&D, and when the product has been standardized, production will move to less developed countries. The innovating country will have problems to compete later in the cycle due to its higher wage level. (Andersson & Johansson, 1984; Daniels & Radebaugh, 1995)

The previous research indicates that distance has a negative effect on trade while GDP and population are having a positive impact on the level of trade. The available literatures also prove that affinities between the trading countries are important, i.e. common border, common language and if both are member of the EU or not. However, the question is whether trade in R&D intensive products as pharmaceutical products are explained by the same factors as trade of goods in general.

In the next Chapter, the variables that will be examined in this thesis will be presented, as well as the method used.

4 Empirical Analysis

This Chapter starts with an introduction of the Gravity Equation, before the variables are presented in section 4.2. Further, the data are introduced in section 4.3. Section 4.4 presents the different product groups. The method is presented in section 4.5. Lastly, in section 4.6, the estimated results of the regression are displayed and analysed.

4.1 The Gravity Equation

Gravity equations are among the core models to explain trade between two locations today. The structure of the model offers an explanation of how attributes of the two locations affect trade. (Andersson, 2007)

The gravity equation has its origin in Newton's gravity law (1687). It was later applied to trade between two locations by Stewart (1947, 1948), Isard (1960) and Tinbergen (1962).

The basic structure of the gravity equation is as follow:

$$Tr_{ij} = CY_i^{\theta_1} Y_j^{\theta_2} D_{ij}^{\theta_3} e_{ij}$$

where Tr_{ij} is the international trade flow from country i to country j , C is a constant, Y_i is the income level of the origin country, Y_j is the income level of the destination country, D_{ij} is the geographic distance between the two countries, often a proxy for transport costs, and e_{ij} is an error term. The θ_1 , θ_2 and θ_3 are the parameters that have to be estimated. (Brakman et al. 2001)

Trade volumes is positively affected by the economic size of the two locations, and negatively related to the distance between them. (Harrigan, 2003)

4.2 Variables

The chosen variables have been influenced by the previous research and by the theory. The variables are either expected to have a positive or negative effect on Sweden's export of pharmaceutical products. In Table 4.1 the variables are displayed and one can also see how the different variables are measured. The motivation for the first four dummy variables is that affinities between the trading countries have proven to be important in previous research. The dummy variables will take on the value 1 if the importing country is a member of the EU⁵, if it has English or any Scandinavian language as an official language in their home country, if it has the same religion as Sweden⁶ and if it borders to Sweden⁷, otherwise it will take the value of 0. The motivation for the last dummy variable is that goods that are transported to countries without a coastline are more expensive than to countries that are not land-locked. The time trend are included to see any differences of the export over the given time period. The distance variable, the GDP/capita variable and the Population variable has also been proved to have significance impact on trade, and are also important ac-

⁵ The members of the EU here are the so-called EU-15, because the other countries were not members at this time.

⁶ All the different church communions of Christianity are included for countries where a majority of the population have its faith in Christianity.

⁷ Countries with maritime borders to Sweden are included as well.

according to the theories. The Area variable is included to eliminate that the Area has anything to do with the export and it is assumed to not have any effect at all.

Table 4.1 Variable explanation

Variable	Parameter	Explanation
$\ln \text{Export}_{ijt}^{\text{SEK}}$	-	Export from country i to country j in SEK at time t
$\ln \text{Export}_{ijt}^{\text{Kilo}}$	-	Export from country i to country j in Kilo at time t
$\ln \text{Export}_{ijt}^{\text{Price/Unit}}$	-	Export from country i to country j in Price/Unit at time t
$\ln \text{Distance}_{ij}$	δ	Distance in kilometres between the capital city's of country i and country j
$\ln \text{GDP/capita}_{jt}$	β	GDP/capita for country j at time t
$\ln \text{Area}_j$	θ	Area of country j
$\ln \text{Population}_{jt}$	φ	Population of country j at time t
D^{EU}	ω	1 if member of EU before 1997, 0 otherwise
D^{Language}	ς	1 if English or any Scandinavian language are an official language in that country, 0 otherwise
D^{Religion}	ξ	1 if Christian country, 0 otherwise
D^{Border}	γ	1 if border to Sweden, 0 otherwise
D^{Water}	η	1 if border to an ocean, 0 otherwise
t	ϱ	A time trend
ϵ	-	An error term

The expected relationship between the dependent variables and the nine independent variables is displayed in Table 4.2. The expected relationship is based upon the theories, but also upon the previous research presented in the introduction part. When the independent variables expectation is unknown or when it is expected to not have any particular effect, it is provided with both a plus and a minus.

In the first row, the parameters for the independent variables are shown. The second row presents the expected affect of the independent variables when the export measured in SEK and in kilos are the dependent variables, while the last row exhibits the expected effect of the independent variables on the unit price.

Table 4.2 Expected impact of the Independent variables on the Dependent variables

Independent variable	Distance _{ij}	GDP/capita _{jt}	Area _j	Population _{jt}	D ^{EU}	D ^{Language}	D ^{Religion}	D ^{Border}	D ^{Water}	t
Expected affect on Export in SEK and in kilos	-	+	+/-	+	+	+	+	+	+	+
Expected affect on unit price	+	+	+/-	+	-	+/-	+/-	-	-	+

Source: Made by the author based upon previous research and the theories

4.3 Data

The data of Sweden's export of pharmaceutical products are collected from Statistics Sweden (SCB). The data cover the time period 1997-2003 and report to what destination country the products are exported.

