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Skill Dispersion and International Trade Patterns

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Preface and acknowledgements

During my pre-master year at the Erasmus University Rotterdam I became very interested in International Economics, especially in the well-known trade theories as the Stolper-Samuelson theorem, Rybczinski theorem and the Heckscher-Ohlin theorem.
Dr. Emami Namini made me familiar with the subject of my thesis, skill dispersion and international trade patterns. This subject is an extension on the above mentioned theorems. Now it is not only the factor that matters for trade, but, also the dispersion of the factors. Since this subject was new for me, I wanted to know more about this and thus, it became the subject of my thesis.

First of all I would like to thank my supervisor Dr. Emami Namini for excellent guidance and advice during my research and for introducing me to this subject.
Then of course, I would like to thank my family, boyfriend and friends who never got tired of hearing me speak about my thesis. I could always count on their endless support.

Danielle Stougie
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Abstract

There are a lot of studies on International trade, in which the aggregate factor endowments of a country and the effect on trade is investigated. Comparative advantage, whether driven by technology or aggregate factor endowments, is the key determinant of international trade. However, only a few empirical studies have investigated the distribution of these endowments and the influence on the trade pattern between countries. However, the distribution of factor endowments can be a source for comparative advantage as well. Thus, not only aggregate factor endowments make a difference in the determination of trade patterns, also the dispersion of these factors matters for trade. In this thesis the factor labor will be considered. The dispersion of skills in a country can raise incentives to trade. It is observed that countries can trade even if the technology in the two countries and the aggregated endowments are the same. In this study, the following hypothesis will be investigated: *Countries with relatively greater skill dispersion will specialize in industries characterized by high-technology products and will eventually export these products.* In order to do this, an empirical framework is set up. 17 different industries of 18 different countries are taken into account. The two most important variables, which are constructed for this study, are skill dispersion and the R&D intensity of export. The technology of a country is visible due to the variable R&D intensity of export. The R&D intensity of export will be regressed on skill dispersion. This study shows that a significantly positive influence of skill dispersion on the R&D intensity of export occurs, which supports the hypothesis that countries with relatively greater skill dispersion will export high-technology products.

Key words: Skill dispersion, comparative advantage, R&D intensity of export.

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1. Introduction

A lot of studies on International trade exist about the influence of factor endowments on international trade. The well known Rybzinsky proposition (Rybczynski, 1955) is a good example. Comparative advantage is the key determinant for trade in almost every trade model. Until recent years, the only sources of comparative advantage were the aggregate endowments of a country and the technology differences between countries. For example, developing countries are abundantly endowed with the factor labor whereas developed countries are more endowed with capital. Therefore, developing countries will export products which use labor intensively in the production process whereas developed countries will export products which use capital intensively in the production process. This approach is originally attributed to Eli Heckscher and is reformulated by Bertil Ohlin (1933). The other source of comparative advantage is based on the technology differences between countries. This approach is attributed to David Ricardo (1817). For example, Germany uses 8 units of labor in the production of food and Italy uses 10 units. Hence, Germany is more efficient in producing food and, therefore exports food in the free trade area.

Now imagine that the technology and the endowments are the same in two trading countries. This is not uncommon since a lot of trade takes place between developed countries. Is there still an incentive to trade? Yes, there is. Less attention is paid to the distribution of the endowments in a country. However, the distribution of these endowments can be a source of comparative advantage as well. This will be the main subject of this thesis. Now, the endowment of a factor is no longer important in order to have comparative advantage, but the dispersion of that factor is important. Thus, not only aggregate factor endowments make a difference in trade patterns; also the dispersion of these factors matters for trade. For example Germany has a relatively low dispersion of skills and the United States a relatively high dispersion of skills, therefore Germany will export medium-technology products, for example cars, and the United States will export high-technology products, for example software.

This study shows that the dispersion of a factor has influence on trade. The factor labor will be the focus of this thesis.

Whether skill dispersion has influence on international trade patterns will be investigated. The most important studies on this subject will be outlined in the literature review.

One of these studies, “skill dispersion and trade flows” written by Bombardini, Gallipoli and Pupato in 2008, is the starting-point of this thesis.

This thesis will be a robust check of what is investigated in that article. The same subject is investigated in this study but with a different method. Compared to the article, different data is used to construct the variables, and another indication for technology in the model is used. Furthermore, different control variables are used in the regression. Finally, some countries in the study of Bombardini et al. have been replaced by other countries or have been omitted in this study. In order to investigate if skill dispersion has a positive effect on international trade, two variables are constructed from the data collected; Skill dispersion and the R&D intensity of export. The R&D intensity of export will be used as identification whether the exported products are high- or low-technology products. A high R&D intensity of export leads to the conclusion that high-technology products will be exported. These two variables are constructed for 17 different export industries of 18 different countries. The R&D intensity of export will be regressed on skill dispersion. For validation purposes, three regressions will be executed. The first regression includes data on the most important export industry, the second includes data on the two most important export industries and the third regression includes data on the three most important export industries. Some control variables are added to the regression as well. These control variables are; GDP per capita, country-wide R&D expenditures, foreign direct investments and gross savings. The method of panel data analysis is used to execute this study.

The exact problem statement of this thesis is; does skill dispersion have influence on international trade patterns? The empirical study justifies an affirmative answer to this question. Skill dispersion has a significant positive influence on the R&D intensity of export. These two variables have a positive relationship indicating that if one variable increases the other one will increase as well. Thus, when relatively high skill dispersion occurs, the R&D intensity of export is also relatively high. A relatively high R&D intensity of export indicates that the exported products are produced with relatively high technology.

This thesis is organized as follows; in the next chapter the related literature on this subject will be discussed, followed by a short summary on it. In the first section of chapter three, an overview of the empirical study will be presented as well as an elaborate description of the model. In the second section the data will be outlined. The third section shows the hypothesis and expectations. The methodology of the study is described in the section four “Estimation Framework”. The preliminary results are given in the fifth section. In the sixth section, the descriptive statistics are given and the results of the regression are given in the last section of this chapter. Finally, one can read the concluding remarks, limitations and recommendations for future research, in the fourth chapter.

2. Related literature

In this chapter, an overview of previous literature on this subject will be given. Several articles will be discussed and compared to each other. A short summary of the literature review will be given in the last section of this chapter.

2.1 Literature review

The key determinant of every trade model is comparative advantage. Comparative advantage may be driven by aggregate factor endowments. Each country will export the commodity which intensively uses the abundant factor of that country in the production process. Comparative advantage can also be driven by technology differences. The country which produces a particular product with the most efficient production process will export that product. However, few studies about the distribution of factor endowments exist. For example, consider the factor labor. The dispersion of skills in a country can raise incentives to trade. It has become of general interest since e.g. rich countries trade with each other; i.e. trade exists between countries with identical technology. It has been observed that trade exists between countries with the same technology and equal aggregated endowments. This literature review will examine if skill dispersion has influence on international trade.

In the paper “skill dispersion and trade flows” written by Bombardini et al. (2009) a model is developed in which comparative advantage is derived from the dispersion in skills of the working population in a country. In each industry there is need for different types of skills. Bombardini et al. suggest that industries are different with respect to the degree of complementarity: one industry requires a homogeneous workforce, and therefore a lot of workers can do complementary tasks, whereas in another industry heterogeneously skilled workers are needed.

For example easy production processes, like engine and turbine manufacturing, are executed by workers with complementary skills, whereas in the production of computers a team of both high skilled and low skilled workers is required, as a result of the different stages in the production process. For comparative advantage to appear in this setting it is possible that the trading countries have the same endowment and technological process, but then there has to be a difference between the countries in the dispersion of skills. The production functions are only super modular and vary in the degree of complementarity of workers' skills. A random match is assumed between firms and workers. This paper shows that skill dispersion contributes as much to international trade as aggregate endowment. The paper investigates the hypothesis that an industry with a lot of skill dispersion will specialize in sectors with a high degree of substitutability among skills. The statement is that countries with a more heterogeneous labor force will export to countries where the complementarity between workers' skills is lower. The degree of complementarity is measured by the dispersion of the wages. Because of the random matching of workers with firms, the skill dispersion is defined by the resulting wage distribution. In sectors where the degree of complementarity is high the wage distribution is compressed. The conclusion of the article is that countries with a lower dispersion have a comparative advantage in sectors where a high degree of complementarity is present because of the need for homogeneous workers i.e. workers with similar skills.

This is similar to what Grossman and Maggi (2000) observed in their article. Grossman and Maggi (2000) show that countries with a relatively homogeneous labor force export the products produced by a technology with complementarity between tasks. Countries with a relatively high dispersed labor force export products for which individual success is more important.

In contrast to Bombardini et al. (2009), Grossman and Maggi (2000) also consider sub modular functions. Assume that workers work in teams of two: super modular means that when two workers work together, they influence each other by raising each other's marginal product. Thus, workers with the same level of skills have to be matched. The idea behind this is that workers' skills are complementary in the production process. Sub modular means that only one high skilled worker is needed: the high skilled worker mitigates the need for another high skilled worker.

Therefore, countries with a high level of skill dispersion have a comparative advantage in industries which are sub modular, whereas countries with a low level of skill dispersion have a comparative advantage in super modular industries.
This is because of the fact that a highly dispersed labor force has many outliers and therefore it is easy to match the most skilled worker to the least qualified worker. Workers in a homogeneous labor force are almost identical and therefore two identical workers are matched to each other, which lead to inefficiency since the second worker's skills are not used in sub-modular functions. Given any four workers, the two highest skilled workers and the two lowest skilled workers are matched to each other to attain maximum output. Thus, in a sector where the production process of a product yields substitutable tasks, a heterogeneous work force has a comparative advantage in producing that product. Within a sector where the production process requires workers with complementary skills it is most efficient to employ homogeneous workers, for average skill is important in this case. It is more efficient when all tasks are executed equally well instead of producing some tasks super efficient and the other ones very poorly. Hence, Grossman and Maggi (2000) conclude that the country in which skill dispersion is relatively low, will export the product with a technology characterized by complementarities between workers. This is because people with similar talent are needed to work together in order to execute complementarily tasks. This is relative easily done in a homogeneous population. The country with a relatively more dispersed work population will export products which are produced with substitutable tasks. In this sector the most skilled worker of a team of two outperforms the other, who is less skilled. Thus, only the most productive and skilled workers matter in the production process.

This is very similar to what Ohnsorge and Trefler (2007) observed in their paper ”Sorting it out: International Trade with Heterogeneous workers”. The implication of workers' heterogeneity for industrial structure, trade and domestic income distribution is investigated in this article. Workers are endowed with skills. In this paper, the only two skills present are communicative skills and quantitative skills. Firms have to take the workers' bundle of skills as given and therefore firms choose the workers that have the correct bundle of skills. The model exists of two industries. A few attributes are considered in the model; high skilled labor, low skilled labor, quantitative abilities, communication skills and teamwork skills.

It is assumed that there is a constant return to scale. The model indicates the sorting behaviour of heterogeneous workers endowed with two attributes. Each worker will select an industry in which the wage is highest for the worker's particular skill bundle. Workers are perfectly mobile and the wage differs across the industries. Furthermore, it is assumed that total output is the sum of all tasks of the workers in the industry together. The endowments of a worker are determined by the parameters of the distribution. These are under normality: μ, ρ, and σ. μ indicates the mean, σ indicates the standard deviation and ρ indicates the correlation between absolute and comparative advantage between workers. The focus of this literature review will be on the parameter ρ. As mentioned before, there are communication skills (l) and quantitative skills (h). Comparative advantage is showed in the following formula: $s = \ln h/l$. When s is high, a country will have a comparative advantage in the quantitative skills. When p is high and positive, the absolute advantage lies in the quantitative industries and the absolute disadvantage lies in the communication industries. When ρ is negative, the opposite is true. If the parameter ρ is close to zero than the absolute advantage lies in both industries. The results from these correlations are that quantitative skills and communication skills are highly correlated in all the countries which were investigated. This means that workers have an absolute advantage in both skills. P tends to be negative, indicating that absolute advantage is negatively correlated with comparative advantage in quantitative skills. In the end it is observed that the country with a higher skill dispersed labor force will export products which only use one skill, either communicative skills or either quantitative skills in the production process.

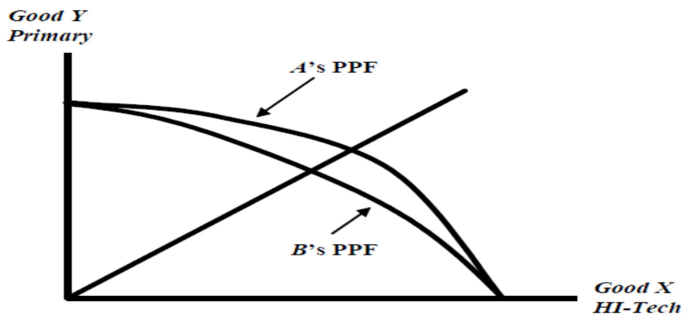
In the paper: "The distribution of Talent and the Pattern and Consequences of International Trade" written by Grossman (2004), a world economy exists of two similar countries except for the fact that the countries have different distributions of skills. It is a fact that workers differ in their ability. This is mostly due to the level of education of a worker and their genetically inherited abilities. The country with a relatively more heterogeneous labor force will produce and export products which are produced by the most talented workers. This is similar with the above conclusions of substitutability between workers' skills. A talented worker will tend to work in an environment where measuring team production is very expensive.

Grossman is convinced that the most important function of the labor market is to allocate the talent in a country into different sectors. This would be done efficiently if there would be a world of perfect labor contracts. Each individual will choose the job which will fit best. This is what is called Adam's invisible hand. Similar to what the papers of Bombardini et al. (2009) and Grossman and Maggi(2000) indicate is, when complementarities in the production function are present, workers of similar talent will work together. However if labor contracts are not perfect, the allocation of talent in a country can be distorted. For example a distortion that could occur is asymmetric information, or the fact that it is difficult to discover the contribution of each team member. National differences in the distribution of skills could lead to comparative advantage. High skilled workers have a greater incentive to join an industry where output is measurable with a large share of low skilled workers than in an industry where output is also measurable but with a low share of low skilled workers. This will create an opportunity for trade. As it is mentioned above, the country in which distribution of skills has a greater spread, exports the products of individual effort and imports the products which where made in teams. An example of Japan and the United States is considered in that article. It is assumed that the average ability and the production technologies in the two countries are the same. It is a fact that Japan has a more homogeneous labor force. Under the assumption that there are imperfect contracts, a talented worker would not like to work in teams because the average will drop due to low skilled people. However, this happens less in Japan since it has a more homogeneous workforce. Thus the average is not as easy influenced as in the United States. A randomly chosen high skilled worker would more likely wish to work in a team in Japan but would more likely wish to work individually in the United States. To investigate if skill dispersion has influence on trade, Grossman (2004) creates a world existing of two countries. It is assumed that talent is uniformly distributed in the two countries and that the mean is similar. The home country has a labor force which is relatively more dispersed than the foreign country. There are two products; software and an automobile. The automobile is relatively easy to make and is produced in teams. Software is produced individually and requires high skilled workers to be produced. It is investigated which country will export which product. As one could expect, after investigations, it is observed that the home country will export the software, which is in line with the previous observations. Due to imperfect contracts the relative price of software will go up in the software-exporting country.

Therefore, the wage for a talented individual will increase and for a low skilled worker the wage will decrease. Because of trade one can conclude that the inequality becomes more unequal. Grossman (2004) concludes that when labor contracts are imperfect, private and social incentives differ. When a talented individual get involved in team production, he generates a positive externality since his presence in the industry improves the talent pool, which raises the average productivity. In contrast, when a talented individual decides to work alone, all the social benefits are appropriated by the talented worker. Diversity in skills among the working population breeds comparative advantage, which yields an incentive to trade.

Spiros Bougheas and Raymond Riezman (2007) also did some research about skill dispersion and international trade. A large share of trade takes place between rich countries i.e. trade between countries with the same technology. The model exists of two countries and two sectors. The two countries are similar in all aspects except for the distribution of skills. One sector uses labor for producing output and the other sector uses human capital for producing output. It is proven that trade between two countries will completely depend on the sector with human capital. Each worker in the model owns one unit of labor and some level of human capital. There are only two products in this model, product X, the high-technology product and product Y, the primary commodity. The high-technology product requires one unit of human capital to be produced and the primary commodity requires one unit of labor to be produced. Because of the difference in skill dispersion, the prices in the two countries will differ in autarky. When the countries would open up to trade there will be trade based on the dispersion of skills. The main question of the article is: What are the consequences for the pattern of trade if the distribution of capital is not the same in the two countries? Suppose that the first country, country A, has a more dispersed distribution in comparison to the second country, country B. Then country A will export the high-technology product X. This is the same conclusion as in all the other papers discussed above. This is shown in Graph 1.

Graph 1: comparative advantage



As showed in the graph, both intercepts are the same for the two countries, meaning that the aggregate endowments of the countries are similar. In the vicinity of the Y intercept the curve of country A is flatter than the curve of country B. And the curve of country A is steeper than the curve of country B in the vicinity of the X intercept. Therefore, country A has a comparative advantage in producing the high-technology product and country B has a comparative advantage in producing commodity Y. In this paper the trade pattern is investigated even further. It is investigated if the above observations have an effect on the inequality in a country. Because of trade the inequality in the country, in which the high-technology product is produced, is increased. And the inequality in the other country is decreased. In country A the workers with low skills have experienced the most loss in income due to this trade effect and the income of workers with the most skills remained the same. In country B exactly the opposite happened.

Morrow (2009) creates a model that specifies if an industry is intensive in skill diversity or intensive in skill similarity. Skill similarity in this article refers to production that benefits when workers are matched with complementarily skills. An example of this kind of production process is a production which exists of multiple similar tasks. Skill diversity implies a production process that benefits when workers with substitutable skills are matched. This production process depends of the quality of the most skilled individuals working in the firm. This paper extends the model of Grossman and Maggi (2000) by adding multiple sectors to the model and it creates new insights of the Stolper-Samuelson (1941) and Rybczynski (1955) theorems. In light of the Stolper-Samuelson proposition, an increase in the price of the output increases the wages of the team and changes the relative wages within the team.

The Rybczynski theorem states that an increase in an endowment will increase the output of the production that uses that particular endowment more than proportional. In light of this article a change in the distribution of skills can imply a change in the production. In order to identify if an industry is intense in skill diversity or skill similarity, a model is created. Skill mix is the technology input factor. The technology can either be similar skill loving, diverse skill loving or neutral for each industry. This is investigated in 30 countries and data from the World Bank is used. To test this, a non linear function of skill mix is used. The industries can be ranked from skill similar to skill diverse. It is expected that skill mix might predict trade patterns. The skill dispersion is indicated by four different educational levels of workers measured as a percentage of total employment in the firm. It is observed that comparative advantage is better explained by skill mix than human capital alone. It is most efficient if different industries use different mixes of skill in their workforce. Also in this article it is observed that there are substitutable skills in a sub modular production function. Again, this is where production depends mostly on the highest skilled worker. If the workforce is constant, more skill dispersion implies more revenue. At last it is tested that skill dispersion has influence on export. It is observed that there is a positive relationship between skill dispersion and international trade.

The last paper that will be discussed in this literature review is the one of Arnoud Costinot (2007) under guidance of Giovanni Maggi. The paper is called “On the origins of comparative advantage”. In this paper, similar techniques are used as the ones mentioned before. The model exists of two countries and one production factor, which inevitably is labor. The products in this world differ in their complexity meaning that for some products to be produced, more tasks must be executed than for other products. If the countries open up to trade, then the country with more skilled workers will specialize in more complex products. Hence, high skilled workers are complementary sources of comparative advantage in the industry where complex products are produced.

2.2 Summary

The above reviews of a few articles about skill dispersion and international trade show that the dispersion of skills in a country can be a source of comparative advantage. Even when countries have the same factor endowments and technology, comparative advantage can occur. A difference between sub modular and super modular production functions exist. Super modular indicates that when two people work together they are stimulating each other; they raise each other's marginal product. Sub modular indicates that the highest skilled worker outperforms the least qualified worker. The skills of the least qualified person will not be used.

In a country with a highly dispersed labor force, relatively more outliers occur, therefore matching the highest skilled worker with the lowest skilled worker and so on, is efficiently done. In a country with a low dispersed labor force, the skills are very similar to each other. Hence, that country has a comparative advantage in completing complementarity tasks. The country which has a relatively more dispersed labor force will export high-technology products and the country which has a relatively low dispersed labor force will export normal products. This is because, for normal products complementary workers are needed and for high-technology products substitutable workers are needed.