The data GDP/capita were collected from UN (Comtrade) and IMF (www.imf.org) databases, as well as the population data. The GDP/capita measure was collected in USA dollars in current USA dollars and adjusted for Purchasing Power Parity (PPP).⁸ The distance is measured in kilometres from Stockholm to the respective destination's capital city.

All the data are collected on a yearly basis for all the 176 destinations.⁹ The dataset consists of all destinations that Sweden exported pharmaceutical products to in the given time period. The descriptive statistics are presented in Table 4.3.

Table 4.3 Descriptive statistics¹⁰

Variable	# obs	Minimum	Maximum	Mean	Median	Std. dev.
Total Export 1997 (in billion SEK)	176	0	3.3	0.1	0.0005	0.4
Total Export 2003 (in billion SEK)	176	0	12.3	0.3	0.0007	1.2

⁸ The GDP/capita measure has been calculated to SEK in order to have the same currency as the export.

⁹ A table of the 176 destinations in the study can be found in Appendix A.

¹⁰ The full descriptive statistics table will be given by the author upon request.

Total Export 1997 (in thousands kilo)	176	0	6378.3	172.1	1.0	659.8
Total Export 2003 (in thousands kilo)	176	0	7343.6	231.7	0.9	892.3
Export in Unit Price 1997	176	0	29480.0	1348.8	379.3	3535.4
Export in Unit Price 2003	176	0	48274.2	2230.8	980.8	5399.8

Source: Made by the author based upon statistics from Statistics Sweden

The country with the largest imports in one single year was the USA. In 2003, the USA imported pharmaceutical products from Sweden at a value of 12.3 billion SEK. The average total export in SEK more than doubled from 1997 to 2003. The average export during 1997 was roughly 170 thousand kilos and increased to approximately 230 thousand kilos in 2003. The Unit price increased from 1348 SEK in 1997 to 2230 SEK in 2003. In 1997, the exports to all destination countries were more clustered together than in 2003. The same was also true when measured in kilos and for the Unit price.

Further, countries that are members of the EU (0.9-1997; 1.9-2003) are on average importing considerably more than non EU-countries (0.05-1997; 0.1-2003). The difference is clear even when measuring the exports in kilo. Sweden exported pharmaceutical products to the EU-countries of approximately 1400 thousand kilos on average in 1997. The same value for the non EU-countries was 66.5 thousand kilos. In 2003, Swedish export increased to almost 1900 thousand kilos to the EU-countries while the export to the non EU-countries increased to nearly 90 thousand kilos. It is interesting to note that the unit price was on average higher to the non EU-countries both 1997 and 2003 compared to the EU-countries. In 1997, the unit price to the EU-countries was on average 1174 SEK compared to 1360 SEK on average for the non EU-countries. In 2003, the values increased to 2061 SEK and 2247 SEK for the EU-countries and the non EU-countries respectively. The export to the EU-countries is more scattered from the mean than the export to the non EU-countries as can be seen by the standard deviation.

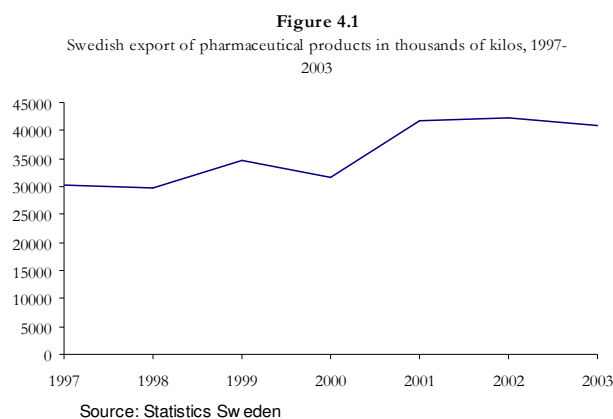
Moving on to the countries that are English or Scandinavian speaking who imported in 1997 pharmaceutical products from Sweden on average exactly (0.2) double the amount compared to the countries that are not English or Scandinavian speaking (0.1). In 2003, the English or Scandinavian speaking countries imported on average pharmaceutical products to a value of 0.5 billion SEK, while the countries with a different language imported on average commodities to a value of 0.2 billion SEK. In kilos, the English or Scandinavian speaking countries imported way more than their counterparts. In 1997, the volumes were 382 thousand kilos compared to nearly 100 thousand kilos. Seven years later, the exports increased to 500 thousand kilos for the English or Scandinavian speaking countries and to roughly 136 thousand kilos for the non English or Scandinavian speaking countries. It is interesting to notice that the average unit price is higher in the countries that are not related to Sweden according to the language. In 1997, the non English or non Scandinavian speaking countries paid 1404 SEK per unit on average, while the countries that are English or Scandinavian speaking paid on average 1191 SEK per unit. In 2003, the unit price increased to 2394 SEK per unit and 1767 SEK per unit for the non English or non Scandinavian speaking countries and for the English or Scandinavian speaking countries respectively. The exports to the country group that are not English or Scandinavian speaking countries,

are more bunched together towards the mean than the English or Scandinavian speaking countries are. This is true for both the exports measured in value and the exports measured in kilos, as well as for the unit price of exports.