3. Empirical Study

In this chapter the empirical study will be discussed. First of all the model of the study will be described. After that an elaborate overview of the data will be discussed. The hypothesis of this study will be pointed out in the third section of this chapter, following with an expectation of the conclusion of the research. The estimation framework will be outlined in the fourth section. In order to execute the regression, a first indication of the relationship between skill dispersion and the R&D intensity of export is shown by a number of scatter plots. These results are presented in the fifth section. In the sixth section of this chapter the descriptive statistics are given and the results of the regression analysis will be discussed in the last section of this chapter.

3.1 The model

The empirical model will be described in this section. 18 countries are included in the empirical model. These countries are selected based on a previous study of Bombardini et al. since, as stated earlier; this study is a robust check of that study. Due to missing data, three original countries are replaced by two new countries. This will not cause any loss of reliability, since there is already a large pool of data. To indicate the relationship between skill dispersion and international trade, data on export and skill dispersion is needed. A distinction is made between export industries. 17 different export industries of 18 different countries are included in the model according to ISIC rev. 3. In appendix A one can find a list of these industries. From these export data, together with data on R&D expenditure in the same industry, a new variable is constructed indicating the R&D intensity of export. With this variable, countries of different size and welfare can be compared. For example the United States is a larger country than Belgium, therefore it is unambiguous that the United States has a larger expenditure on R&D but this does not yet say anything about the R&D intensity per unit value of export.

In order to make a difference between export of high-technology products and normal products, a form of technology has to be included in the model.

In the study of Bombardini et al. this technology is indicated with wage dispersion in a country. The data source for wage dispersion, however, was not public. In this empirical study the R&D intensity of export is used to indicate the technology in a country, since the R&D intensity of the production of a specific product indicates whether a relatively high or low technology is used in the production process. Further explanation of this variable can be found in the next section. In order to include the aspect of comparative advantage, a measure of skill dispersion is added to this model. Each country has its own relative index of skill dispersion. In this way it becomes visible which country has a relatively more dispersed workforce than the other. How this measure of skill dispersion is constructed is explained in the next section, "Data". Several control variables which might influence the R&D intensity of export have to be included as well. These are: GDP per capita, country-wide R&D expenditures, foreign direct investment and gross savings and are also described and explained in the next section. Finally, all data for only the three most important export industries for each of the 18 countries are taken to execute this study.

3.2 The data

In this section data which have been used in order to execute this research will be described. There are three leading variables that will be discussed. These are; skill dispersion, R&D expenditures and export of goods at current prices.

Skill Dispersion

The data on skill dispersion within a country are gathered from the World Development Indicators Online. These data are collected for 18 different countries based on the research of Bombardini et al. The countries included are; Denmark, Germany, The Netherlands, Belgium, New Zeeland, Czech Republic, Slovenia, Poland, Italy, Ireland, Spain, Sweden, Hungary, United Kingdom, United States, Norway, Finland and France. The years that have been taken into account are 1995 to 2008. This large amount of years is used for validation purposes.

The expenditures per student on primary, secondary and tertiary education as a percentage of GDP per capita and GDP per capita itself are used to create a measure of skill dispersion within a country. The number of workers with primary, secondary and tertiary education could have been used too. The reason to have chosen for this particular data is outlined in the appendix. A measure of skill dispersion can be constructed from the expenditure per student on the three different educational levels in current US dollars. In order to do so, a standard deviation has been constructed. Secondary education is held as the mean. The following formula is used to calculate the standard deviation per year: The sum of: $\sqrt{}$ (Observation – Mean) ^{2}.

Observation in this formula indicates primary or tertiary education. The standard deviation is divided by 1000 since it is more convenient to use in calculations. With this measure of dispersion one can compare countries with each other based on skill dispersion. A higher standard deviation in one country compared to another indicates more skill dispersion in that country. Thus, this study is about relative skill dispersion and not about absolute skill dispersion. The skill dispersion in all 18 countries does not differ a great amount, therefore the relativity is that important.

The R&D intensity of export

This variable is constructed since a difference in country size between the countries within this study occurs, a form of technology has to be present in the model and to indicate international trade. If R&D expenditure from industry A is divided by export in industry A, the R&D expenditure per value unit of export becomes visible and this is a valid variable to compare countries with each other. The R&D expenditure indicates the technology in a country. If there is a lot of R&D in a certain industry, high technology is used in the production process. Thus, in particular it is stated that a high R&D intensity per unit of export indicates, for that particular country, that it produces and exports high technology products.

Data on the export of a country are gathered from the OECD statistics[1], in particular the STAN database for structural analysis. The data on export are taken for the years 1995 to 2008.

[1] This information can be found on http://www.oecd.org

This data set is compounded of 17 different industries of 18 different countries. These industries are categorized according to ISIC rev. 3. The data on R&D expenditure are coming from the STAN database for structural analysis as well. Thus, these data are also compounded of 17 industries for each of the 18 countries. To easily relate the R&D expenditures in a country with the export in the same country these data are also presented in current prices.

Control variables

In order to investigate if there is a real relationship between skill dispersion and international trade some control variables are included in the regression. These control variables might influence the dependent variable. The control variables are: GDP per capita, Country-wide R&D expenditures, gross savings and foreign direct investments. All the observations for these variables are taken for the years 1995 to 2008.

GDP per capita

Data on GDP per capita are collected from the OECD website, http://www.oecd.org, in particular the "national education at a glance 2009". GDP per capita could influence the R&D intensity of export. GDP is one of the most important indicators of economic growth. If GDP per capita grows, more capital is available in a country, implying more advanced techniques, thus, a higher R&D intensity of export.

Foreign direct investments

Data on foreign direct investments are collected from the World Development Indicators online. It is expected that FDI can influence the R&D intensity of export. Multinational firms produce with more advanced technologies and, thus, FDI inflows might increase the R&D intensity of export.

Gross savings

Data on gross savings are also available at the World Development Indicators online. It is expected that gross savings can influence the R&D intensity of export in a way that gross savings can go in to physical or human capital.

This indicates that more advanced technologies would be used in the production process if there are more savings and, thus, might increase the R&D intensity of export.

R&D expenditures country-wide

Data on country-wide R&D expenditures are taken from the World Development Indicators online. A higher level of R&D expenditures country wide can account for higher R&D expenditures per important export sector and, thus, might increase the R&D intensity of export.

3.3 Hypothesis and expectations

In this section the hypothesis of this study will be described. The expectations for the outcome of this research are stated in this section as well.

To examine whether skill dispersion has influence on international trade patterns, the following hypothesis need to be tested.

Countries with relatively greater skill dispersion will specialize in industries characterized by high-technology products and will eventually export these products.

In order to investigate this hypothesis, data, which is described in the previous section, is needed. The relationship between skill dispersion and the R&D intensity of export has to be investigated. In order to accept the hypothesis, the relationship has to be positive. Skill dispersion and the R&D intensity of export have to react in the same direction. This will be investigated by running a regression of the R&D intensity of export on skill dispersion. This empirical study will be explained in the next section. Since the literature review already gave a proper indication whether skill dispersion has a positive influence on the pattern of trade, the conclusion of previous literature on this subject is that skill dispersion is higher in countries where high-technology products are exported.

Thus, what is expected is that this regression, which is executed in this study, will show a positive significant relationship between skill dispersion and the R&D intensity of export. This indicates that if skill dispersion increases, the R&D intensity of export will increase as well. Thus, one can conclude that if the R&D intensity of export increases, products produced with more advanced technology will be exported since the R&D intensity of export indicates technology. This positive relationship indicates that a decrease in skill dispersion will decrease the R&D intensity of export as well. Hence, if the R&D intensity of export decreases, products produced with less advanced technology will be exported. This is expected since a heterogeneous workforce is needed in order to produce high-technology products. The production of high-technology products has different production stages and for each different stage, workers of different skills are needed. Therefore, a workforce with relatively greater spread has a comparative advantage in producing high-technology products. In order to produce normal products, a homogeneous labor force is needed. Therefore, a relatively low dispersed country has a comparative advantage in producing low-technology products.

3.4 Estimation framework

In this section the methodology of the empirical study will be illustrated. The empirical study deviates from the research of Bombardini et al. In the article of Bombardini et al. many mathematical formulas are used to indicate skill dispersion and technology. The influence of skill dispersion on international trade in this thesis is illustrated with a regression analysis. But first, some scatter plots are executed for each country individually to give a first insight of the relationship between skill dispersion and the R&D intensity of export. For each country three scatter plots are executed; one for the most important export industry in that country, one for the two most important export industries in that country and one for the three most important export industries in that country. These scatter plots can be found in appendix B. The results of the scatter plots are outlined in the section “Preliminary results”.

The regression, R&D intensity on skill dispersion, is executed in Eviews. To execute this study, panel data analysis is used since the data which have been used in this study involve both cross-section and time-series identifiers. This study could not have been executed with cross-section or time-series data only. Data is collected over time and for the same individuals. These individuals can be firms, cities, households and in this case countries. Another reason for using a panel data analysis is because of the increased number of data points which generates additional degrees of freedom. A third advantage of this type of analysis is that it diminishes the problems that might arise if an omitted-variables problem occurs and the disturbance term is more likely to consist of time-series-related disturbance, cross-section disturbance and a combination of these two.

The panel data analysis has three approaches; independently pooled panels, random effects model and fixed effects models. In this study the fixed effect model is used since there are unique attributes that are the same for each country and do not vary over time. The model with fixed effects adds dummy variables to allow for changing intercept due to omitted-variables[2].

The dependent variable in this empirical study is the R&D intensity of export. The independent variable is skill dispersion. To investigate if a relationship between these two exists, the four control variables are included in the regression analysis.

The regression equation is written as follows:

$$Y = \alpha + \beta X_{it} + \gamma_2 W_{t2} + \gamma_3 W_{3t} + \ldots + \gamma_N W_{N\,t} + \delta_2 Z_{i2}\ \delta_3 Z_{i3} + \ldots \delta_T Z_{iT} + \varepsilon_{it}$$

Where W_{it} = {1 for *i* th individual, i = 2, ..., N

{0 otherwise

Z_{it} = {1 for *t* th time period, t= 2, ..., T

{0 otherwise

The degrees of freedom can be calculated by the number of countries multiplied by the amount of years minus number of countries and minus number of years. A total of 220 degrees of freedom is obtained.

[2] This information is from the textbook of Pindyck and Rubinfeld (1998) called Econometric models and Economic forecasts.

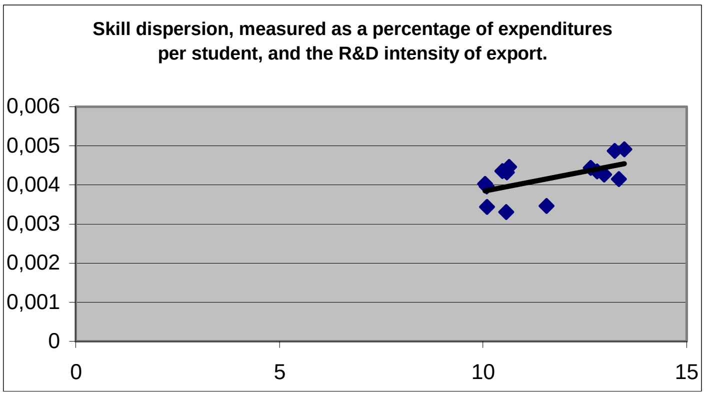
The level of significance which will be used is five percent, since it is more precise than a ten percent significance level. This is because the probability to accept the wrong assumptions is smaller.

Three regressions will be executed in order to investigate the relationship between skill dispersion and the R&D intensity of export. In the first regression, only data for the most important export industry is included. Data for the two most important export industries are included in the second regression and in the third regression; data for the three most important industries are included.

3.5 Preliminary results

In this section an overview of the results from the scatter plots will be given. These scatter plots are executed before the actual empirical research. These scatter plots show the linear relationship between skill dispersion and the R&D intensity of export. The scatter plots are executed for each country individually and for the three groups of industries separately. The scatter plots are executed with the other measure of skill dispersion, the number of labor force with primary, secondary and tertiary education as well, in order to compare the two measures of skill dispersion with each other and finally choose the right measure of skill dispersion to be used during this study.

Graph 2: Scatter plot Denmark – the most important export industry



Starting with Denmark, the scatter plot shows a positive relationship. This indicates that skill dispersion and the R&D intensity of export move in the same direction.

If skill dispersion increases the R&D intensity of export will increase as well. Thus, this scatter plot supports the earlier described hypothesis that countries with greater skill dispersion will export high-technology products.

To indicate how the scatter plots look like, the one for Denmark's three most important industries is shown above, the other scatter plots are shown in appendix B.

The scatter plots of several other countries support the hypothesis of this study as well. These countries are; Finland, Sweden, Hungary, New Zeeland, United Kingdom, United States, Spain and Poland. However the scatter plots of the other half of the countries which are included in this study show a negative relationship between skill dispersion and the R&D intensity of export. This indicates that skill dispersion and the R&D intensity of export do not move in the same direction. Based on this, one could speculate that the hypothesis should be rejected. However, this is not the case. To investigate the hypothesis of this study in a proper way, all countries have to be considered together instead of considering the specific countries individually. These scatter plots might be influenced by country specific factors and therefore show a distorted view of the relationship between skill dispersion and the R&D intensity of export, since cross-section effects and time specific effects are not accounted for. In the regression analyses it is shown, that if these two effects are accounted for, the relationship between skill dispersion and the R&D intensity is positive. It also can be that control variables, which are not considered in this two-dimensional analysis, distort the results. Thus, it is necessary to include them in the regression analysis.

3.6 Descriptive statistics

In this section the descriptive statistics of the data will be outlined. A summery of the main futures of the data set will be given. Below, one can see the summary of the data set.

Table 1: Descriptive statistics over all countries and years

	Skill dispersion	R&D intensity of the most important export industry	R&D intensity of the two most important export industries	R&D intensity of the three most important export industries	GDP per Capita	Foreign direct investments	Gross savings	Country-wide R&D expenditures
Mean	3.653187	0.032464	0.031346	0.031363	23902.49	2.97E+10	1.85E+11	1505197
Median	2.677000	0.018564	0.017812	0.017567	24175.17	1.01E+10	5.50E+10	317.3343
Maximum	18.68900	0.202874	0.189799	0.187620	94567.91	3.28E+11	1.79E+12	34133722
Minimum	0.094000	3.91E-05	3.89E-05	3.89E-05	3603.793	-3.03E+10	4.81E+09	36.03793
Std. Dev.	3.447928	0.042893	0.040878	0.040741	15244.61	5.29E+10	3.55E+11	6301694
Observations	252	252	252	252	252	252	252	252

The table contains the mean, median, maximum, minimum and standard deviation for skill dispersion, the R&D intensity of export in the most important industry, the R&D intensity of export in the two most important industries, the R&D intensity of export in the three most important export industries, GDP per capita, foreign direct investments, gross savings and country-wide R&D expenditure. These are the descriptive statistics over all countries and years.

As already mentioned in the section data, skill dispersion between countries does not differ much. This is shown in the table above as well. The standard deviation is small, 3.447928, for the variable skill dispersion. The descriptive statistics of the R&D intensity of export are almost the same for the three groups of export industries since the most important export industry is included in each group and the two most important industries are included in two groups.

3.7 Regression results and interpretations

In order to execute the regression analysis, all data for all countries are added in a regression in Eviews. The regression is shown below:

The R&D Intensity of export = α+ β_1*skill dispersion + β_2*GDP per capita + β_3*FDI + β_4*gross savings + β_5 *R&D expenditure + [CX=F, PER=F]

The objective is to find additional support that skill dispersion has influence on international trade. First, the regression for the most important industry is executed. One can see the output of this regression below.

Output 1: Skill dispersion and the R&D intensity of export - the most important export industry

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.038682	0.002977	12.99266	0.0000
Skill dispersion	0.001133	0.000539	2.101980	0.0367**
GDP per capita	4.84E-08	1.46E-07	0.330561	0.7413
FDI	-5.39E-15	2.05E-14	-0.263157	0.7927
Gross savings	-5.91E-14	1.21E-14	-4.887280	0.0000**
R&D expenditure	-2.80E-10	4.67E-10	-0.600218	0.5490
Effects Specification				
Cross-section fixed (dummy variables)				
Period fixed (dummy variables)				
Total panel (balanced) observations:				252
R-squared				0.975452

The dependent variable is the R&D intensity of export. 18 cross sections are and 14 periods are included. ** indicates the coefficient is significant on a five percent level.

18 cross sections and 14 periods are included in the regression. The total amount of observations in this regression is 252. The dependent variable in this regression is the R&D intensity of export. As mentioned earlier in this thesis, the method of this regression is Panel Least Squares. These characteristics of the regression hold for all three regressions which will be described below.

As one can see in the output above, the coefficient for skill dispersion is positive, indicating a positive relationship with the R&D intensity of export. To investigate if skill dispersion has influence on the R&D intensity of export, the probability has to be considered. The probability of skill dispersion is 0.0367.

The level of significance is five percent and therefore the variable skill dispersion is significant since the probability of it is below five percent.

GDP per capita, as one can see in output one, has a positive coefficient but is not significant on a five percent significance level. The variable, foreign direct investments, has a negative coefficient and is not significant on a five percent significance level. The coefficient for the variable gross savings has a negative sign. As shown in the output above, this variable is significant on a five percent significance level. The last control variable to be discussed is country-wide R&D expenditure which is called R&D expenditure in Eviews. The output shows that the coefficient is negative. The probability of this coefficient is 0.5490 which implies that the variable is not significant on a five percent significance level. In order to investigate if the variable skill dispersion is significantly different from zero, a test is executed. This test is called the Wald-test in Eviews which is better known as the F-test. The H0 and Ha are compounded as follows:

H0: The variable skill dispersion is not significantly different from zero, parameter is not significant.

Ha: The variable skill dispersion is significantly different from zero, parameter is significant.

Output 2: Significance of skill dispersion

Test Statistic	Value	df	Probability
T-statistic	2.101980	216	0.0367
F-statistic	4.418321	(1, 216)	0.0367**
Chi-square	4.418321	1	0.0356

**Significant on a five percent significance level.

As one can see in the output above, the probability of the F-statistic is 0.0367. This is below the five percent significance level and therefore the H0 can be rejected. This indicates that skill dispersion on its own is significant and has a positive significant influence on the R&D intensity of export.

The output of the second regression is shown below.

Output 3: Skill dispersion and the R&D intensity of export - the two most important export industries

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.036143	0.002776	13.01926	0.0000
Skill dispersion	0.001146	0.000503	2.280197	0.0236**
GDP per capita	4.48E-08	1.37E-07	0.328523	0.7428
FDI	-4.77E-15	1.91E-14	-0.249731	0.8030
Gross savings	-5.13E-14	1.13E-14	-4.548252	0.0000**
R&D expenditure	-2.84E-10	4.36E-10	-0.652797	0.5146
		Effects Specification		
Cross-section fixed (dummy variables)				
Period fixed (dummy variables)				
Total panel (balanced) observations:				252
R-squared				0.976499

The dependent variable is the R&D intensity of export. 18 cross sections are and 14 periods are included. ** indicates the coefficient is significant on a five percent level.

The most important part of the output is the coefficient and probability of the variable skill dispersion. As one can see in the output above, the coefficient for skill dispersion has a positive sign. This variable has a probability of 0.0236, indicating that it is significant on a five percent significance level. The control variable GDP per capita has a negative coefficient. The probability of this variable is 0.7428, which means that it is not significant on a five percent significance level. The coefficient of the variable foreign direct investment is negative. The probability is 0.8030 which is higher than the significance level, thus the variable is not significant. Gross savings however are significant again. Its coefficient has a negative sign.

The last variable to be discussed for this regression, country-wide R&D expenditure, is not significant since the probability of this variable is 0.5146. The sign of the coefficient is negative. In order to investigate if the variable skill dispersion is significantly different from zero the Wald-test is executed. The H0 and Ha are compounded as follows:

H0: The variable skill dispersion is not significantly different from zero, parameter is not significant.

Ha: The variable skill dispersion is significantly different from zero, parameter is significant.

Output 4: Significance of skill dispersion

Test Statistic	Value	df	Probability
T-statistic	2.280197	216	0.0236
F-statistic	5.199296	(1, 216)	0.0236**
Chi-square	5.199296	1	0.0226

** Significant on a five percent significance level

The H0 will be rejected since the probability of the F-statistics is 0.0236, as is showed in output four. Therefore, it can be stated that skill dispersion is significant and has a significant influence on the R&D intensity of export. The third regression shows the same results as before. The coefficient for skill dispersion has a positive sign, which is shown in output five.

Output 5: Skill dispersion and the R&D intensity of export - the three most important export industries

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.035782	0.002770	12.91622	0.0000
Skill dispersion	0.001105	0.000502	2.201750	0.0287**
GDP per capita	5.59E-08	1.36E-07	0.410668	0.6817
FDI	-5.58E-15	1.91E-14	-0.292555	0.7701
Gross savings	-4.93E-14	1.13E-14	-4.383175	0.0000**
R&D expenditure	-3.33E-10	4.35E-10	-0.766639	0.4441
Effects Specification				
Cross-section fixed (dummy variables)				
Period fixed (dummy variables)				
Total panel (balanced) observations:				252
R-squared				0.976440

The dependent variable is the R&D intensity of export. 18 cross sections are and 14 periods are included. ** indicates the coefficient is significant on a five percent level.

The probability of the variable skill dispersion is 0.0287, which indicates that this variable is significant on a five percent significance level. The coefficient for GDP per capita is negative in this regression as well. The probability of this variable is 0.6817, which is not below five percent. Thus, this variable is not significant.
The variable foreign direct investment has a negative coefficient and a probability of 0.7701. This probability is higher than allowed indicating that this variable is not significant. Again, the variable gross savings is significant since a probability of 0.0000 occurs. For country-wide R&D expenditure it is shown that the coefficient is negative. The probability of this variable is above the five percent significance level and, thus, not significant.

To investigate if skill dispersion on its own is significant in this regression, again the Wald-test is executed. The H0 and Ha are compounded as follows:

H0: The variable skill dispersion is not significantly different from zero, parameter is not significant.

Ha: The variable skill dispersion is significantly different from zero, parameter is significant.

The results are shown in the output below and indicating that the variable skill dispersion is significantly different from zero since the probability of the F-statistic is 0.0287 and therefore the H0 will be rejected.

Output 6: Significance of skill dispersion

Test Statistic	Value	df	Probability
T-statistic	2.201750	216	0.0287
F-statistic	4.847705	(1, 216)	0.0287**
Chi-square	4.847705	1	0.0277

** Significant on a five percent significance level

The three regressions are showing the same results. This indicates that these regressions support each other's conclusions, which comes down to a great reliance of the empirical study.

The variables, GDP per capita, foreign direct investment and country-wide R&D expenditure are not significant. This is true for all three regressions. This indicates that all three mentioned variables have no significant influence on the R&D intensity of export. This might indicate that the country-wide R&D expenditures, GDP per capita and the foreign direct investments are not spend on the R&D of the three most important export industries selected in this thesis. However, Gross savings does have effect on the R&D intensity of export. The relation between gross savings and the R&D intensity of export is negative.

Thus, one can conclude that gross savings do not go into physical capital of the three most important industries, or to physical capital at all. In all three regressions the variable skill dispersion is positive and significant. The Wald tests show that skill dispersion is significantly different from zero. This positive sign of the coefficient for skill dispersion indicates that the contribution of skill dispersion on the R&D intensity of export is positive. This supports the expectations of a positive relationship between these two variables which were stated in section 3.4.

Since the variable skill dispersion is significant, it is stated that skill dispersion has a positive significant effect on the R&D intensity of export.

This means, if skill dispersion is relatively high, the R&D intensity of export is also relatively high. As described before, if the R&D intensity of export is relatively high in a country, relatively high-technology products will be produced, since there is comparative advantage based on technology in that country. For this reason, the hypothesis will be accepted. Thus, countries with relatively greater skill dispersion will specialise in industries characterized by high-technology products and will eventually export these products. Hence, it can be concluded that skill dispersion does have effect on the pattern of trade.

4. Concluding Remarks

In this last chapter, the concluding remarks of this thesis will be given. The conclusion and summary of this thesis will be given in the first section. Then the limitations of this study will be discussed in the next section. Finally, recommendations for future research will be given in the last section.

4.1 Conclusion and summary

As already concluded in the literature review, skill dispersion has effect on international trade. The objective of this empirical study is to investigate, if it is true that skill dispersion has effect on the pattern of trade. In the case of sub modular production functions, the most qualified person will outperform the least qualified person when working together. If these two persons are both high skilled workers, then one worker's high skills will not be used, which is not efficient. It is more efficient to match a low skilled worker with a high skilled worker, which is easier done in a heterogeneous labor force. Hence, the country with a heterogeneous labor force has a comparative advantage in producing high-technology products, since workers of different skills are needed in the different stages of the production process. A country with a homogeneous labor force has a comparative advantage in producing low-technology products, since complementary tasks need to be executed in the production process. In theory this reasoning makes sense, therefore it is investigated in this study if this holds empirically as well. In order to investigate if skill dispersion has influence on international trade, an empirical model is created. The necessary data is collected, a measure of skill dispersion has been constructed and, of course, a measure of technology in the production process has been constructed as well, which is called the R&D intensity of export and which is also the dependent variable. First of all, many scatter plots were executed to have a global idea of the relationship before executing the empirical test.

To investigate the relationship between these two variables a regression has been made using panel data analysis. As discussed in the previous chapter, the results are positive. Based on the regression analysis it has been concluded that skill dispersion has a positive influence on the R&D intensity of export.

Therefore, the statement is justified that evidence is found for the existence of influence of skill dispersion on international trade in a way that higher skill dispersion in a country leads to producing high-technology products in that country.

For this reason, the hypothesis of this thesis; “*Countries with relatively greater skill dispersion will specialize in industries characterized by high-technology products and will eventually export these products”,* will be accepted.

This result supports previous literature on this subject. And thus this study is in agreement with the article of Bombardini et al. Skill dispersion does have effect on the pattern of trade.

4.2 Limitations

This thesis, like all other studies conducted, has its limitations. These limitations should be considered when interpreting the results.

1. For the variable skill dispersion to be constructed, there are two possibilities. Data on the expenditures per student on primary, secondary and tertiary or, data on the labor force with primary, secondary and tertiary education can be used. These two measures must indicate the same relationship with the R&D intensity of export. However, this is not true as one can conclude from the scatter plots, in appendix B.
2. This study is aimed to be a robust check of the article of Bombardini et al. However, for some countries data was not available. Therefore, three countries are not considered which were investigated in the article of Bombardini et al.
3. The data which is used for this study is almost complete. Unfortunately, data could not be found for some combinations of countries and years. In order to have a reliable outcome, Eviews filled these gaps.

4.3 Recommendations for future research

The objective of this study is to investigate if skill dispersion affects the pattern of trade. The method which is used in this thesis is a regression of the R&D intensity of export on skill dispersion. The variables which have been constructed and how they are constructed should be known after reading this thesis. It would be interesting to include the element of inequality in this study. Due to imperfect contract and due to trade the inequality in a country with a more dispersed labor force, could become more unequal. A country with a relatively high skill dispersed labor force will produce high-technology products. In this country, workers will work in teams, as cited in Grossman (2004). With imperfect labor contracts, a talented individual would prefer to work individually. Since trade may encourage further specialization in individualistic production in a country with a more dispersed labor force, the distribution of income becomes more distorted. This would be an interesting extension to this study.

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http://www.oecd.org

World development indicators online

Appendix

A. Additional information

Measuring skill dispersion

At first, two proper measures of skill dispersion are considered. These are: The expenditure per student on primary, secondary and tertiary education and the number of workers with primary, secondary and tertiary education. Basically, both measures of skill dispersion have to react in the same direction. If the percentage of secondary education becomes higher from one year to the next year, the number of workers with secondary education must increase as well. However, the linking between the three types of education does not have to be the same for the two types of measures. Unfortunately this is not the case for this data set. Therefore, it is obvious to see in the next part of the appendix that the scatter plots of the two measures show different results. It has to be considered that one measure of skill dispersion measures the actual numbers of people with a primary, secondary and tertiary education and the other measures the expenditures on these types of education. Hence, a low number of workers with tertiary education lead to relatively higher expenditures on tertiary education because this type of education is most expensive. It could be due to country-specific factors and the lack of control variables in this two-dimensional model, that the two measures of skill dispersion show different results.

List of export industries according ISIC rev. 3.

Below one can find the list of categories used in this study. ISIC stands for: International Standard Industrial Classification of All Economic Activities, Rev.3.

1. Agriculture, hunting and forestry

2. Fishing

3. Mining and quarrying

4. Manufacturing

5. Electricity, gas and water supply

6. Construction

7. Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods

8. Hotels and restaurants

9. Transport, storage and communications

10. Financial intermediation

11. Real estate, renting and business activities

12. Public administration and defence; compulsory social security

13. Education

14. Health and social work

15. Other community, social and personal service activities

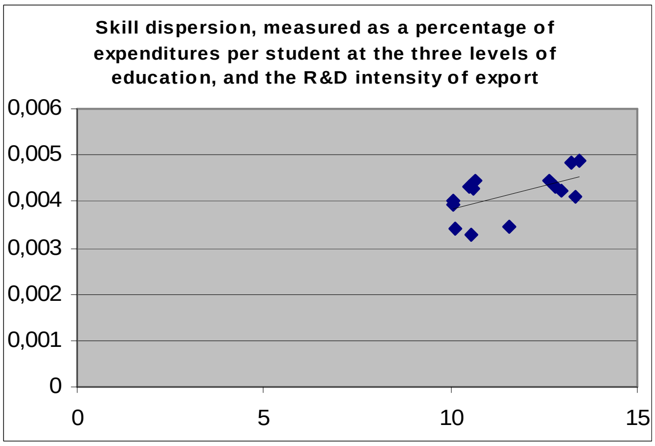
16. Private households with employed persons

17. Extra-territorial organizations and bodies

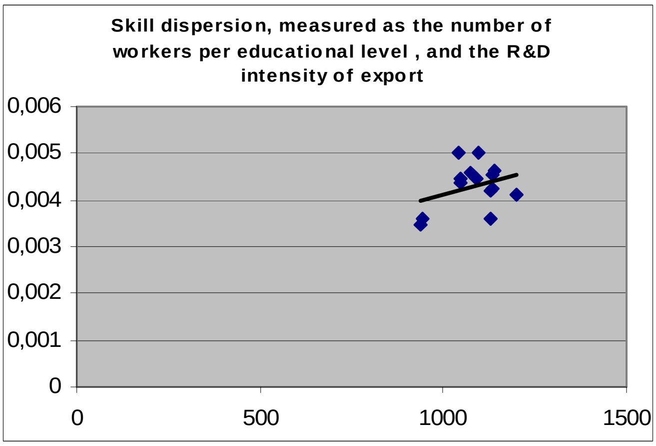
B. Scatter plots

All scatter plots are shown below. The title of the graph indicates the relevant export industry and the relevant measure of skill dispersion. On the vertical axes the R&D intensity of export is displayed and on the horizontal axes the measure of skill dispersion is displayed.

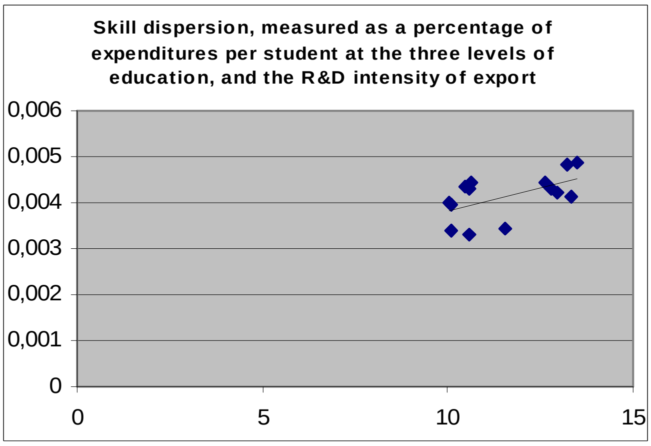
Graph 3: Scatter plot Denmark- most important industry



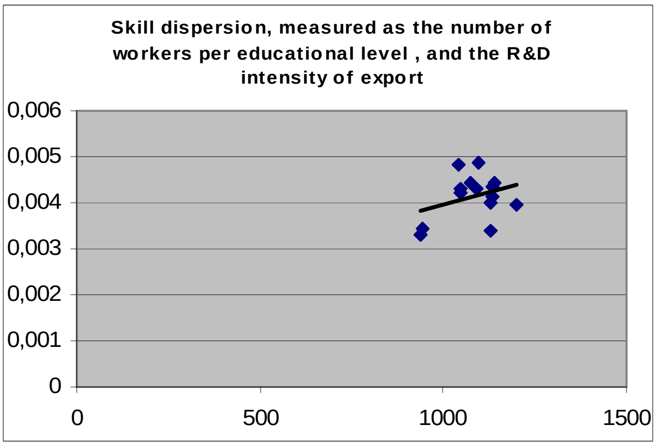
Graph 4: Scatter plot Denmark- most important industry



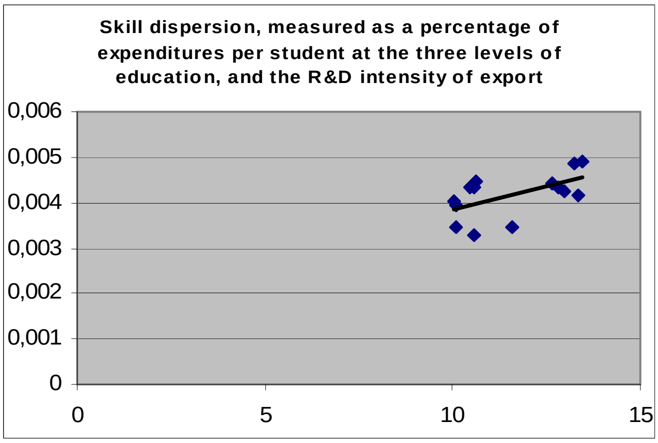
Graph 5: Scatter plot Denmark-two most important industries



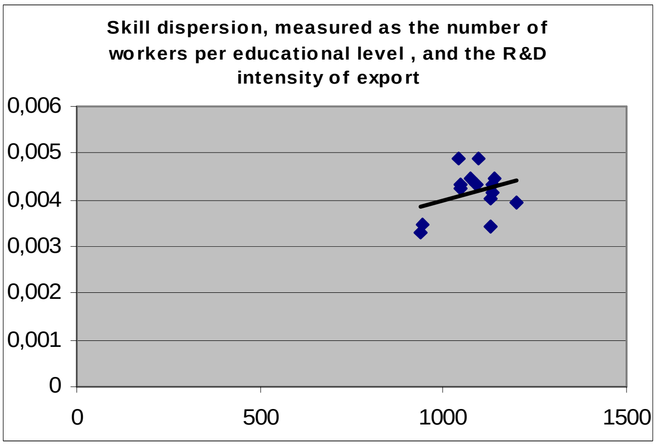
Graph 6: Scatter plot Denmark- two most important industries



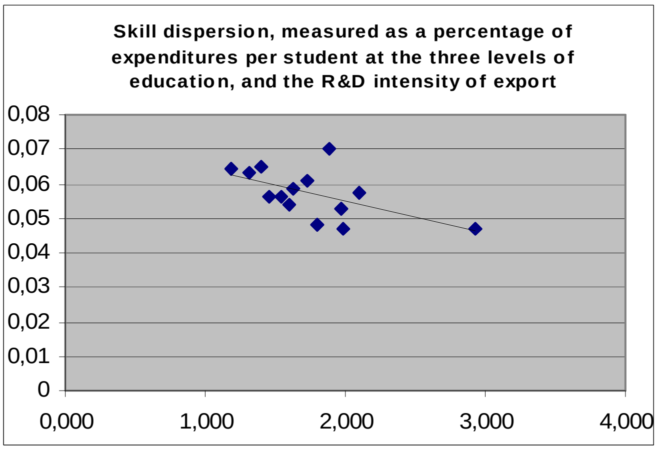
Graph 7: Scatter plot Denmark-three most important industries



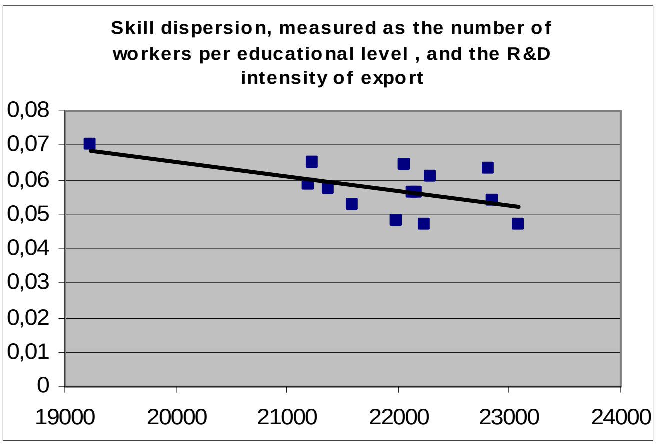
Graph 8: Scatter plot Denmark- three most important industries



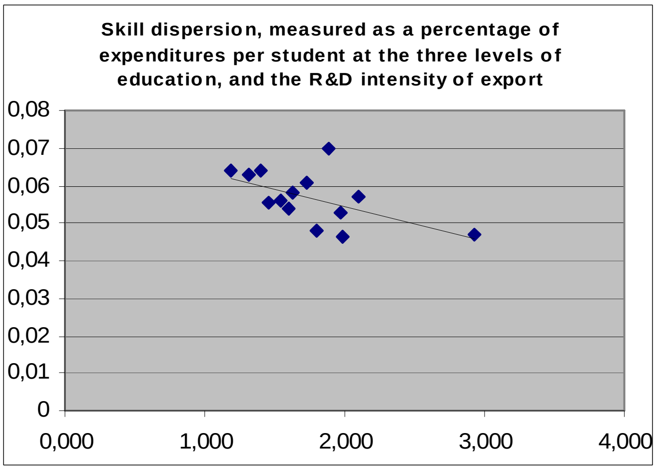
Graph 9: Scatter plot Germany- most important industry



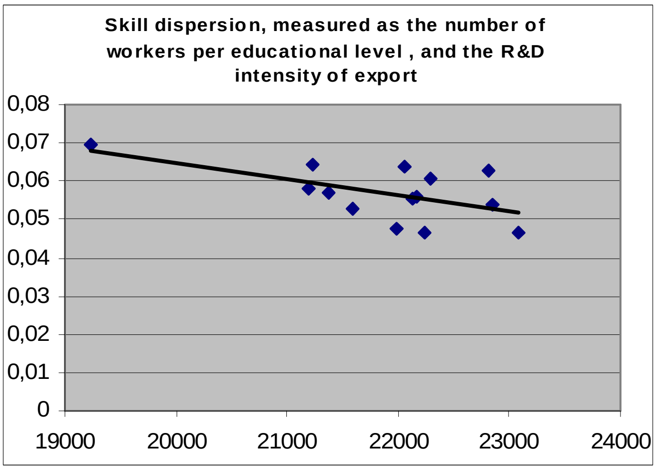
Graph 10: Scatter plot Germany- most important industry



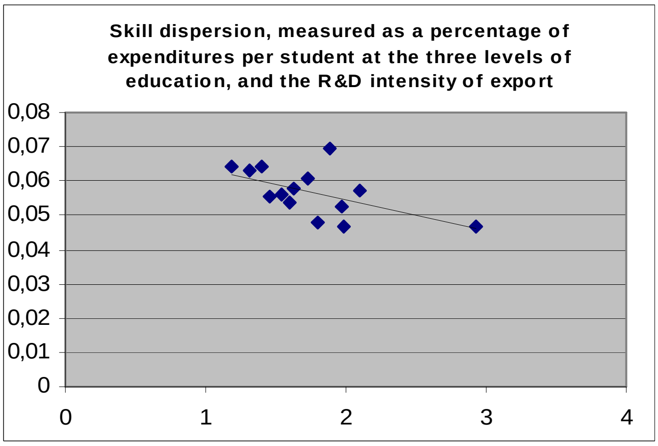
Graph 11: Scatter plot Germany- two most important industries