Sweden exports significantly more to the countries with the same religion than to countries with a different religion than Sweden. In 1997, countries with the same religion imported pharmaceutical goods to a value of 0.2 billion SEK on average, while the other group only imported to an average value of 0.04 billion SEK. In 2003, the import increased to 0.5 billion SEK on average for the countries with the same religion as Sweden, while the countries with a different religion increased their imports to 0.1 billion SEK on average. The increase when measuring in kilos from 1997 to 2003 was from approximately 270 thousand kilos to 365 thousand kilos for the countries with the same religion as Sweden. For the other group, the destination countries with a different religion compared to Sweden, the increase was from 32 thousand kilos to 44 thousand kilos. The price per unit of commodity was higher for the countries with a different religion than Sweden in 1997, 1742 SEK on average compared to 1103 SEK. However, in 2003, the countries that have the religion in common with Sweden faced a higher unit price on average, 2352 SEK per unit compared to 2116 SEK per unit for the other countries. Further, the pharmaceutical export to the countries with the same religion as Sweden are more spread out from the mean than the pharmaceutical export to countries with a different religion than Sweden. The exception was the unit price that was more clustered for countries with the same religion as Sweden than countries with a different religion in both 1997 and 2003.

Moreover, comparing the countries that are bordering Sweden to those who not, one can see that the bordering countries imported pharmaceutical products from Sweden to a value of 0.7 billion SEK on average in 1997. In 2003, the import increased to 1.2 billion SEK. The average exports to the countries that are not bordering Sweden were 0.1 billion in 1997 and that figure increased to 0.2 billion SEK in 2003. The exports measured in kilos also increased for the two country groups. In 2003, the exports in kilos to the bordering countries were 2536 thousand kilos on average, which was an increase of approximately 800 thousand kilos from 1997. The non-bordering countries increased their exports from 87 thousand kilos on average in 1997 to nearly 110 thousand kilos in 2003. Moreover, it is interesting to note that the countries that are further away, hence not bordering Sweden, are paying a much higher average unit price than the countries that are bordering Sweden. In 1997, the bordering countries paid an average unit price of roughly 370 SEK, while the non-bordering countries paid on average 1400 SEK per unit of pharmaceutical product. The unit price increased to about 480 SEK per unit in 2003 for the countries bordering to Sweden, while the non-bordering countries also faced a price increase (2324SEK per unit). The countries that are bordering to Sweden diversified more according to their import relative to countries that are not bordering to Sweden, i.e. they were more scattered than their counterparts. However, the unit price to the bordering countries was clustered closer towards the mean than to the non bordering countries.

Further, the land-locked countries imported pharmaceutical

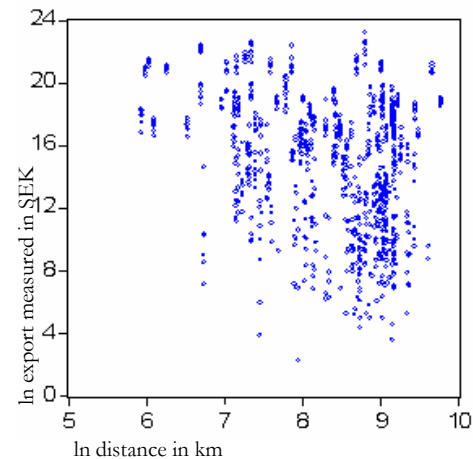


products to a value of only 0.02 billion SEK on average in 1997, while the countries that are bordering to Sweden imported on average pharmaceutical products to a value of 0.2 billion SEK. Seven years later, the land-locked countries imported pharmaceutical products to the same value as 1997, while the non land-locked countries increased their average import to 0.4 billion SEK. However, the exports in kilos increased for the land-locked countries from 19.7 thousand kilos to 20.8 thousand kilos. The countries with a border to the water increased their export in kilos from 222 thousand kilos on average in 1997 to more than 300 thousand kilos on average in 2003. The land-locked countries paid a lower unit price on average both in 1997 and 2003. In 1997, the non land-locked countries paid 1400 SEK per unit while the other country group paid 1192 SEK per unit on average. Both country groups faced an increase in the unit price. The land-locked countries paid on average 1832 SEK per unit in 2003 while the non land-locked countries paid 2363 SEK per unit on average. This is opposite to what expected. Moreover, the pharmaceutical exports to the countries that are land-locked are more clustered than the countries that are not land-locked. However, the unit prices to the countries with a border to water are more bunched together towards the mean than for the land-locked countries.

In Figure 4.1 above, Sweden's exports of pharmaceutical products measured in kilos over the given time period are displayed. Even though the export value increased from approximately 22.7 billion SEK in 1997 to roughly 51.8 billion SEK in 2003, the export in kilos did not have the same massive increase. However, the export measured in kilo's increased as well, from nearly 30.3 million kilo's in 1997 to almost 40.8 million kilo's in 2003. This means that Sweden's real export of pharmaceutical products has increased during the observed time period.

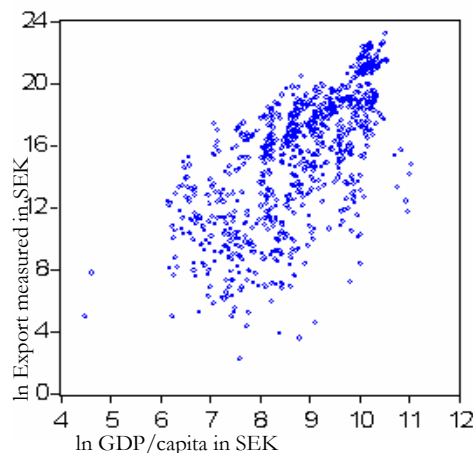
In order to provide the reader with an understanding of the data, Figure 4.2 and Figure 4.3 illustrates the export in value versus the distance for the destination countries and the export in value versus the GDP/capita respectively. When plotting the average export for the different destination countries against the distance, one can discern the negative impact distances have on the level of trade as is shown in Figure 4.2.