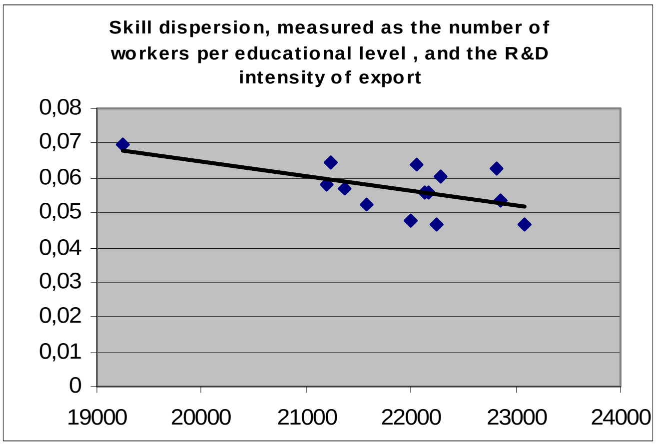
Graph 12: Scatter plot Germany- two most important industries



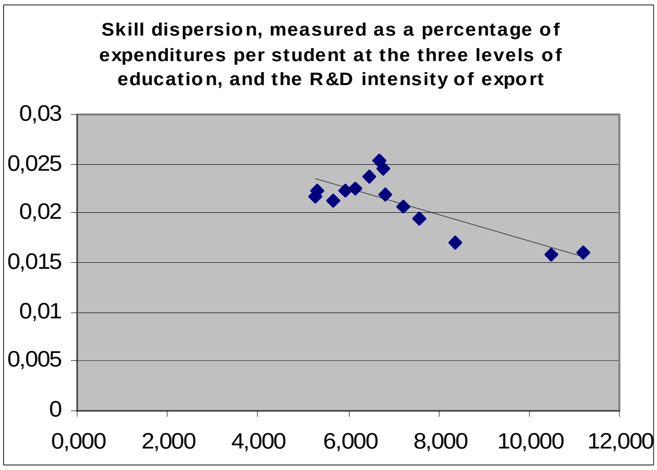
Graph 13: Scatter plot Germany- three most important industries



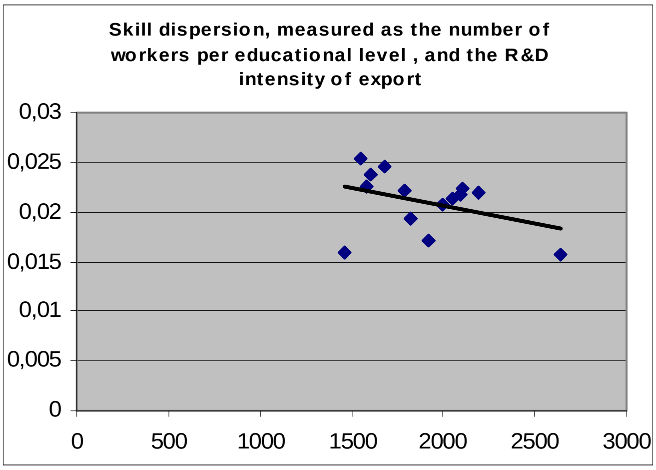
Graph 14: Scatter plot Germany- three most important industries



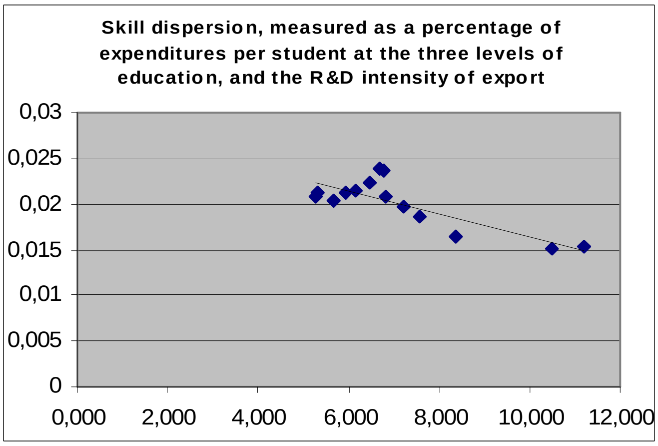
Graph 15: Scatter plot The Netherlands- most important industry



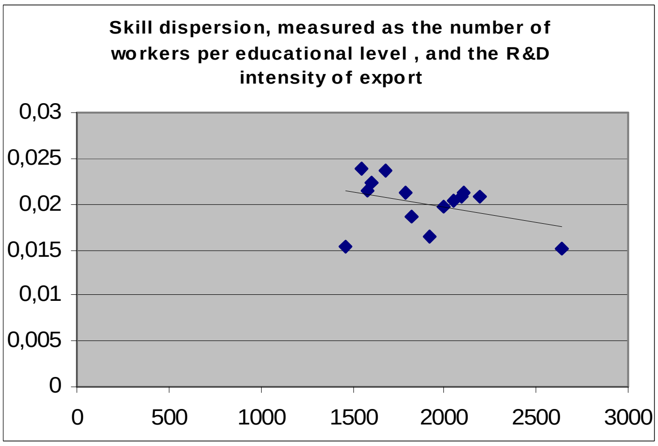
Graph 16: Scatter plot The Netherlands- most important industry



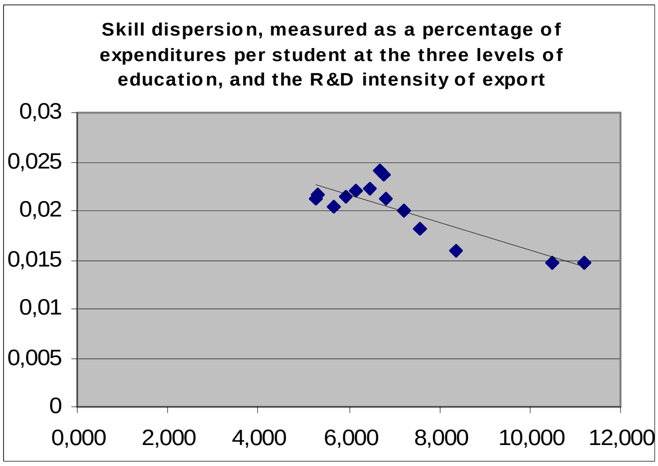
Graph 17: Scatter plot The Netherlands- two most important industries



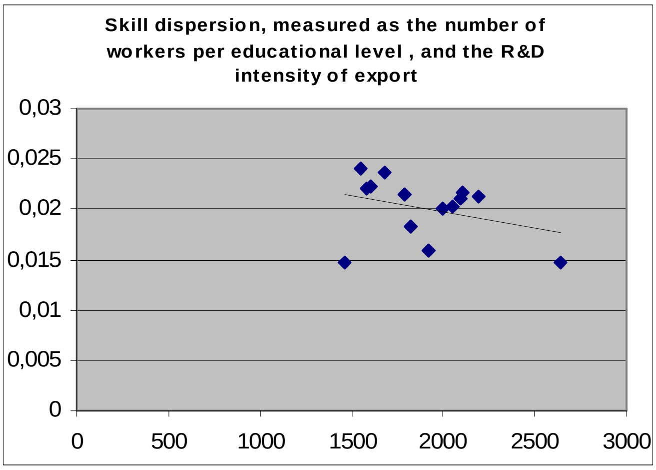
Graph 18: Scatter plot The Netherlands- two most important industries



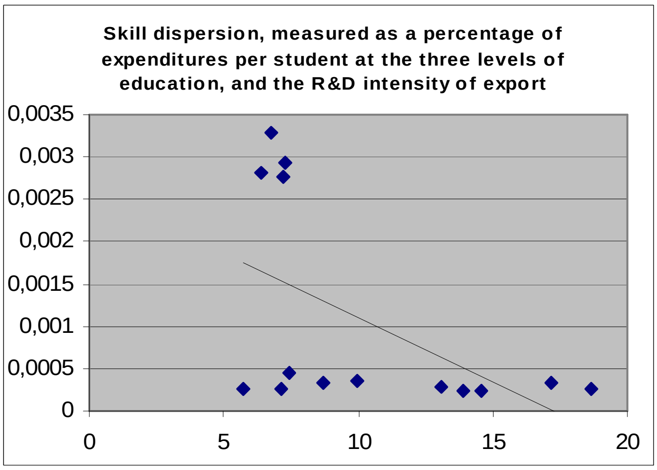
Graph 19: Scatter plot The Netherlands- three most important industries



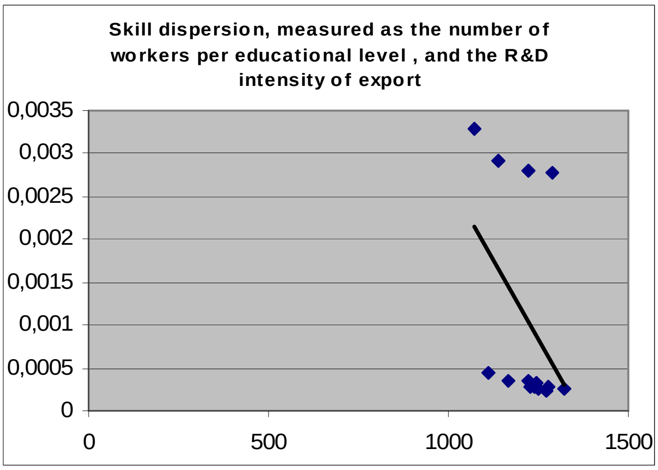
Graph 20: Scatter plot The Netherlands- three most important industries



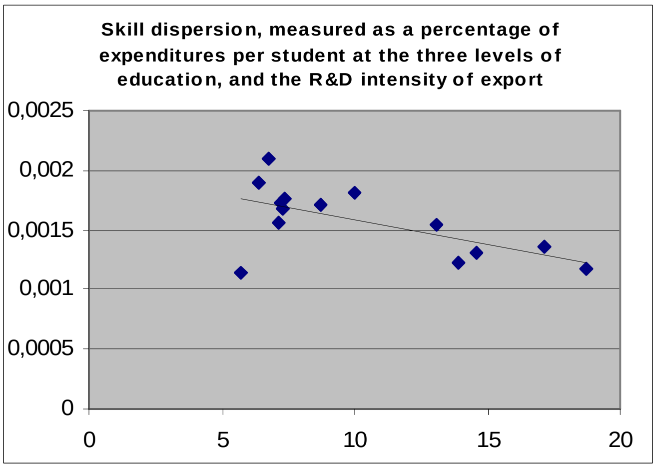
Graph 21: Scatter plot Norway- most important industry



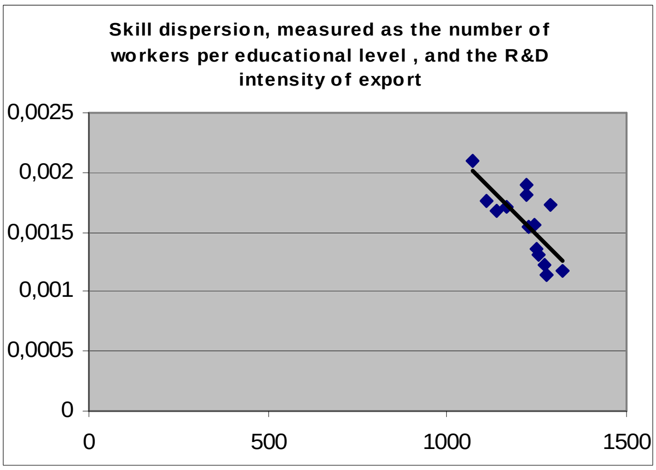
Graph 22: Scatter plot Norway- most important industry



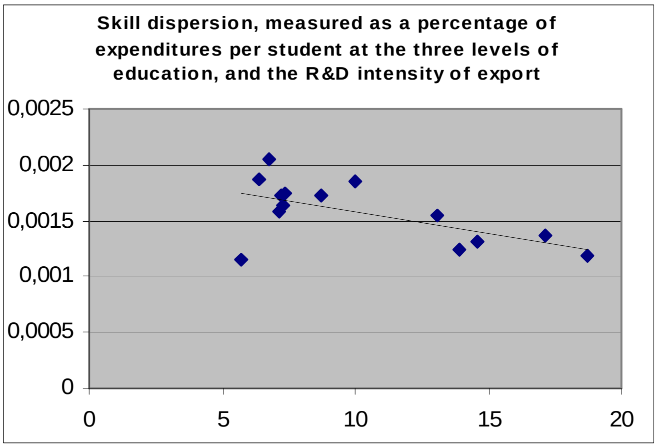
Graph 23: Scatter plot Norway- two most important industries



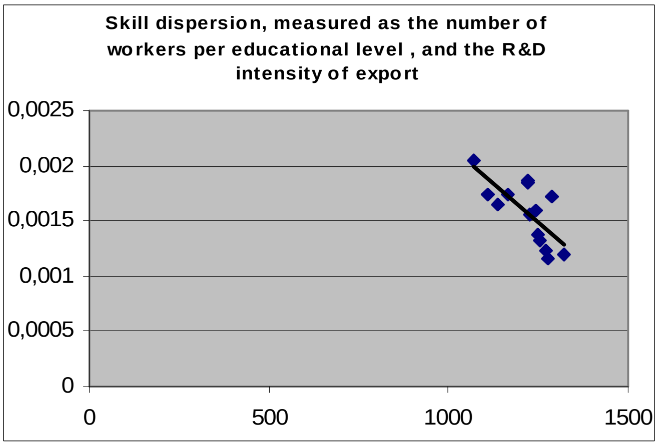
Graph 24: Scatter plot Norway- two most important industries



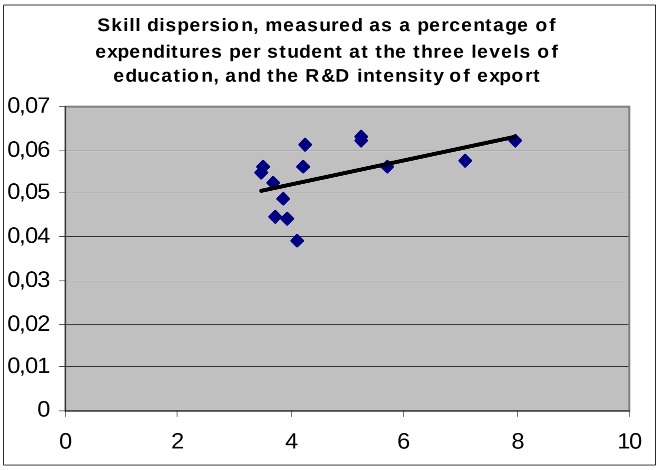
Graph 25: Scatter plot Norway- three most important industries



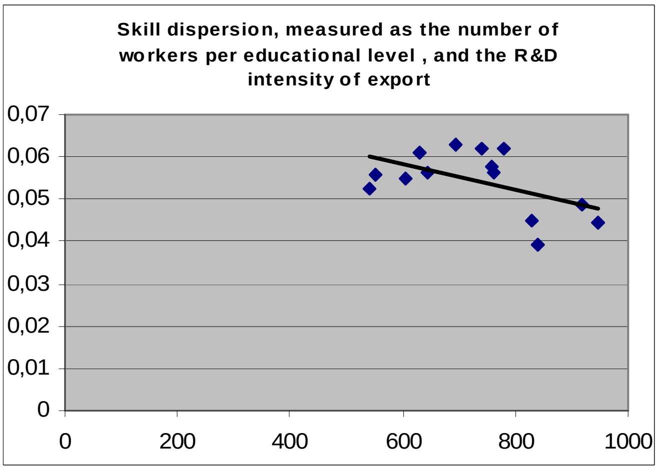
Graph 26: Scatter plot Norway- three most important industries



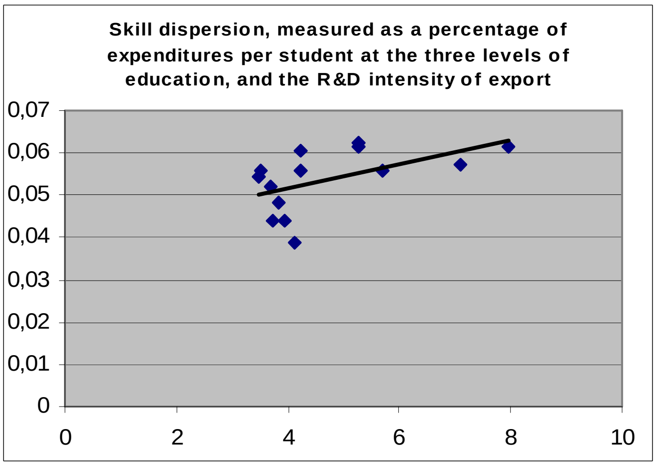
Graph 27: Scatter plot Finland- most important industry



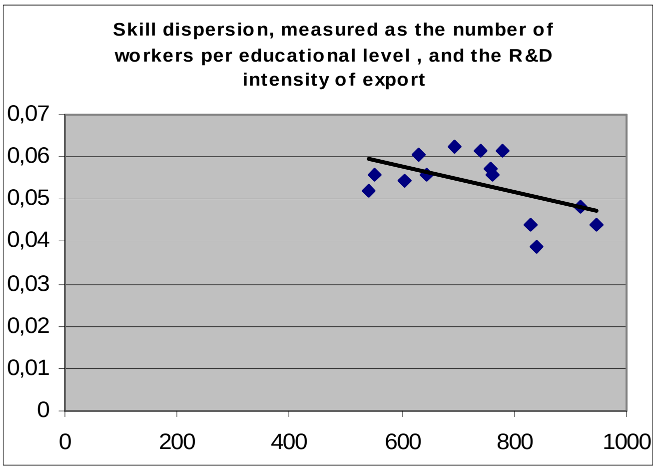
Graph 28: Scatter plot Finland- most important industry



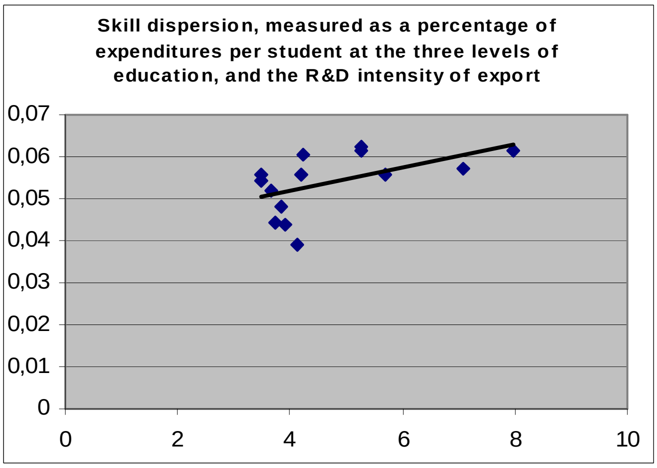
Graph 29: Scatter plot Finland- two most important industries



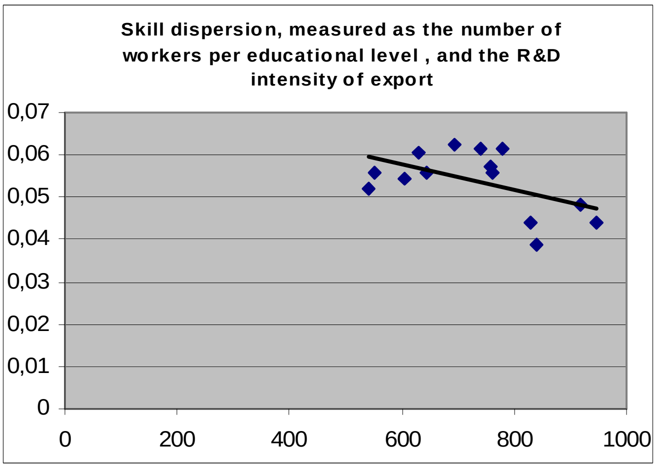
Graph 30: Scatter plot Finland- two most important industries



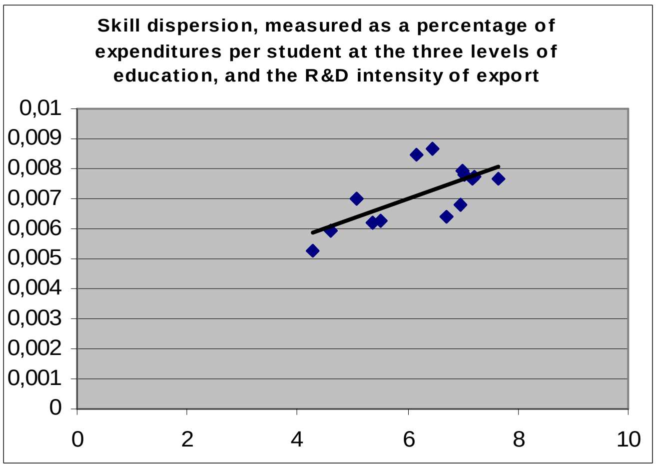
Graph 31: Scatter plot Finland- three most important industries



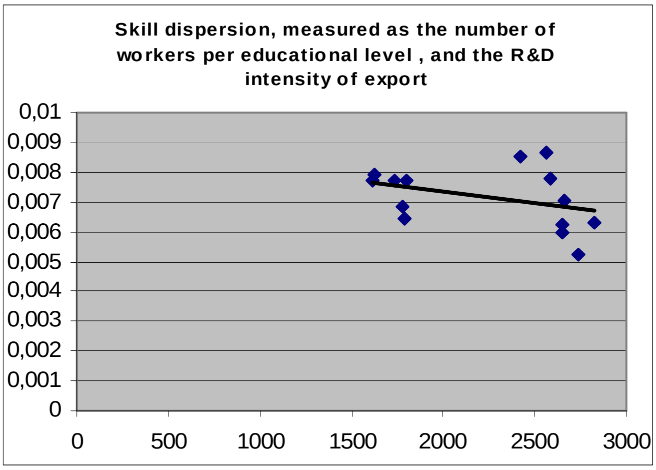
Graph 32: Scatter plot Finland- three most important industries



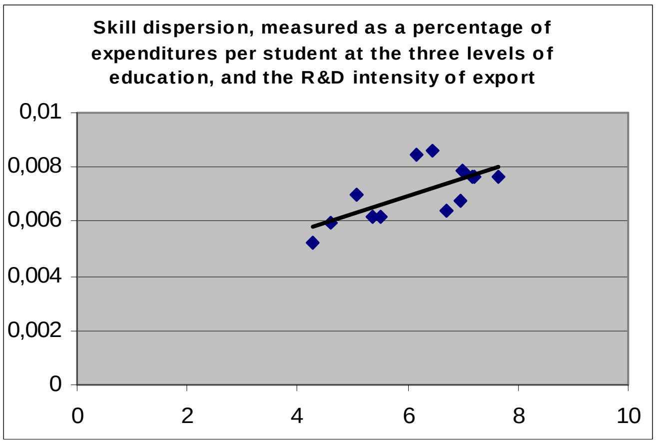
Graph 33: Scatter plot Sweden- most important industry



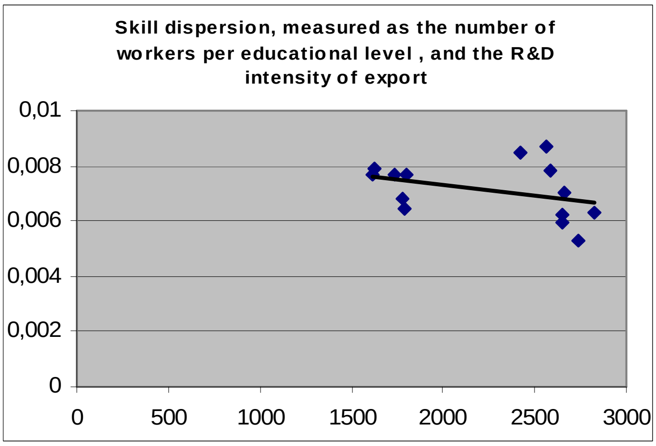
Graph 34: Scatter plot Sweden- most important industry



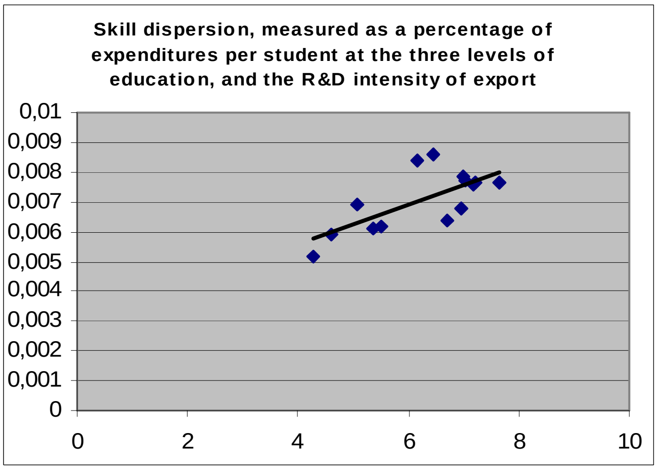
Graph 35: Scatter plot Sweden- two most important industries



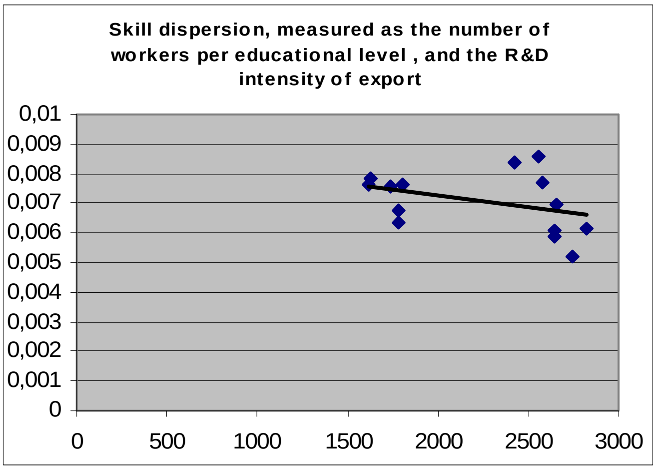
Graph 36: Scatter plot Sweden- two most important industries



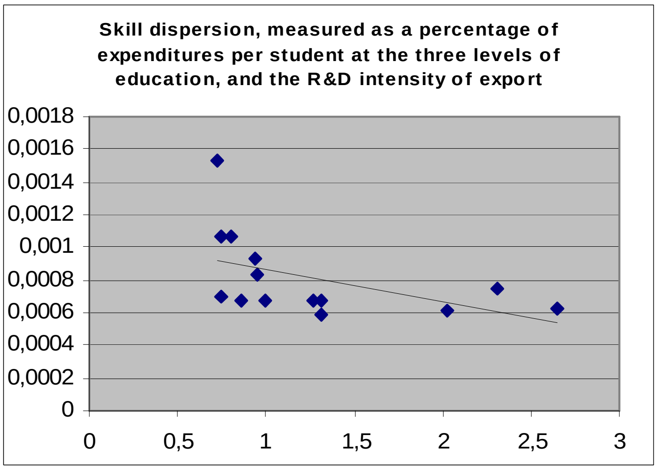
Graph 37: Scatter plot Sweden- three most important industries



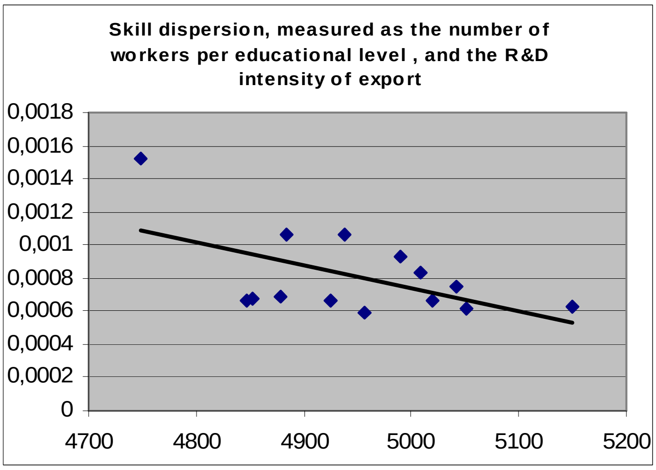
Graph 38: Scatter plot Sweden- three most important industries



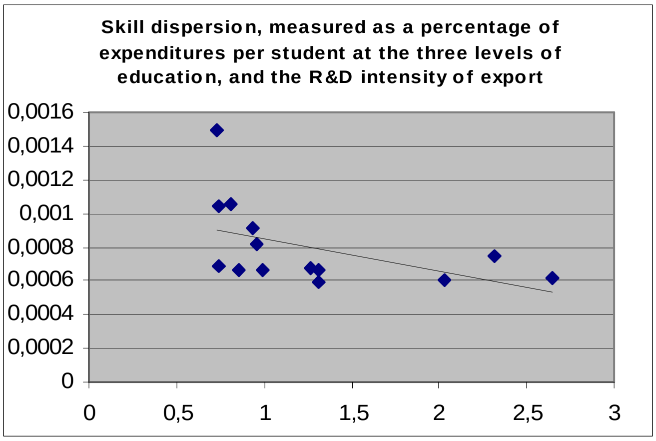
Graph 39: Scatter plot Czech Republic- most important industry



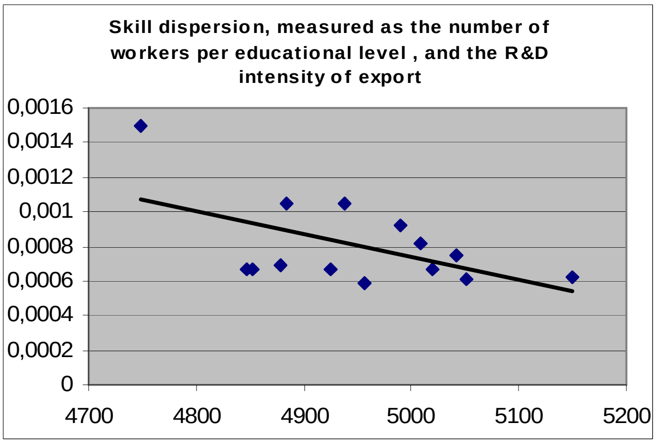
Graph 40: Scatter plot Czech Republic- most important industry



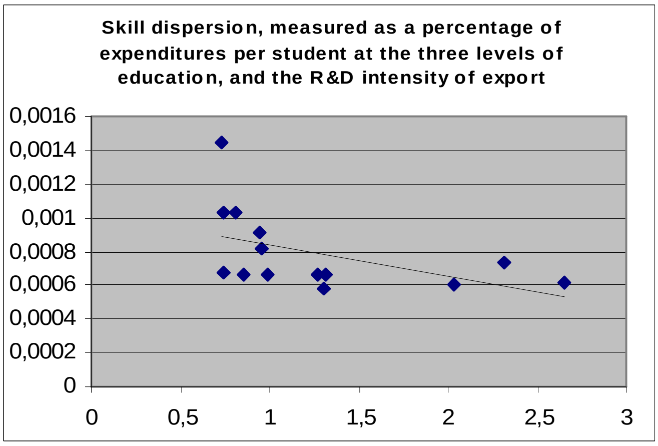
Graph 41: Scatter plot Czech Republic- two most important industries



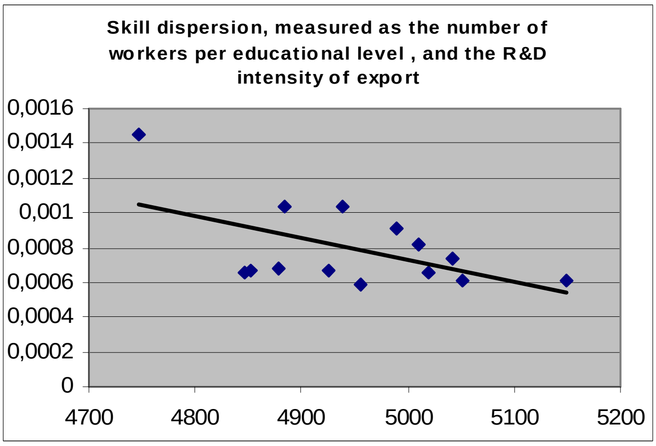
Graph 42: Scatter plot Czech Republic- two most important industries



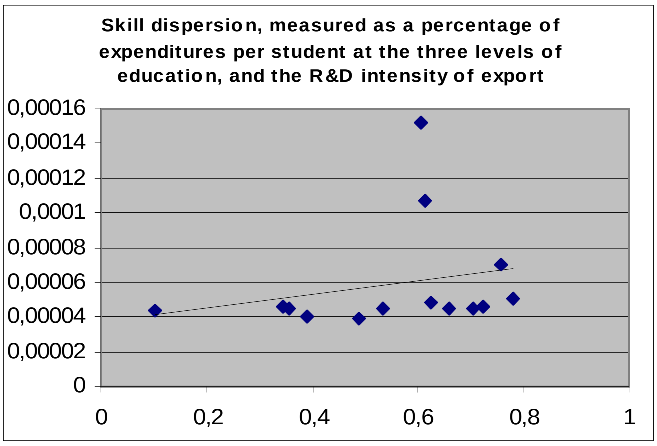
Graph 43: Scatter plot Czech Republic- three most important industries



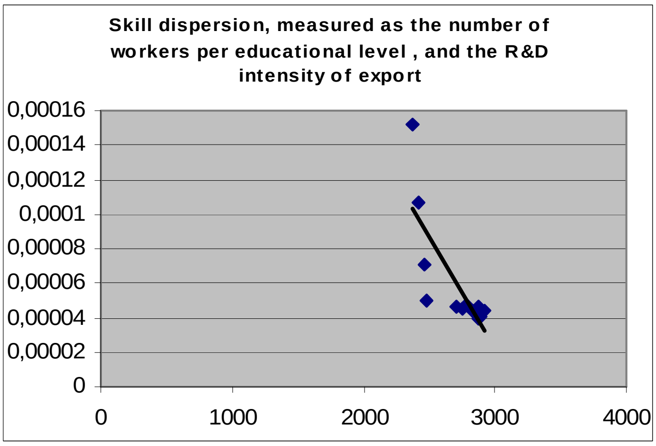
Graph 44: Scatter plot Czech Republic- three most important industries



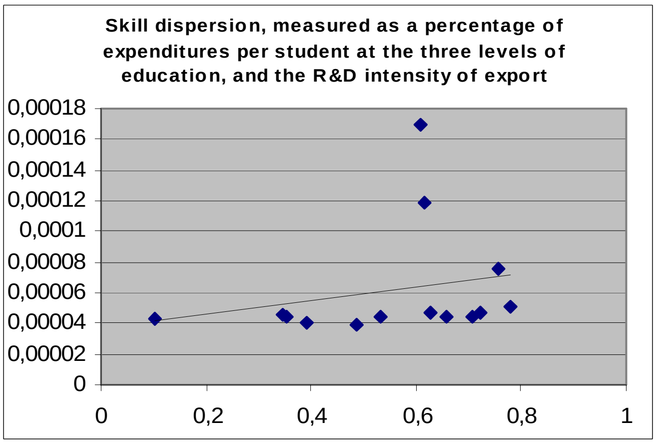
Graph 45: Scatter plot Hungary- most important industry



Graph 46: Scatter plot Hungary- most important industry



Graph 47: Scatter plot Hungary- two most important industries



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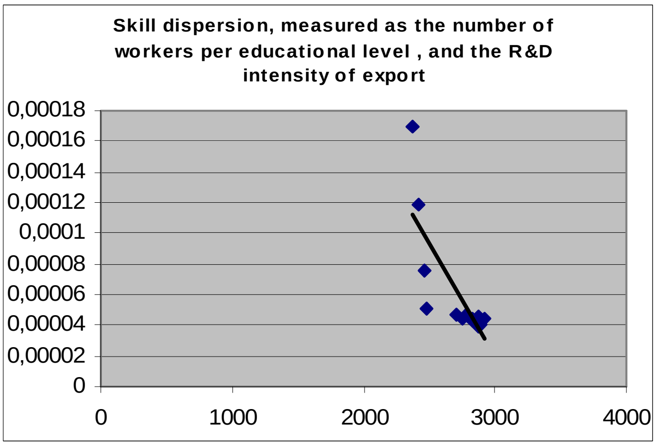
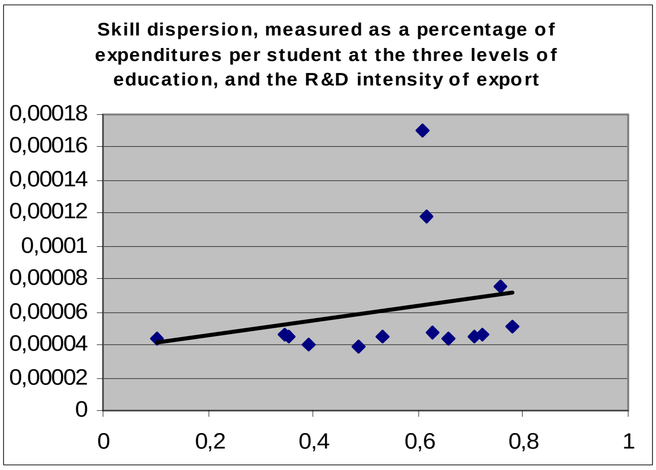
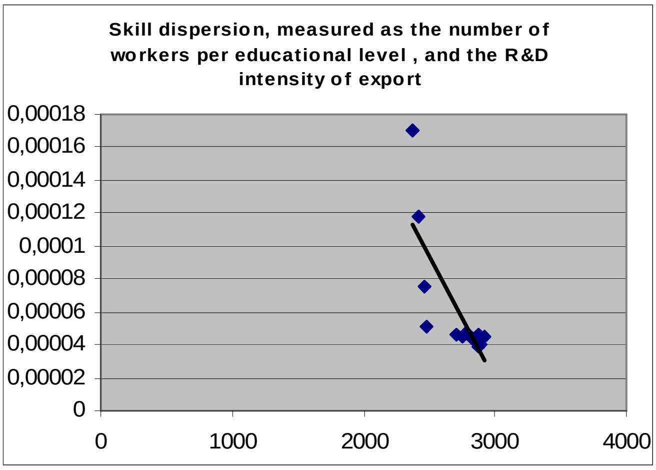


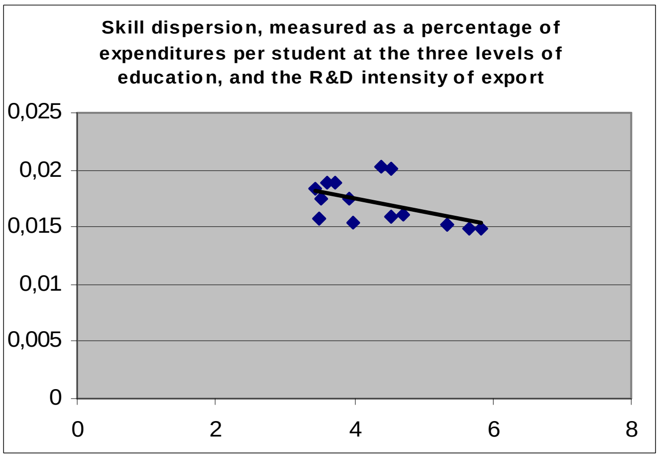
Graph 49: Scatter plot Hungary- three most important industries



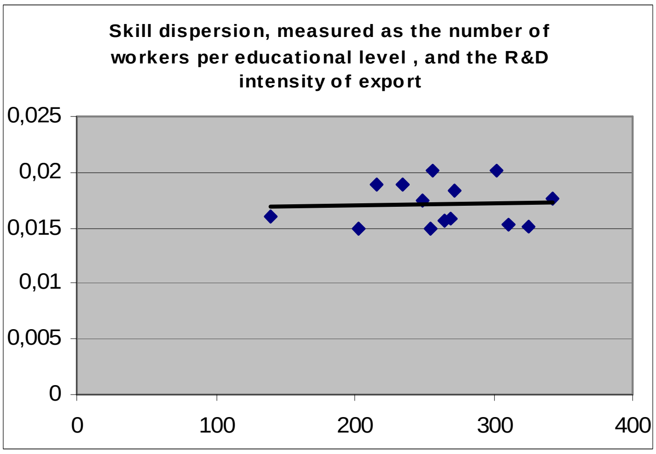
Graph 50: Scatter plot Hungary- three most important industries



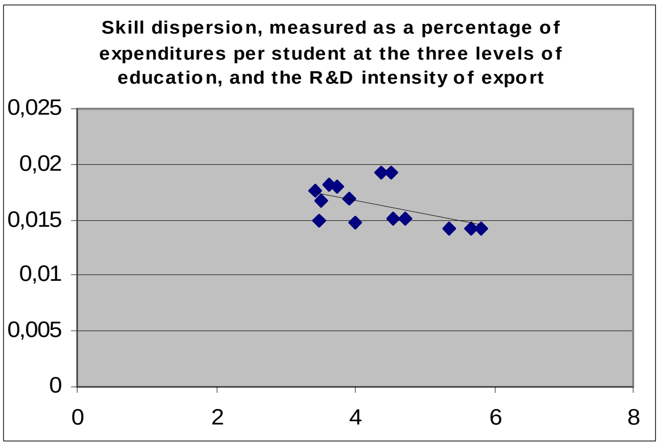
Graph 51: Scatter plot Belgium- most important industry