Figure 4.2 Display of distance distribution to export as an average over the period, 1997-2003



Source: Constructed by the author

Figure 4.3 Display of GDP/capita distribution to export as an average over the period, 1997-2003



Source: Constructed by the author

In Figure 4.3 on the other side, the average export for the different destination countries is plotted against the average GDP/capita over the given time period for the importing countries. As can be seen, the GDP/capita level in the importing country has undoubtedly a positive effect on the level of trade.

4.4 Export per product category

The Swedish export of pharmaceutical products can be divided into six product groups. In Table 4.4, the export in SEK, the export in kilo and the unit price for the different product groups can be seen for 1997 and 2003, as well as how many destination countries that are importing from the different product groups.

Table 4.4 Export for the different product groups 1997 and 2003

Product group ¹¹	# of Countries	Export (in billion SEK)	Export (in thousand kilo)	Export Price/Unit
1. Glands and other organs for organo-therapeutic uses (1997)	70	0.003	1.2	2936.5
1. Glands and other organs for organo-therapeutic uses (2003)	70	0.4	4.8	76751.3
2. Human blood (1997)	120	0.2	1370.2	166.0
2. Human blood (2003)	120	1.3	1195.5	1064.0
3. Medicaments consisting of two or more constituents (1997)	112	1.0	2130.3	458.1
3. Medicaments consisting of two or more constituents (2003)	112	0.9	2264.4	386.3
4. Medicaments consisting of mixed or unmixed products (1997)	159	21.0	24663.6	853.2
4. Medicaments consisting of mixed or unmixed products (2003)	159	48.4	34370.1	1408.4
5. Wadding, gauze, bandages and similar articles (1997)	113	0.3	1874.5	177.2
5. Wadding, gauze, bandages and similar articles (2003)	113	0.4	2447.9	158.9
6. Sterile surgical catgut (1997)	117	0.2	255.8	791.1
6. Sterile surgical catgut (2003)	117	0.5	500.1	982.2

Source: Statistics Sweden

1. ¹¹ The whole definitions for the product groups can be found in appendix 2.

As can be seen, Sweden exports most of the fourth product group (medicaments consisting of mixed or unmixed products). It was also a significant increase in the exports of the fourth product group from 1997 to 2003, from 21 billion SEK to nearly 50 billion SEK.

Further, the export for all the different product groups increased except for the third product group (medicaments consisting of two or more constituents) which decreased from 1.0 billion SEK in 1997 to 0.9 billion SEK in 2003. However, when measured in kilo, the third product group increased the exports. On the other hand, the second product group (human blood) decreased exports in volume from 1370 thousand kilos in 1997 to roughly 1200 thousand kilos seven years later.

The unit price have decreased for two of the six product groups, the third (458 SEK per unit to 386 SEK per unit) and the fifth one (177 SEK per unit to 158 SEK per unit). The unit price increased for all the other product groups.

The product group 4, with the largest export, also exports to the most amounts of destination countries, 159 different countries. The least amount of countries are importing pharmaceutical products of product category one, only 70 different countries. The first product category is also the smallest export group, both according to value and volume.

In Table 4.5, one can see how the relative price per unit of commodity have developed over the given time period¹². In four out of the six product groups the relative price has increased from 1997 to 2003. Even though the prices per unit have fluctuated rather significantly in some of the product groups, the increase in prices can not be ignored. It has had a considerable impact on the total increase in Swedish exports of pharmaceutical products.

Table 4.5 Relative Unit price over time for the different product groups

Product group/Year	1997	1998	1999	2000	2001	2002	2003
1. Glands and other organs for organo-therapeutic uses	0.014	0.005	0.006	0.466	0.018	0.109	0.381
2. Human blood	0.050	0.078	0.083	0.157	0.084	0.227	0.321
3. Medicaments consisting of two or more constituents	0.139	0.171	0.110	0.120	0.167	0.175	0.117
4. Medicaments consisting of mixed or unmixed products	0.105	0.126	0.138	0.166	0.149	0.144	0.173
5. Wadding, gauze, bandages and similar articles	0.137	0.176	0.188	0.155	0.142	0.080	0.123
6. Sterile surgical catgut	0.143	0.130	0.112	0.113	0.131	0.192	0.178

Source: Statistics Sweden

¹² The relative price is calculated as follows; $P_{t,x} / \sum P_{t,x}$

4.5 Method

This thesis uses regression analysis to test the hypothesis and uses a 95% confidence level to accept or reject the results. The equations that will be estimated are multiple-regressions consisting of panel data and the first regression has the following form;

Regression 4.1

$$\ln \text{Export}_{ijt}^{\text{SEK}} = \alpha + \beta \ln \text{GDP/capita}_{jt} + \delta \ln \text{Distance}_{ij} + \theta \ln \text{area}_j + \varphi \ln \text{population}_{jt} + \omega D^{\text{EU}} + \varsigma D^{\text{Language}} + \xi D^{\text{Religion}} + \gamma D^{\text{Border}} + \eta D^{\text{Water}} + \varrho t + \varepsilon$$

Furthermore, in an attempt to estimate the real trade effect, the next regression will have export in amount of kilo instead of value in SEK as the dependent variable. This is due to the fact that an increase in value is not necessitated an increase in amount exported. The second regression therefore takes the following expression;