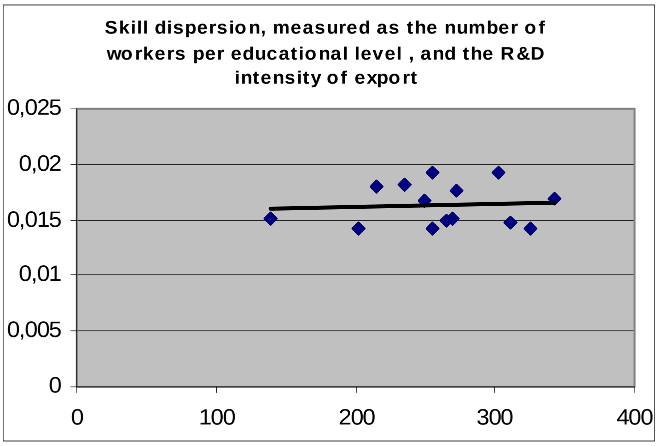
Graph 52: Scatter plot Belgium- most important industry



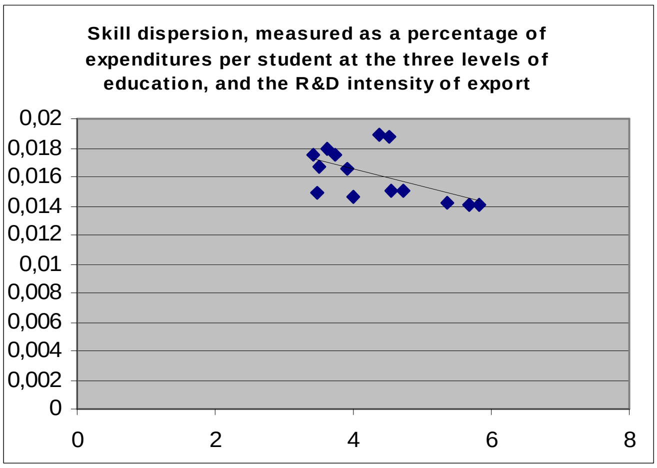
Graph 53: Scatter plot Belgium- two most important industries



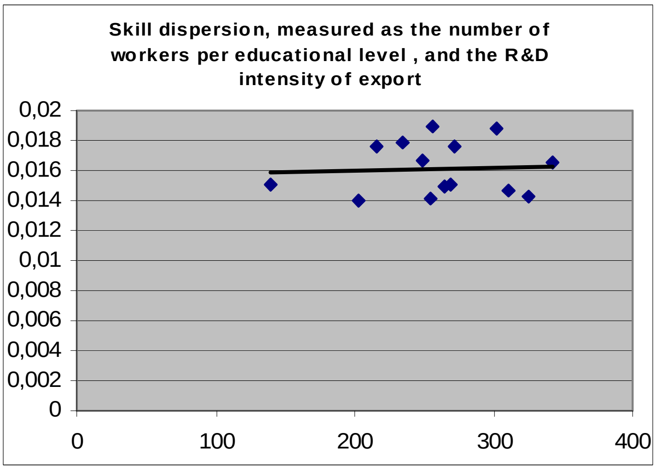
Graph 54: Scatter plot Belgium- two most important industries



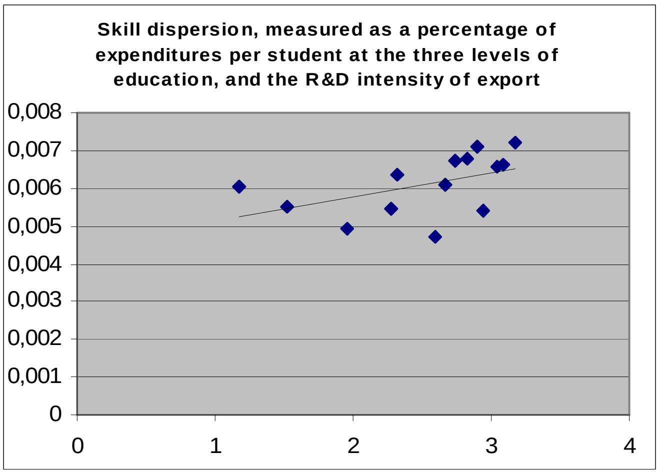
Graph 55: Scatter plot Belgium- three most important industries



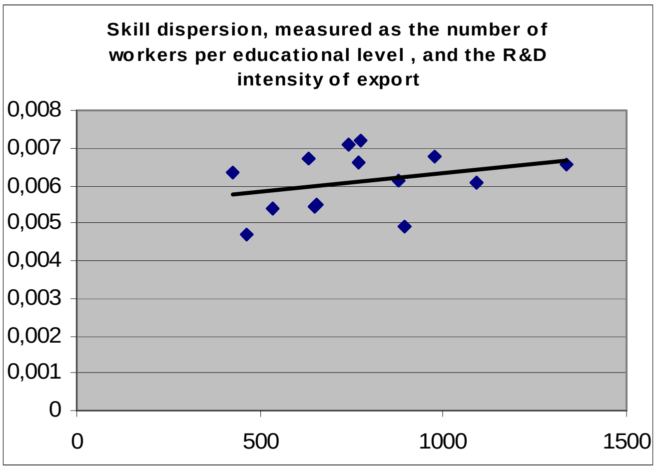
Graph 56: Scatter plot Belgium- three most important industries



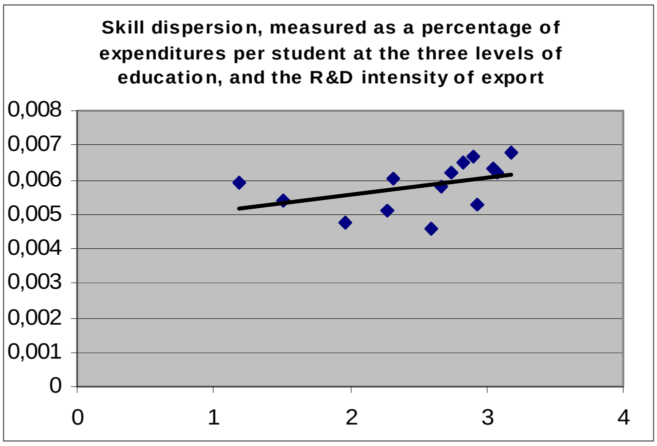
Graph 57: Scatter plot New Zealand- most important industry



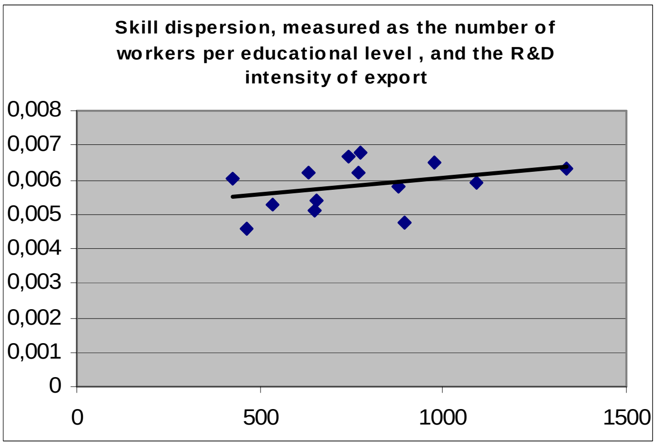
Graph 58: Scatter plot New Zealand- most important industry



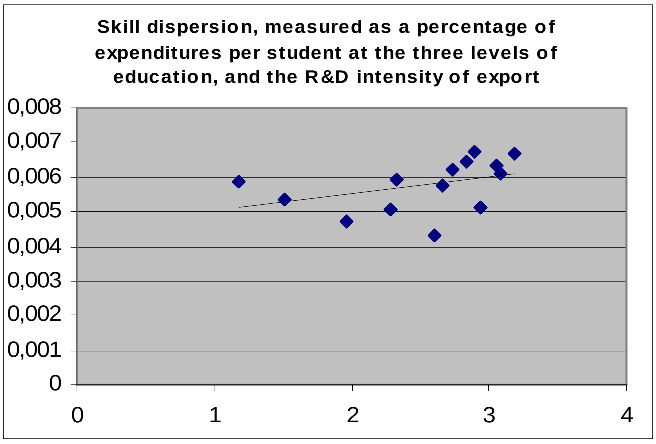
Graph 59: Scatter plot New Zealand- two most important industries



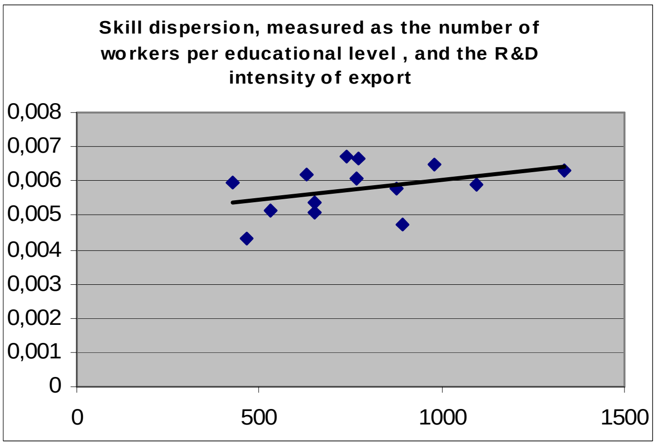
Graph 60: Scatter plot New Zealand- two most important industries



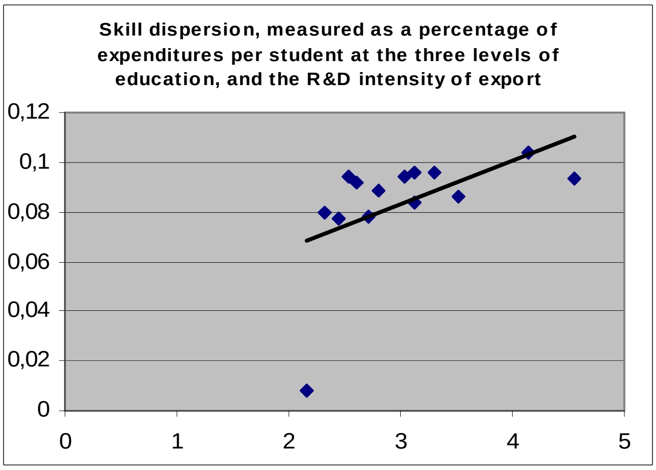
Graph 61: Scatter plot New Zeeland- three most important industries



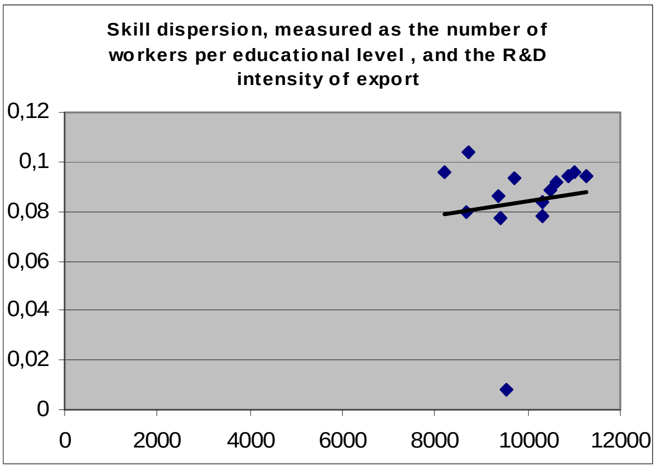
Graph 62: Scatter plot New Zeeland- three most important industries



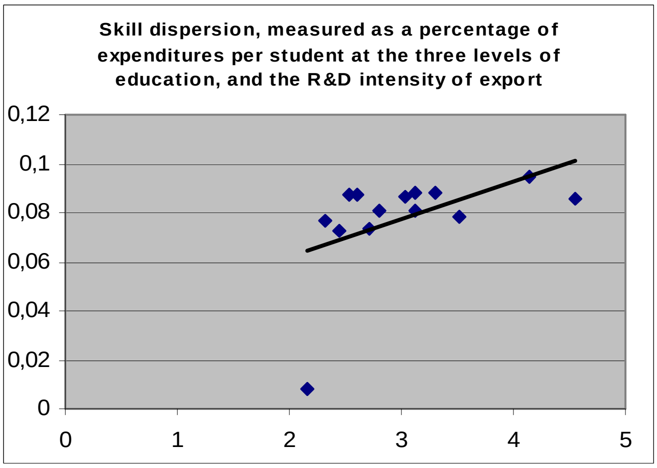
Graph 63: Scatter plot United Kingdom- most important industry



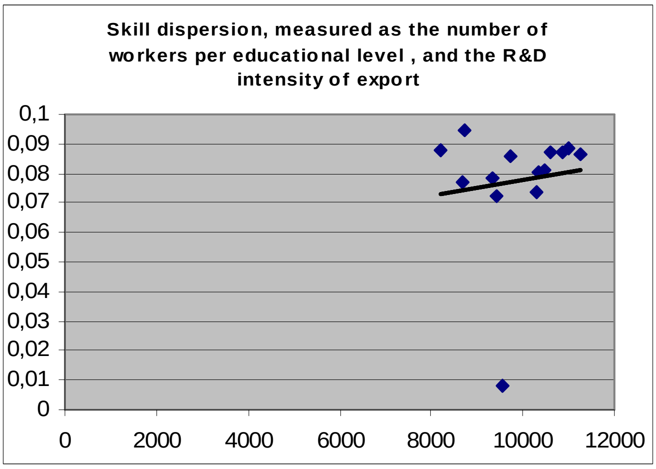
Graph 64: Scatter plot United Kingdom- most important industry



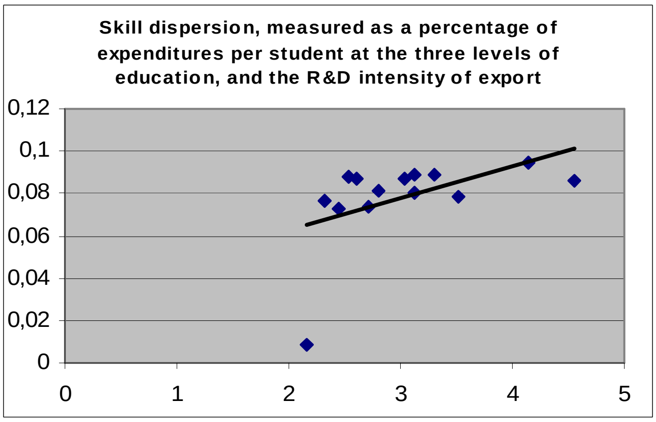
Graph 65: Scatter plot United Kingdom-two most important industries



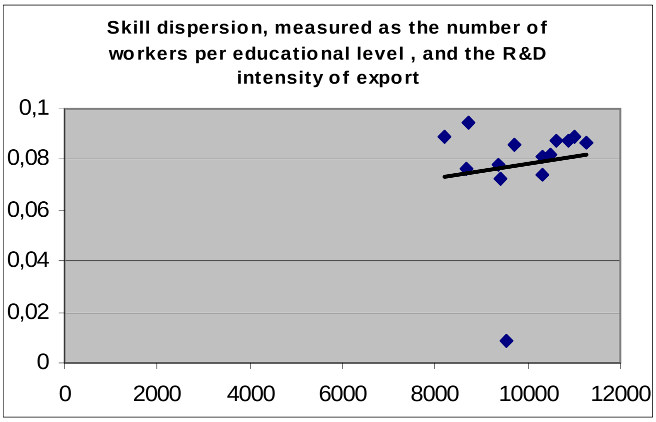
Graph 66: Scatter plot United Kingdom- two most important industries



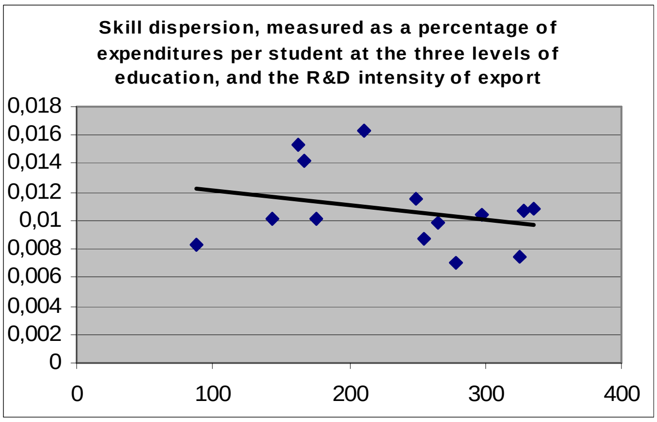
Graph 67: Scatter plot United Kingdom- three most important industries



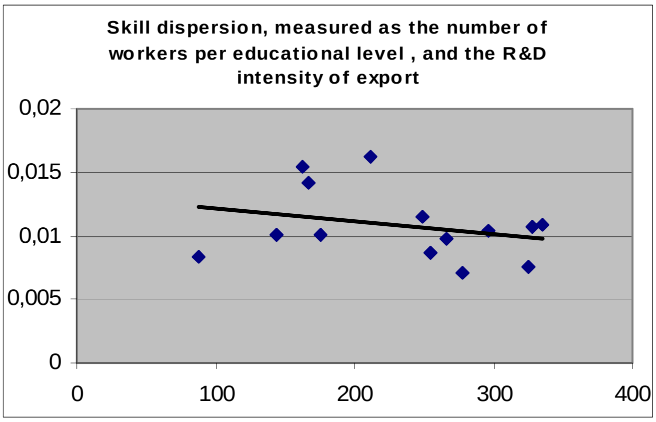
Graph 68: Scatter plot United Kingdom- three most important industries



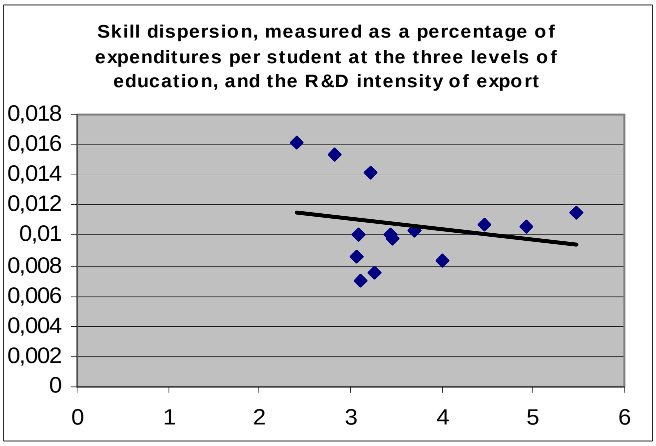
Graph 69: Scatter plot Ireland- most important industry



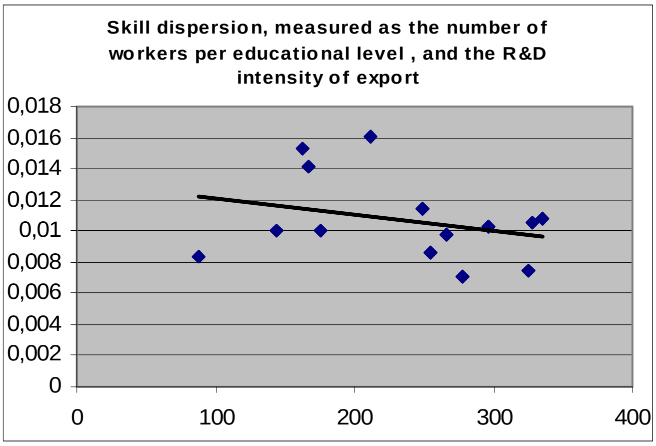
Graph 70: Scatter plot Ireland- most important industry



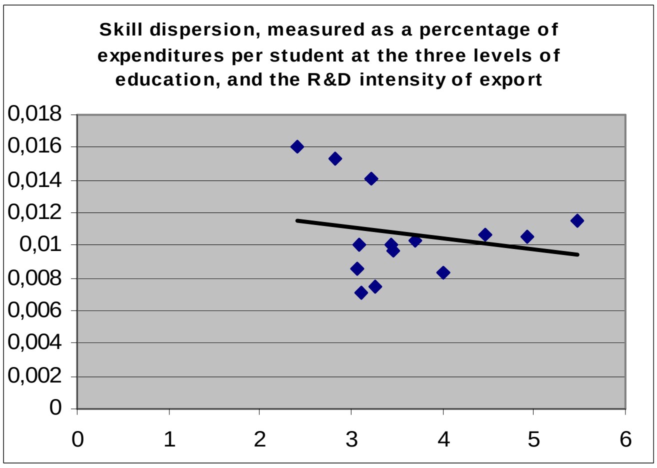
Graph 71: Scatter plot Ireland- two most important industries