Regression 4.2

$$\ln \text{Export}_{ijt}^{\text{Kilo}} = \alpha + \beta \ln \text{GDP/capita}_{jt} + \delta \ln \text{Distance}_{ij} + \theta \ln \text{area}_j + \varphi \ln \text{population}_{jt} + \omega D^{\text{EU}} + \varsigma D^{\text{Language}} + \xi D^{\text{Religion}} + \gamma D^{\text{Border}} + \eta D^{\text{Water}} + \varrho t + \varepsilon$$

The third regression will use the unit price of the pharmaceutical products exported as the dependent variable. This is done to get a better picture of which type of countries that are paying the highest unit price. The unit price is calculated by dividing the price by the kilo for every destination country every year. The following regression was run;

Regression 4.3

$$\ln \text{Export}_{ijt}^{\text{Price/Unit}} = \alpha + \beta \ln \text{GDP/capita}_{jt} + \delta \ln \text{Distance}_{ij} + \theta \ln \text{area}_j + \varphi \ln \text{population}_{jt} + \omega D^{\text{EU}} + \varsigma D^{\text{Language}} + \xi D^{\text{Religion}} + \gamma D^{\text{Border}} + \eta D^{\text{Water}} + \varrho t + \varepsilon$$

A fourth and last regression will be run only including the destination countries that are importing pharmaceutical products of group 4, the medicaments consisting of mixed or unmixed products for therapeutic or prophylactic uses. This is done to get rid of effects that the smaller product groups may cause and to confirm the first regression result. The export for this regression will be measured in SEK and it therefore takes the following form;

Regression 4.4

$$\ln \text{Export}_{ijt}^{\text{SEK}} = \alpha + \beta \ln \text{GDP/capita}_{jt} + \delta \ln \text{Distance}_{ij} + \theta \ln \text{area}_j + \varphi \ln \text{population}_{jt} + \omega D^{\text{EU}} + \varsigma D^{\text{Language}} + \xi D^{\text{Religion}} + \gamma D^{\text{Border}} + \eta D^{\text{Water}} + \varrho t + \varepsilon$$

4.6 Results and Analysis

In this section, the estimated results of the regression will be presented. The results will also be discussed and analysed. The first regression examined was Regression 4.1 where the export measured in SEK was the dependent variable. The parameters estimation result can be found in Table 4.6.

Table 4.6 Estimates of parameters in Regression 4.1 when Exports in SEK is used as dependent variable

Variable	Parameter	Coefficient ¹³	Expected Impact
α		-51.79 (-3.65)	
$\ln \text{Distance}_{ij}$	δ	-1.87 (-7.54)*	-
$\ln \text{GDP/capita}_{jt}$	β	3.44 (8.56)*	+
$\ln \text{Area}_j$	θ	-0.38 (-1.66)	+/-
$\ln \text{Population}_{jt}$	φ	2.06 (5.25)*	+
D^{EU}	ω	-2.23 (-9.16)*	+
D^{Language}	ς	0.36 (0.91)	+
D^{Religion}	ξ	2.30 (2.70)*	+
D^{Border}	γ	-1.87 (-1.25)	+
D^{water}	η	3.32 (5.73)*	+
t	ϱ	0.009 (0.05)	+
$R^2: 0.78$	# obs: 861 ¹⁴	DW ¹⁵ : 2.27	
Adj. $R^2: 0.78$	F-stat: 309.09		

* means significant at 5% significance level

From Table 4.6, one can see that the F-value (309.09) is statistically significant. However, three of the independent variables are statistically insignificant. They are the Area (-1.66) and the dummy variables for Language (0.91) and if bordering to Sweden (-1.25).

All the other independent variables are significant. However, the dummy variable for EU-countries does not have the expected sign. The EU-countries are importing on average 2.23 units less than countries that are not a member of EU.

¹³ t-values is presented in parenthesis

¹⁴ Once again, the different amount of observations is due to lack of data for some of the smallest destination countries.

¹⁵ All the four regressions are adjusted for both heteroscedasticity and autocorrelation with the help of White's test for heteroscedasticity and Durbin Watson's test for autocorrelation.

If the distance increases, the export to that destination country is on average decreasing. Further, when a country increases its welfare (measured in GDP/capita), that country are on average increasing its import of pharmaceutical products from Sweden. The population variable can be interpreted in the same manner. A population increase in a country has on average a positive effect on the export to that destination country.

The dummy variable for testing the religion effect indicate that Sweden export pharmaceutical products on average more to countries with the same religion than to countries with another religion. The dummy variable that is used if the destination country are bordering to water are also significant. It means that destination countries that are bordering to the water are importing more on average than their counterparts that are land-locked.

The R^2 -value indicates that the independent variables explain 78% of the changes in the dependent variable, the export of pharmaceutical products measured in SEK.

One can only speculate why three of the variables were insignificant. The area variable were insignificant, and that is certainly since the area of a country has nothing to do with how rich a country is or how much pharmaceutical products it needs, contrary to GDP/capita and population for instance. Further, the reason for the insignificance of the Dummy variable for indicating the potential effects for countries that are English or Scandinavian speaking is probably due to the globalization of the world and language difference's is no longer a problem.

An explanation for the insignificance for the Dummy variable for countries bordering to Sweden was can be that affinities are not having such a strong influence in the pharmaceutical industry, because many products are protected by patents and are only produced in one country, and therefore one is forced to import from that country no matter where it is produced. Moreover, the same motivation can be applied to the dummy variable for countries that are members of the EU or not. This variable is significant, but it implies that EU-member countries on average import less pharmaceutical products from Sweden than countries that are not members of the EU.

Comparing the results to Sinai (1970) and Tesar (1975), one can see that the results in these regressions did not agree with their findings. Even though the dummy variables for countries with same religion as Sweden were significant, the overall impression is that a psychologically closer country does not tend to import more pharmaceutical products from Sweden than any other countries. The same can be said about the findings by Johansson and Westin (1994a; 1994b). They also found that distance is an important factor, and that was also found in this study.

Further, Hacker and Johansson (2001) found that trade flows within country groups (e.g. among Nordic and Baltic-Nordic countries) was higher. The dummy variable for countries that are bordering to Sweden was insignificant in this regression. However, in Table 4.3, one can see that Sweden exports more of pharmaceutical products to the bordering countries on average than to countries that not bordering Sweden.

Comparing the results to Hacker and Einarsson (2003), there findings agreed in some parts, e.g. that trade decreases with distance and increases with GDP/capita and population. However, Hacker and Einarsson also found that trade flows increases to bordering countries, something that could be discern also in the pharmaceutical export, even though the dummy variable for bordering countries were insignificant.

Further, Andersson (2007) found that Nordic, Baltic, countries bordering to water and/or English speaking countries were having positive relations to trade. This regression proved that countries bordering to water are also having a positive effect on the export of pharmaceutical products, but that the affinities proved by Andersson is not of that importance in the pharmaceutical export.

Regression 4.2 tests the relationship when the export measured in volume is used as the dependent variable. This is done to measure the real export and not include the inflation.

Table 4.7 Estimates of parameters in Regression 4.2 when Exports in kilos is used as dependent variable

Variable	Parameter	Coefficient	Expected Impact
α		-277.54 (-1.10)	
$\ln\text{Distance}_{ij}$	δ	-2.73 (-2.72)*	-
$\ln\text{GDP/capita}_{jt}$	β	1.70 (3.47)*	+
$\ln\text{Area}_j$	θ	0.15 (0.44)	+/-
$\ln\text{Population}_{jt}$	φ	0.98 (1.58)	+
D^{EU}	ω	-0.58 (-0.47)	+
D^{Language}	ς	0.30 (0.36)	+
D^{Religion}	ξ	1.72 (1.26)	+
D^{Border}	γ	-0.86 (-0.31)	+
D^{water}	η	1.90 (1.52)	+
t	ϱ	0.13 (1.06)	+
$R^2: 0.86^{16}$	# obs: 717	DW: 2.22	
Adj. $R^2: 0.85$	F-stat: 386.93		

* means significant at 5% significance level

In this regression, only two of the independent variables are significant. It is the distance (-2.72) and the GDP/capita (3.47) variables. The distance variable indicates that distance have on average a negative impact on the export of pharmaceutical products, while the export on average increases when the GDP/capita for the importing country increases. The R^2 -value of 0.86 means that 86% of the changes in the export in kilos are explained by the independent variables.

Once again, one can only conjecture about why the other variables are insignificant. Obviously they have not a statistically significant impact of to which countries Sweden exports

¹⁶ A high R^2 value and few significant independent variables is a typical sign of mult-collinearity. However, the same R^2 value can be obtained even with fewer independent variables.

pharmaceutical products to. The reason might be the same as before, that pharmaceutical products are often protected by patents, and therefore only produced in one country and the importing countries have no choice were to import from.

The results in regression two concur with the theory and the previous research that the distance and GDP/capita affect the export. One can think that Sweden, that is a country with a relatively small population needs to export to as many destination countries as possible, due to the small home market, and that affinity therefore does not matter to a noteworthy extent. The fact that studies have shown have expensive it is to develop a new medicine and that only 30% of the new medicines actually covers its own R&D costs, Sweden, as well as all producers of pharmaceutical products, needs to export to as many countries as possible to cover its own costs and gain profits. Moreover, the result of this regression coincides with the findings from e.g. Johansson and Westin (1994a; 1994b), Hacker and Einarsson (2003) and Andersson (2007) that distance and GDP/capita is important factors in export.

In an attempt to verify which factors that affect the unit price of the exported products, Regression 4.3 are estimated, where the price per Unit are used as the dependent variable. In Table 4.8 the result of the Regression 4.3 are presented.

Table 4.8 Estimates of parameters in Regression 4.3 when Exports in Unit price is used as dependent variable

Variable	Parameter	Coefficient	Expected Impact
α		-97.41 (-0.85)	
$\ln \text{Distance}_{ij}$	δ	0.07 (0.27)	+
$\ln \text{GDP/capita}_{jt}$	β	1.09 (5.94)*	+
$\ln \text{Area}_i$	θ	-0.26 (-3.30)*	+/-
$\ln \text{Population}_{jt}$	φ	0.71 (4.69)*	+
D^{EU}	ω	-0.90 (-7.56)*	-
D^{Language}	ς	-0.13 (-0.56)	+/-
D^{Religion}	ξ	0.85 (3.05)*	+/-
D^{Border}	γ	-1.52 (-2.56)*	-
D^{water}	η	1.15 (4.13)*	-
t	ϱ	0.04 (0.72)	+
R ² : 0.43	# obs: 861	DW: 2.06	
Adj. R ² : 0.42	F-stat: 63.16		

* means significant at 5% significance level

In this regression, there were only two variables that were insignificant. It was the distance variable (0.27) and the dummy variable for Language effects (-0.56). Even though all the

other variables were significant, the independent variables only explain 43% of the changes in the export unit price.