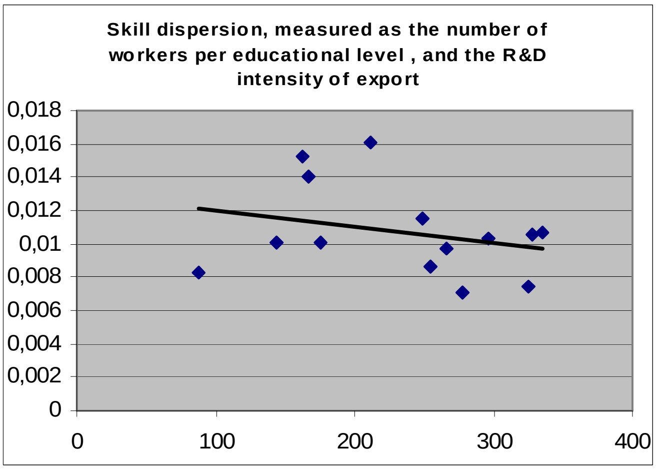
Graph 72: Scatter plot Ireland- two most important industries



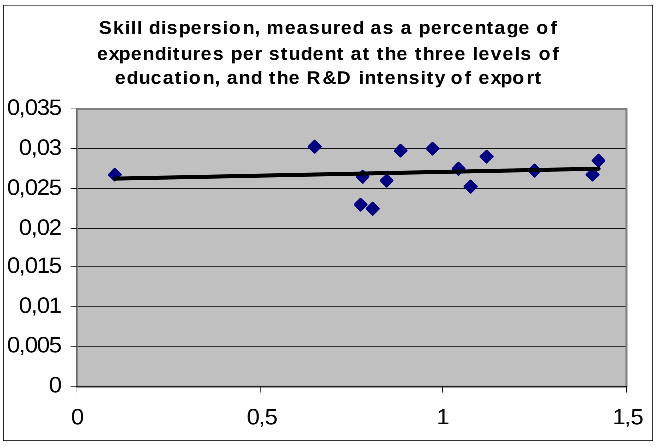
Graph 73: Scatter plot Ireland- three most important industries



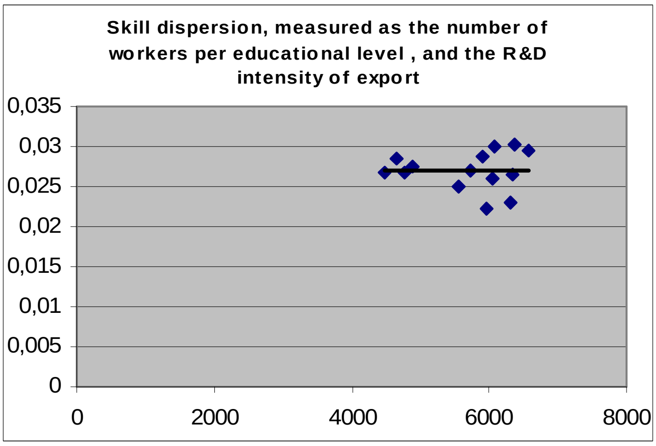
Graph74: Scatter plot Ireland- three most important industries



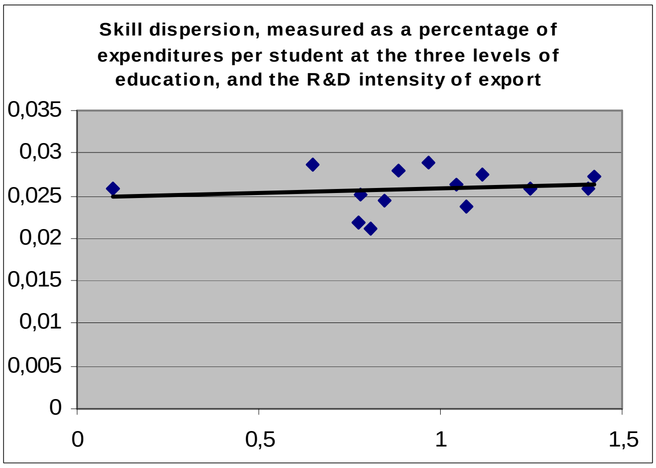
Graph75: Scatter plot Spain- most important industry



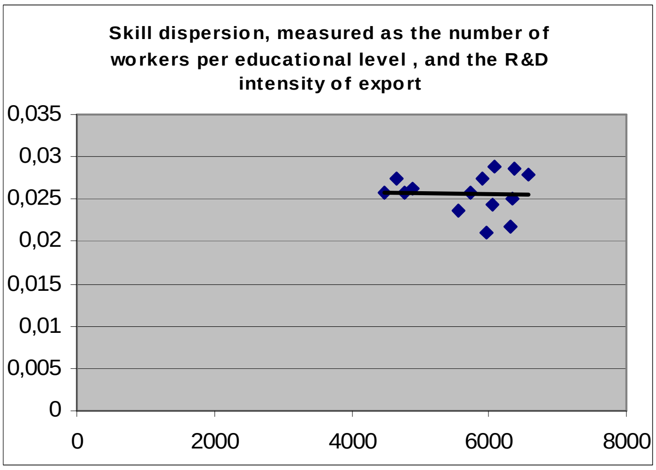
Graph 76: Scatter plot Spain- most important industry



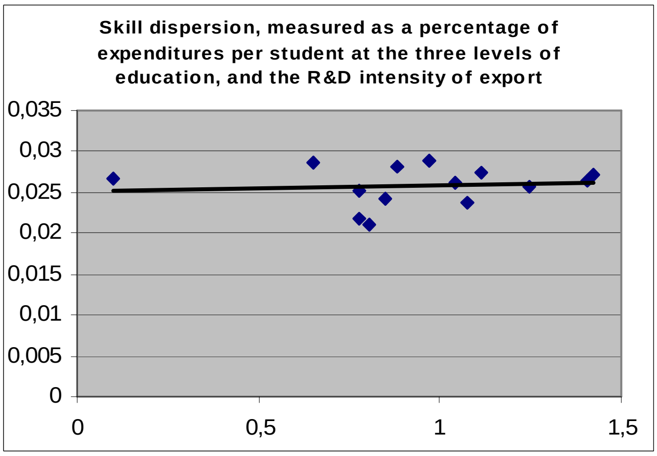
Graph 77: Scatter plot Spain- two most important industries



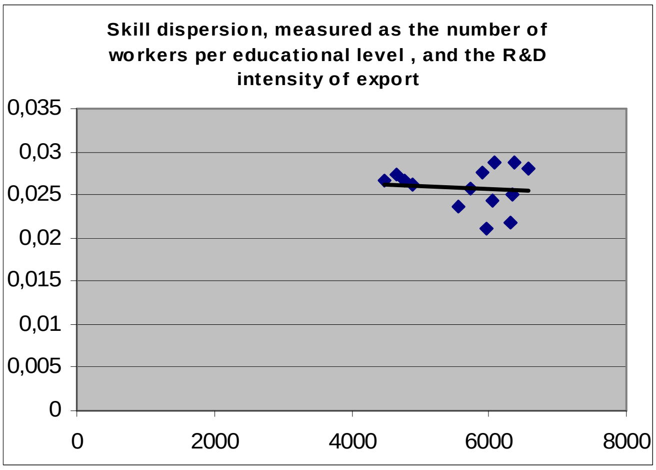
Graph 78: Scatter plot Spain- two most important industries



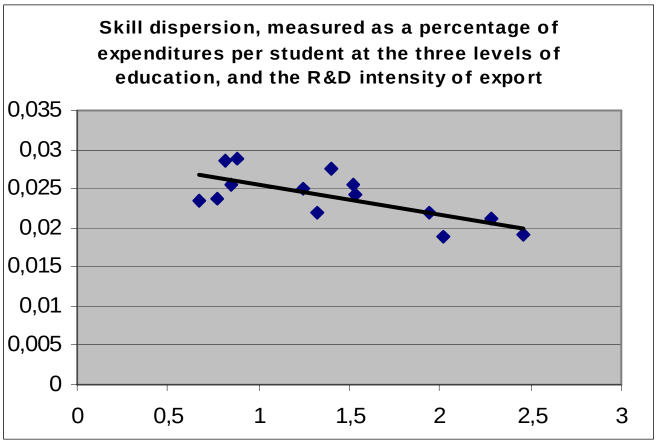
Graph 79: Scatter plot Spain- three most important industries



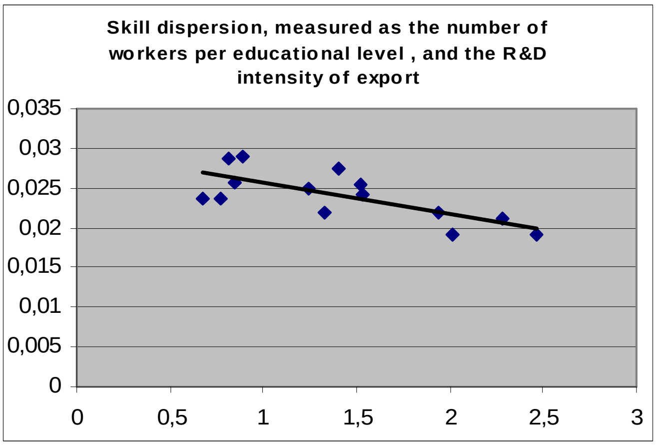
Graph 80: Scatter plot Spain- three most important industries



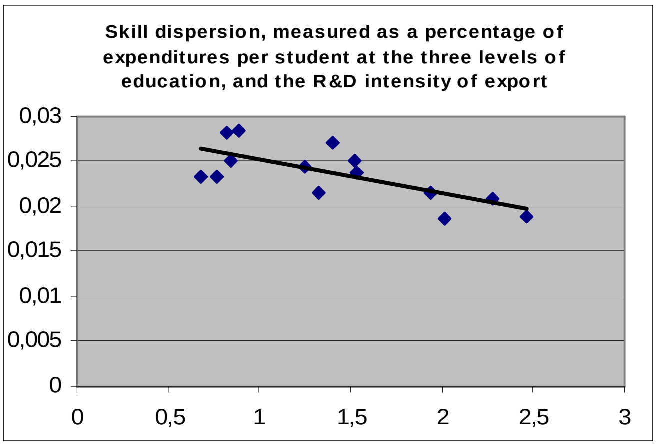
Graph 81: Scatter plot Italy- most important industry



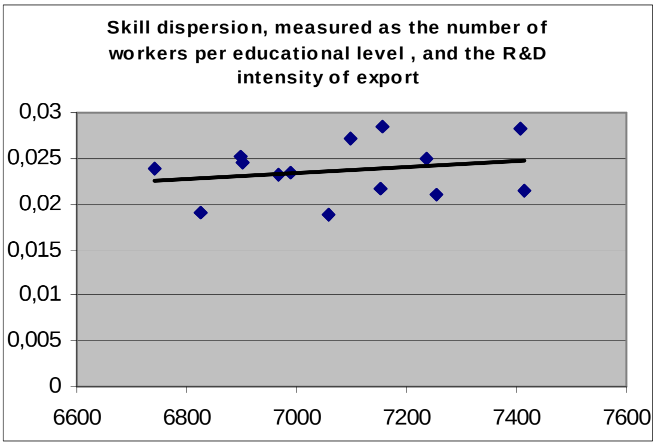
Graph 82: Scatter plot Italy- most important industry



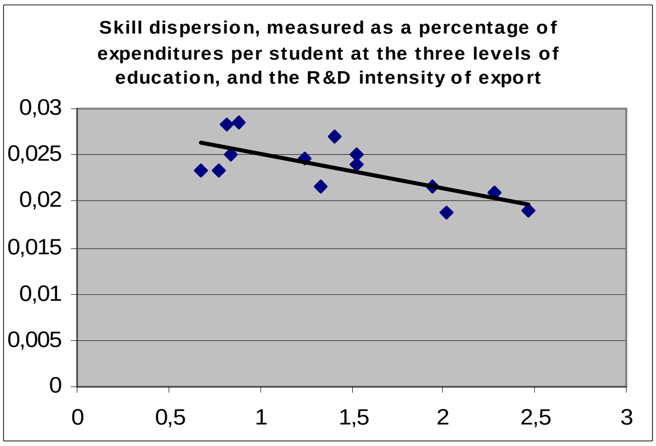
Graph 83: Scatter plot Italy- two most important industries



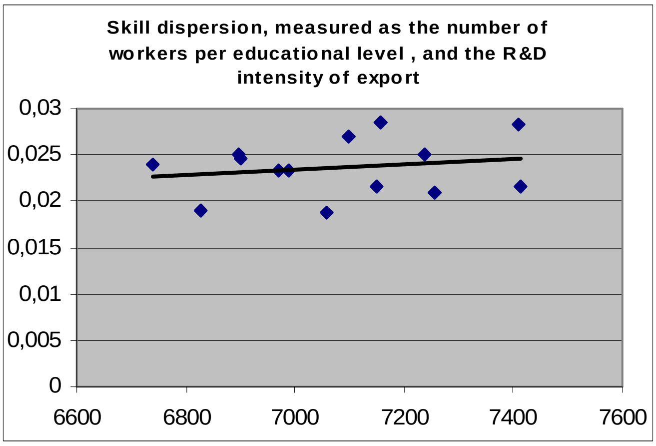
Graph 84: Scatter plot Italy- two most important industries



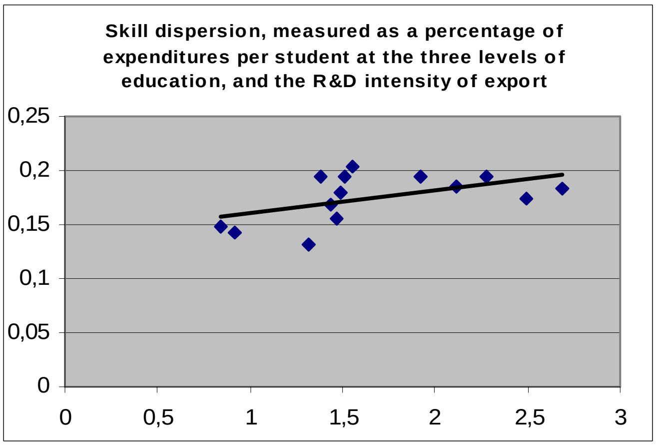
Graph 85: Scatter plot Italy- three most important industries



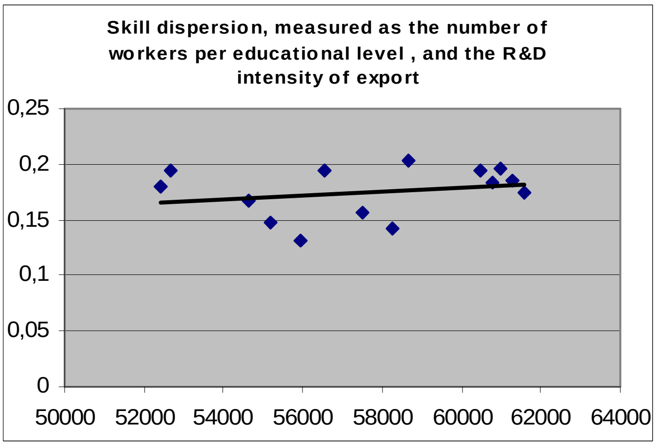
Graph 86: Scatter plot Italy- three most important industries



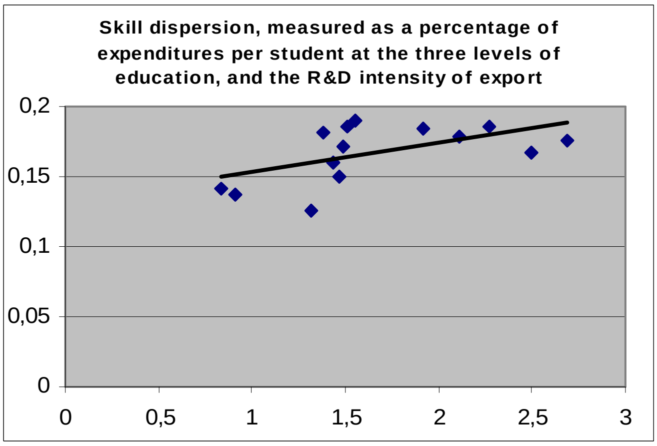
Graph 87: Scatter plot United States- most important industry



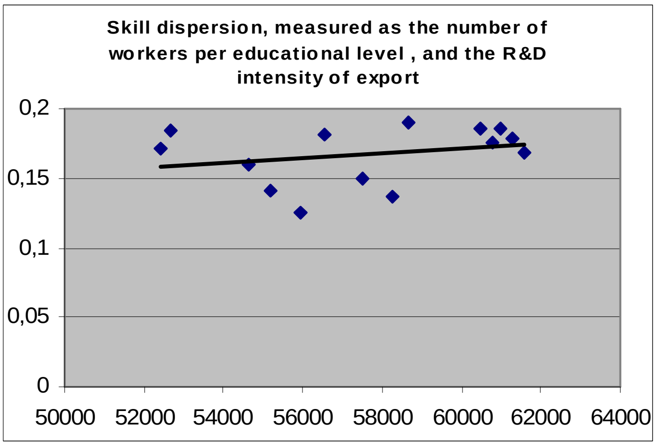
Graph 88: Scatter plot United States- most important industry



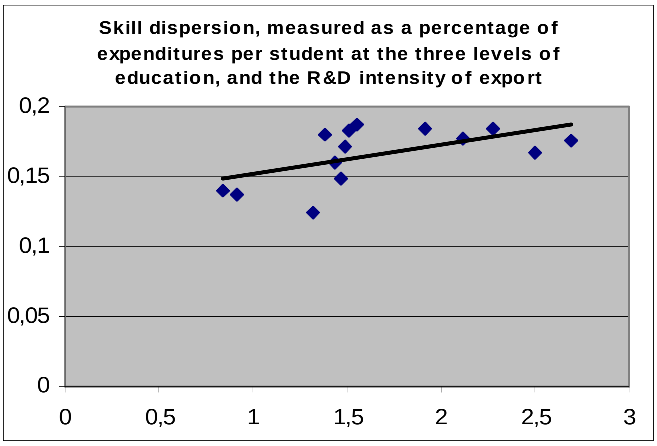
Graph 89: Scatter plot United States- two most important industries



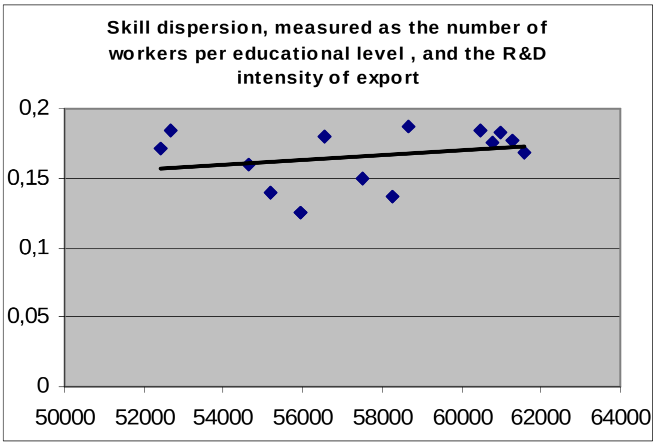
Graph 90: Scatter plot United States- two most important industries



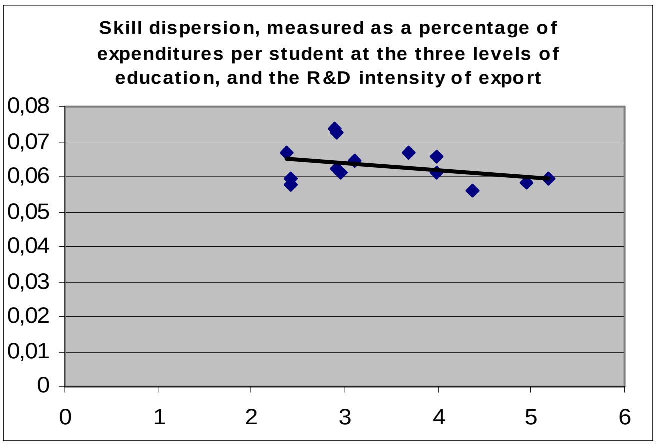
Graph 91: Scatter plot United States- three most important industries



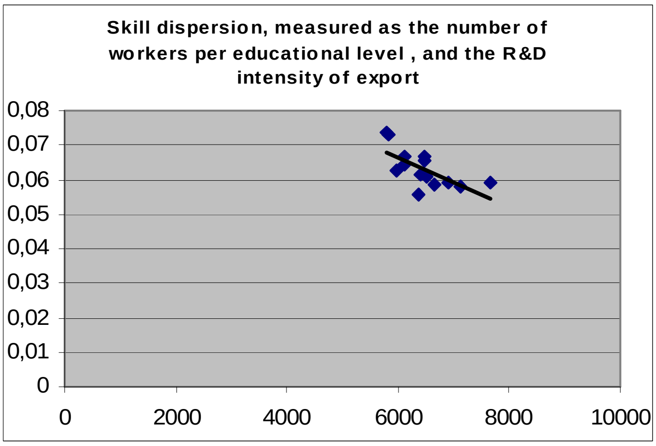
Graph 92: Scatter plot United States- three most important industries



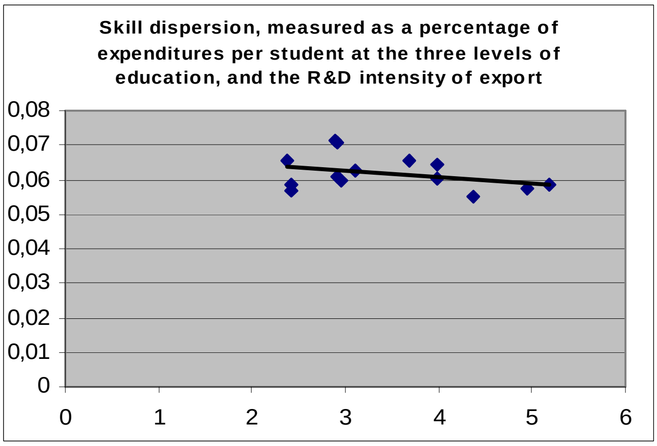
Graph 93: Scatter plot France- most important industry



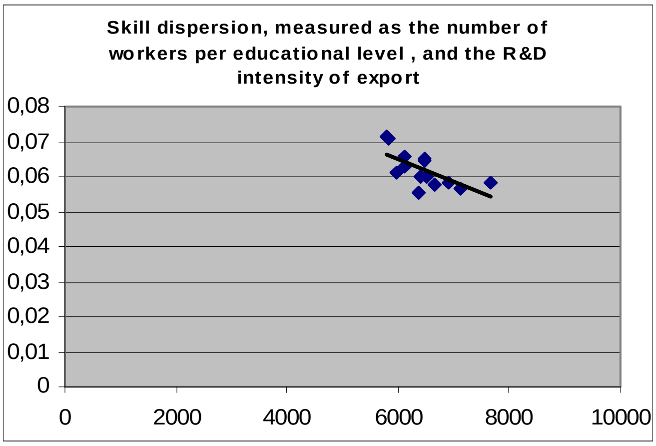
Graph 94: Scatter plot France- most important industry



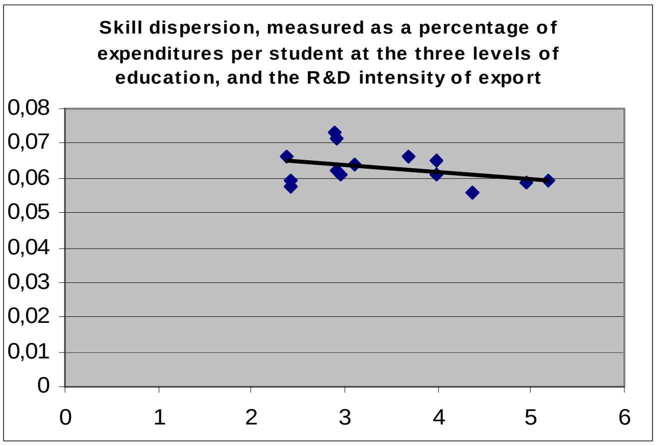
Graph 95: Scatter plot France- two most important industries



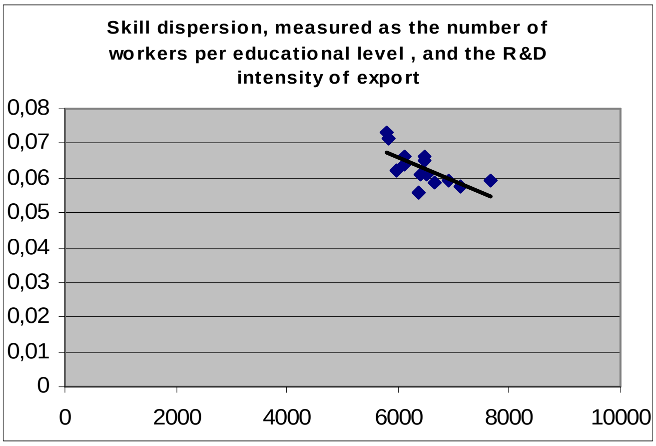
Graph 96: Scatter plot France- two most important industries



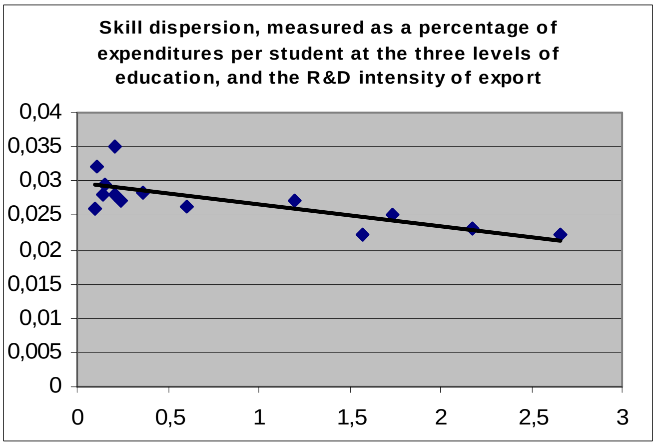
Graph 97: Scatter plot France- three most important industries



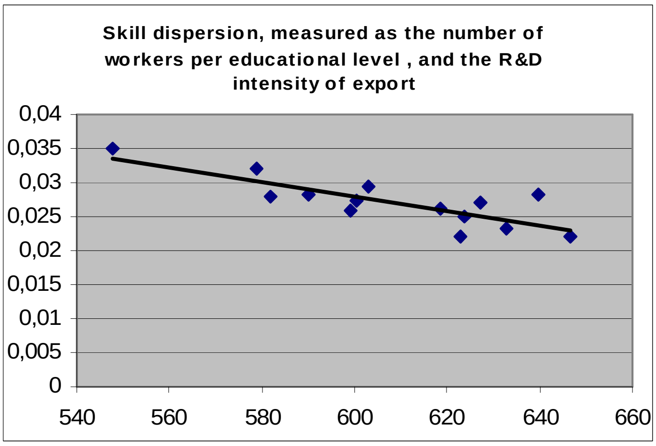
Graph 98: Scatter plot France- three most important industries



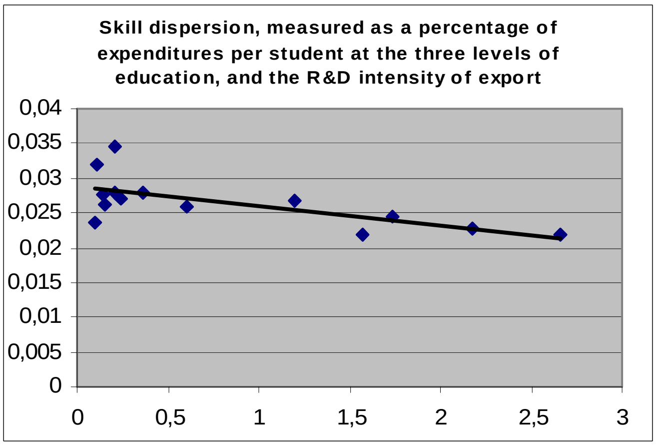
Graph 99: Scatter plot Slovenia- most important industry



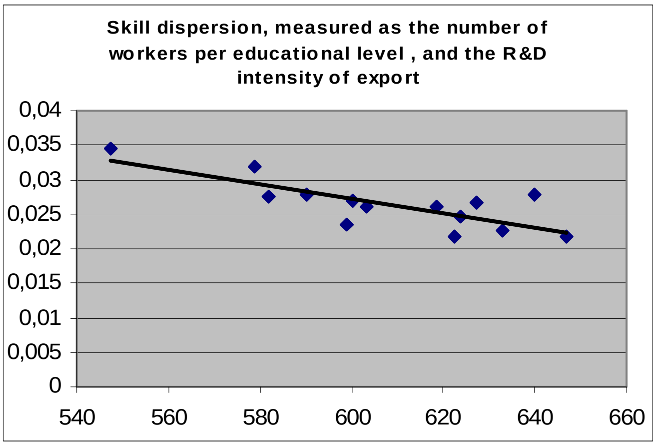
Graph 100: Scatter plot Slovenia- most important industry



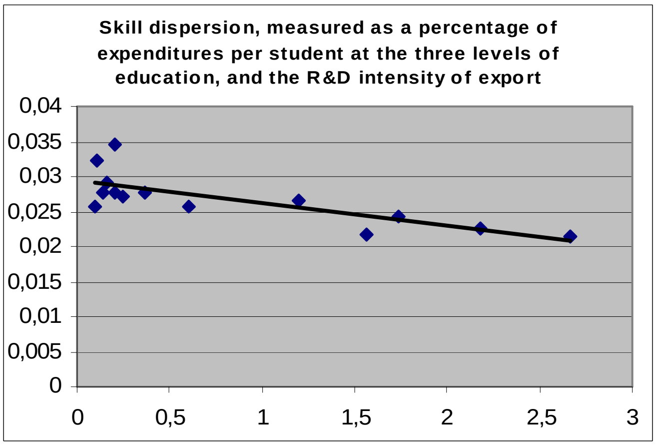
Graph 101: Scatter plot Slovenia- two most important industries



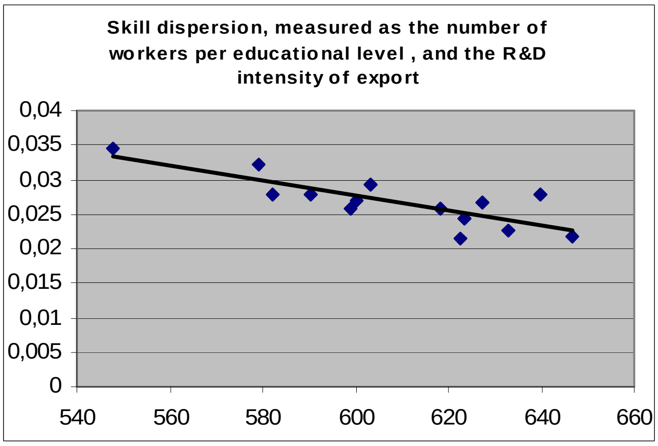
Graph 102: Scatter plot Slovenia- two most important industries



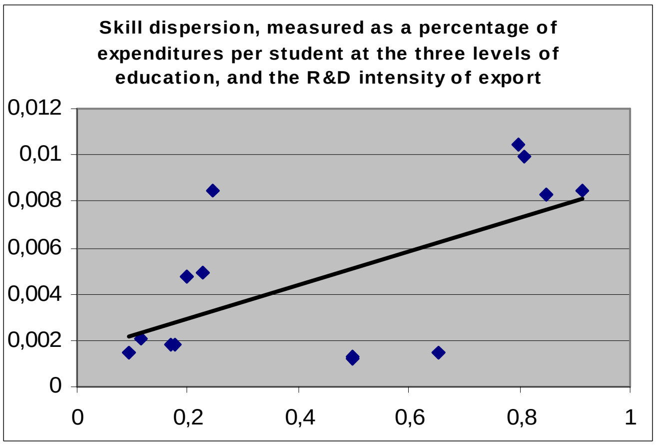
Graph 103: Scatter plot Slovenia- three most important industries



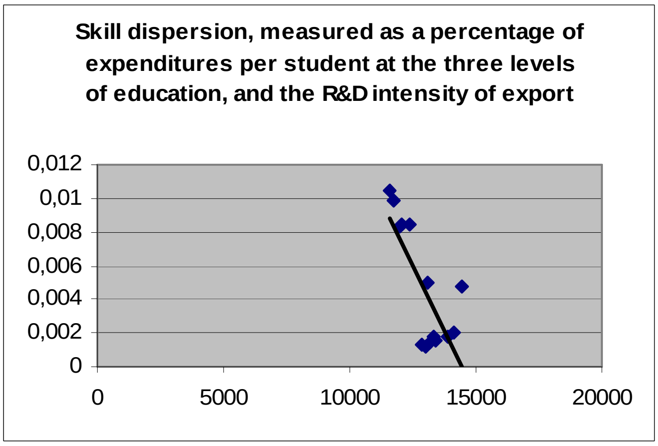
Graph 104: Scatter plot Slovenia- three most important industries



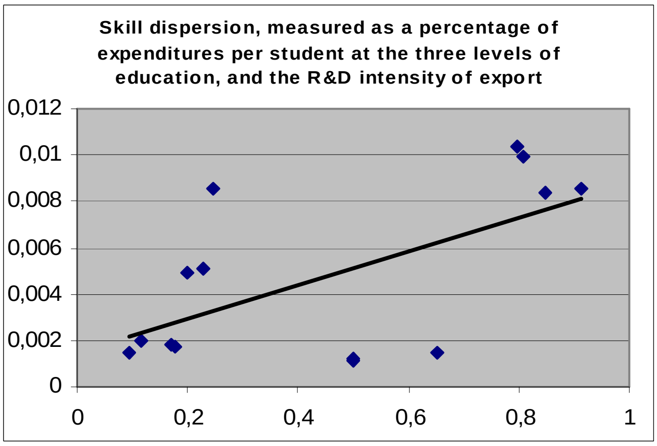
Graph 105: Scatter plot Poland- most important industry



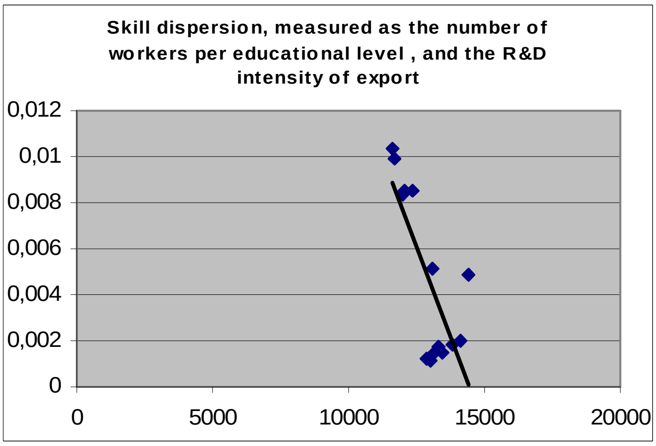
Graph 106: Scatter plot Poland- most important industry



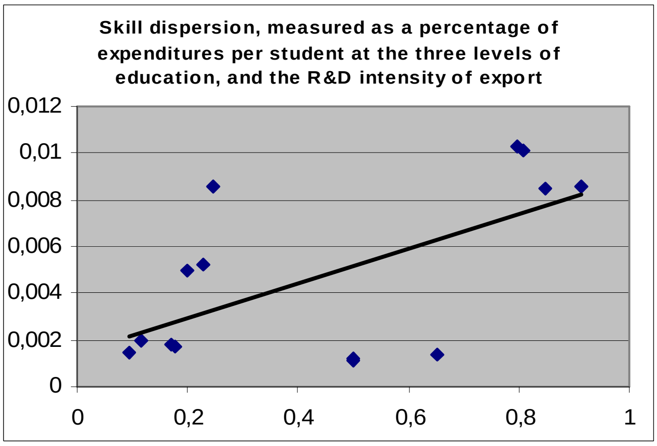
Graph 107: Scatter plot Poland- two most important industries



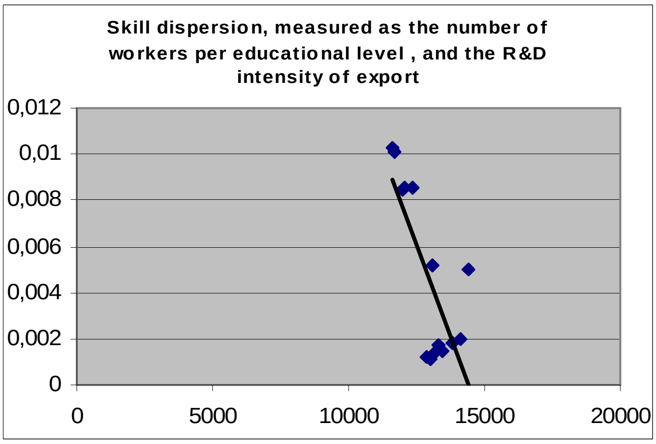
Graph 108: Scatter plot Poland- two most important industries



Graph 109: Scatter plot Poland- three most important industries



Graph 110: Scatter plot Poland- three most important industries



C. Regression outputs

In this part the output of the regressions will be shown.

Output 7: Skill dispersion and the R&D intensity of export - the most important export industry

Method: Panel Least Squares
Sample: 1995 2008
Periods included: 14
Cross-sections included: 18
Total panel (balanced) observations: 252

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.038682	0.002977	12.99266	0.0000
Skill dispersion	0.001133	0.000539	2.101980	0.0367**
GDP per capita	4.84E-08	1.46E-07	0.330561	0.7413
FDI	-5.39E-15	2.05E-14	-0.263157	0.7927
Gross savings	-5.91E-14	1.21E-14	-4.887280	0.0000**
R&D expenditure	-2.80E-10	4.67E-10	-0.600218	0.5490

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.975452	Mean dependent var	0.032464
Adjusted R-squared	0.971474	S.D. dependent var	0.042893
S.E. of regression	0.007245	Akaike info criterion	-6.885569
Sum squared resid	0.011336	Schwarz criterion	-6.381365
Log likelihood	903.5817	Hannan-Quinn criter.	-6.682687
F-statistic	245.2270	Durbin-Watson stat	1.712007
Prob(F-statistic)	0.000000		

The dependent variable is the R&D intensity of export. ** indicates the coefficient is significant on a five percent level.

Output 8: Skill dispersion and the R&D intensity of export – the two most important export industries

Method: Panel Least Squares

Sample: 1995 2008

Periods included: 14

Cross-sections included: 18

Total panel (balanced) observations: 252

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.036143	0.002776	13.01926	0.0000
Skill dispersion	0.001146	0.000503	2.280197	0.0236**
GDP per capita	4.48E-08	1.37E-07	0.328523	0.7428
FDI	-4.77E-15	1.91E-14	-0.249731	0.8030
Gross savings	-5.13E-14	1.13E-14	-4.548252	0.0000**
R&D expenditure	-2.84E-10	4.36E-10	-0.652797	0.5146

Effects Specification

Cross-section fixed (dummy variables)

Period fixed (dummy variables)

R-squared	0.976499	Mean dependent var	0.031346
Adjusted R-squared	0.972691	S.D. dependent var	0.040878
S.E. of regression	0.006755	Akaike info criterion	-7.025442
Sum squared resid	0.009857	Schwarz criterion	-6.521238
Log likelihood	921.2057	Hannan-Quinn criter.	-6.822560
F-statistic	256.4321	Durbin-Watson stat	1.663496
Prob(F-statistic)	0.000000		

The dependent variable is the R&D intensity of export. ** indicates the coefficient is significant on a five percent level.

Output 9: Skill dispersion and the R&D intensity of export – the three most important export industries

Method: Panel Least Squares
Sample: 1995 2008
Periods included: 14
Cross-sections included: 18
Total panel (balanced) observations: 252

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	0.035782	0.002770	12.91622	0.0000
Skill dispersion	0.001105	0.000502	2.201750	0.0287**
GDP per capita	5.59E-08	1.36E-07	0.410668	0.6817
FDI	-5.58E-15	1.91E-14	-0.292555	0.7701
Gross savings	-4.93E-14	1.13E-14	-4.383175	0.0000**
R&D expenditure	-3.33E-10	4.35E-10	-0.766639	0.4441

Effects Specification

Cross-section fixed (dummy variables)
Period fixed (dummy variables)

R-squared	0.976440	Mean dependent var	0.031363
Adjusted R-squared	0.972622	S.D. dependent var	0.040741
S.E. of regression	0.006741	Akaike info criterion	-7.029648
Sum squared resid	0.009815	Schwarz criterion	-6.525444
Log likelihood	921.7356	Hannan-Quinn criter.	-6.826767
F-statistic	255.7740	Durbin-Watson stat	1.656659
Prob(F-statistic)	0.000000		

The dependent variable is the R&D intensity of export. ** indicates the coefficient is significant on a five percent level.