The strange thing is that some of the variables have the wrong sign of their coefficient to what expected. For example, the dummy variable for countries that are bordering water indicate that the countries that are not land-locked faces an average unit price that are higher than land-locked countries. Also, the countries with the same religion as Sweden are on average paying more for their pharmaceutical products than countries with a different religion than Sweden.

The destination countries with a small area are on average paying a lower unit price than their counterparts. Countries that are members of the EU 15 and countries bordering to Sweden are paying a lower unit price on average than non EU-countries and to countries that are not bordering Sweden.

The result in Table 4.8 is very interesting. It tells one that affinities actually matters in the price per unit of pharmaceutical commodity. The distance variable was expected to have a positive effect on the unit price, hence when distance increases unit price increases. This was expected due to the transportation costs. Even though all the other variables were significant, the variables only explain 43% of the changes in unit price of export.

The remarkable observation that countries that are bordering water are on average paying a higher unit price than countries that are land-locked is contrary to both previous research and the theory. The reason for this is probably that the land-locked countries are importing so small amounts of pharmaceutical products so the transport costs is not of any significance importance.

The result of this regression did not agree with the previous research. Andersson (2007) found that countries bordering to water was on average importing more because they are paying a lower price than their counterparts due to the lower transport costs. However, this study proves that the case is the opposite in the pharmaceutical export from Sweden.

The last regression run will only involve pharmaceutical products from product group four, the largest product group. It will be measured in SEK and is run to make sure that the smaller products groups are not misleading and to confirm the result of the first regression. The estimated result of Regression 4.4 is displayed in Table 4.9.

Table 4.9 Estimates of parameters in Regression 4.4 when Exports in SEK of product group 4 is used as dependent variable

Variable	Parameter	Coefficient	Expected Impact
α		-446.18 (-2.25)*	
$\ln\text{Distance}_{ij}$	δ	-1.21 (-3.40)*	-
$\ln\text{GDP}/\text{capita}_{jt}$	β	4.01 (10.56)*	+
$\ln\text{Area}_j$	θ	-0.25 (-1.05)	+/-
$\ln\text{Population}_{jt}$	φ	1.95 (5.81)*	+
D^{EU}	ω	-1.63 (-3.58)*	+

D^{Language}	ς	0.64 (0.85)	+
D^{Religion}	ξ	1.36 (1.53)	+
D^{Border}	γ	-0.38 (-0.51)	+
D^{water}	η	2.22 (2.21)*	+
t	ϱ	0.20 (2.00)*	+
$R^2: 0.77$	# obs: 825	DW: 2.26	
Adj. $R^2: 0.77$	F-stat: 279.56		

* means significant at 5% significance level

The result of this last regression seems to agree with the result of the Regression 4.1. The only difference was that the dummy variable for religion effects was insignificant in this last regression. The R^2 value tells us that the independent variables explain 77% of the changes in Sweden's export of pharmaceutical product of medicaments consisting of mixed or un-mixed products for therapeutic or prophylactic uses.

Further, the dummy variable for EU-membership indicates that the EU-countries import on average less than the other countries. The dummy variable for countries bordering to water are positive, hence, they are importing more on average than countries that are land-locked. Moreover, countries that increase their welfare (measured in GDP/capita), increase on average their export of medicaments consisting of mixed or un-mixed products for therapeutic or prophylactic uses from Sweden. When the distance increases, the export to that destination country decreases by on average. The population variable tells us that the population on average is having a positive effect on the export.

The reason why the dummy variables for EU-countries and countries bordering to Sweden are negative is assumed to be that affinities are not as strong in the pharmaceutical export because the companies need to export to as many destination countries as possible, in order to cover its own R&D costs.

The dummy variable for countries that are not land-locked were also significant and this coincides with the previous research, e.g. Andersson (2007) who found that land-locked countries on average import a smaller amount due to the fact that much of the exports are shipped. Sinai (1970) and Tesar (1975) found that psychologically closer countries tend to import more than others. This could not be found in the export of pharmaceutical products, even though countries with the same religion as Sweden on average import more than countries with a different religion.

Moreover, Hacker and Johansson (2001) found that trade flows within country groups was higher. Both the dummy variable for countries member of the EU and countries bordering to Sweden was significant, but were having the wrong sign to what expected. Comparing the results to Hacker and Einarsson (2003) and Andersson (2007), the findings agree in the sense that distance and GDP/capita were having an impact on trade.

5 Conclusion and suggestions for further research

The purpose of this thesis was to examine what factors that affect Swedish export of pharmaceutical products. To examine this, Sweden's export of pharmaceutical products from 1997 to 2003 was analysed. The data was collected from Statistics Sweden, UN database (comtrade) and from IMF (www.imf.org).

The findings show that distance and GDP/capita have an impact on the export of pharmaceutical products, as well as the population. The strong affinities between the export country and the importing countries shown in previous studies and indicated by the theory are not present in this study. However, countries with the same religion as Sweden are on average importing more of pharmaceutical products than countries with a different religion than Sweden. Moreover, countries that are bordering to water, i.e. that is not land-locked, are on average importing more pharmaceutical products, just as found in the previous research.

Further, the unit price was expected to vary according to distance. However, the distance variable was not even significant at the 95% confidence level. The unit price depends instead positively on GDP/capita, population, religion in the importing country and if the country is bordering to water. The unit price of pharmaceutical products exports from Sweden decreases if the area in the receiving country is small, if the importing country is a member of the EU or if it is bordering to Sweden.

The finding that affinities between the trading countries in the pharmaceutical sector is not that strong, one would be interesting to know if affinities are strong in other Swedish major exporting sectors, e.g. the telecom sector and the motor vehicle sector. A similar study can also be done for other major exporters of pharmaceutical products, to analyse if the same holds in the export of pharmaceutical products also in other countries. Further, one can also analyse why Sweden are losing export share's in the export of pharmaceutical products comparing to the OECD countries. Moreover, it would be interesting to examine if this result is true also in other R&D intensive industries.

The same analysis would be very interesting with demographic factors. One could for example include how much the different countries spend on health care per capita, number of doctors and the age structure in the country, due to the fact that older citizens tend to need more medicines than younger and healthier persons.

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Appendix 1.

Table A1. The 176 destinations in the study

Albania	Cambodia	Finland	Japan	Moldova
Algeria	Cameroon	France	Jordan	Mongolia
American Samoa	Canada	Gabon	Kazakhstan	Morocco
Andorra	Cayman Islands	Gambia	Kenya	Mozambique
Angola	Central African Rep.	Georgia	Komm. Mili. Sekret- ess, EU-country	Myanmar (Burma)
Argentina	Ceuta	Germany	Korea, Dem. Peo- ple's Rep.	Namibia
Armenia	Chad	Ghana	Korea, Rep.	Nepal
Aruba	Chile	Gibraltar	Kuwait	Netherlands
Australia	China	Greece	Kyrgyz Rep.	Netherlands Antilles
Austria	Colombia	Greenland	Laos	New Zealand
Azerbaijan	Congo, Rep.	Guatemala	Latvia	Nicaragua
Bahamas	Costa Rica	Guinea	Lebanon	Niger
Bahrain	Croatia	Guinea-Bissau	Libya	Nigeria
Bangladesh	Cuba, Rep.	Guyana	Liechtenstein	Norway
Barbados	Cyprus	Haiti	Lithuania	Oman
Belarus	Czech Rep.	Honduras	Luxembourg	Pakistan
Belgium	Democratic Rep. of Congo	Hong Kong	Macedonia, Rep.	Panama
Benin	Denmark	Hungary	Madagascar	Paraguay
Bermuda	Djibouti	Iceland	Malaysia	Peru
Bolivia	Dominican Rep.	India	Malawi	Philippines, Rep.
Bosnia and Herzego- vina	Egypt	Indonesia	Maldives	Poland
Botswana	Ecuador	Iran, Islamic Rep.	Mali, Rep.	Portugal
Brazil	El Salvador	Iraq, Rep.	Malta	Qatar
British Indian Ocean Territory	Equatorial Guinea	Ireland	Mauretania	Romania
Brunei	Estonia	Israel	Mauritius	Russia
Bulgaria	Ethiopia	Italy	Mayotte	Rwanda
Burkina Faso	Eritrea	Ivory Coast	Mexico	Saint Lucia
Burundi	Faroe Islands	Jamaica	Micronesia Fed. State	Saint Pierre and Mi- quelon
San Marino	Slovak Rep.	Syrian Arab Rep.	Turkey	Uzbekistan

Saudi Arabia	Slovenia	Taiwan	Uganda	Venezuela
Senegal	South Africa	Tanzania	Ukraine	Vietnam
Serbia	Spain	Thailand	United Arab Emirates	Virgin Islands (USA)
Serbia and Montenegro	Sri Lanka	Togo	United Kingdom	Yemen
Sierra Leone	Sudan	Trinidad and Tobago, Rep.	United States	Yugoslavia
Singapore	Switzerland	Tunisia	Uruguay	Zambia
				Zimbabwe

Appendix 2

The whole definitions for the product groups are as follow:

1. Glands and other organs for organo-therapeutic uses, dried, whether or not powdered; extracts of glands or other organs or of their secretions for organo-therapeutic uses; heparin and its salts; other human or animal substances prepared for therapeutic or prophylactic uses, not elsewhere specified or included
2. Human blood; animal blood prepared for therapeutic, prophylactic or diagnostic uses; antisera and other blood fractions and modified immunological products, whether or not obtained by means of biotechnological processes; vaccines, toxins, cultures of micro-organisms (excluding yeasts) and similar products
3. Medicaments (excluding goods of heading 3002, 3005 or 3006) consisting of two or more constituents which have been mixed together for therapeutic or prophylactic uses, not put up in measured doses or in forms or packings for retail sale
4. Medicaments (excluding goods of heading 3002, 3005 or 3006) consisting of mixed or unmixed products for therapeutic or prophylactic uses, put up in measured doses (including those in the form of transdermal administration systems) or in forms or packings for retail sale
5. Wadding, gauze, bandages and similar articles (for example, dressings, adhesive plasters, poultices), impregnated or coated with pharmaceutical substances or put up in forms or packings for retail sale for medical, surgical, dental or veterinary purposes
6. Sterile surgical catgut, similar sterile suture materials (including sterile absorbable surgical or dental yarns) and sterile tissue adhesives for surgical wound closure; sterile laminaria and sterile laminaria tents; sterile absorbable surgical or dental haemostatics; sterile surgical or dental adhesion barriers, whether or not absorbable