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The use of formal education in Denmark 1980-1992

by

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Preliminary : All comments welcome

Abstract

Education of the labour force is often seen as one of the most important factors for the development of affluent economies. Denmark is such an economy with a GDP per capita above those of Germany and the US. Furthermore inequality is low.

Denmark has only 5.1 million inhabitants and is closely interconnected to Central Europe, both in infrastructure (Border to Germany, and ferry lines to Scandinavia, UK, Germany and Poland) and economically (EU-member since 1973). The Danish economy has been open to im- and export of all kinds of goods for decades.

This article analyses the role of formal education for the development of the Danish economy. It uses input-output tables and is based on the Heckscher-Ohlin-Vanek model for trade and factor endowment.

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1. Introduction

Education of the labour force is often seen as one of the most important factors for the development and functioning of affluent economies. Denmark is such an economy with a GDP per capita above those of Germany and the US. Furthermore inequality is low and even decreased in the 1980'es. Denmark consists of only 5.1 million inhabitants closely interconnected to Cental Europe, both in infrastructure (Border to Germany, and ferrylines to Scandinavia, UK , Germany and Poland) and economically (EU-member since 1973). The Danish economy has been extremely open to im- and export of all kinds of goods for decades. The achievements of the Danish economy were attained under "open market terms".

This article analyses the role of formal education for the development of the Danish economy. It is important to underline, that the articles is about formal education and not about human capital. Human capital is a much broader concept, including all kinds of productive attributes embedded in the labour force: informal and on-the-job training, experience, health- and nutritional status, etc. Education on the other hand, takes place in the educational system with its teachers and classrooms, examinations and tests. Education is in contemporary societies a huge business encompassing 1/4 of the total population, who have education as their daily main activity: Pupils/students and teachers/professors from 1st grade to Ph.D. level.

What to explain?

Denmark is one of the richest countries in the world. In 1994 GDP per capita amounted to 28,181 US\$ or 10% more than in US (figure 1). In the OECD only Japan and Switzerland had higher GDP. To which extend can education of the Danes explain this achievement?

During the 1960es and 1970es the Danish welfare state was developed with high public employment and high taxes. Moreover, due to inflation and income tax incentives for private households to incur debts, construction of single family houses was high. In other words, for many years the Danish economy and the use of labour was twisted toward domestic demands: Labour and other productive resources were occupied in the domestic sectors . The result was trade and current account balance deficits for more than two decades. However from the mid 1980es to the beginning of the 1990es a remarkable recovery took place: A deficit of more

than 5% of GDP in 1986 was turned into a surplus of 4% in 1993 (figure 2). To which extent was this accomplished by removing productive resources (labour) from the domestic sector to the trade sector of the Danish economy?

Last but not least wage inequality in Denmark is smaller than in most other countries. The wage-return to education is low: 0-6 percent per year of completed formal education (Hansen 1993, Westergaard-Nielsen 1996, Belzil & Hansen 1997) compared to 8-10 percent in UK and USA (Stewart 1996, Ashenfelter & Rouse 1998). Moreover inequality in Denmark did not increase from in the 1980s (Hummelgaard & Husted 1994, Pedersen & Smith 1997).

Abbildung 1 GDP per capita 1980, 1986 and 1994. Denmark, Germany and USA

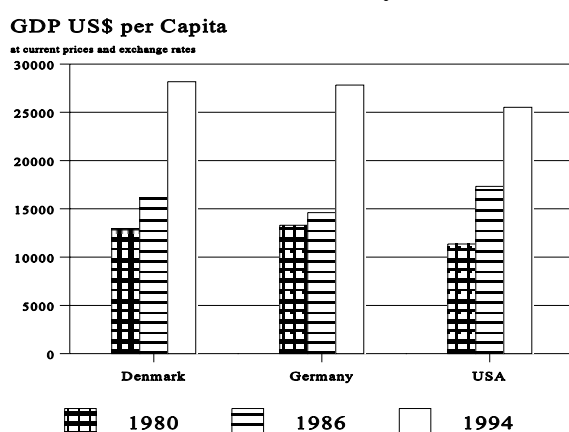
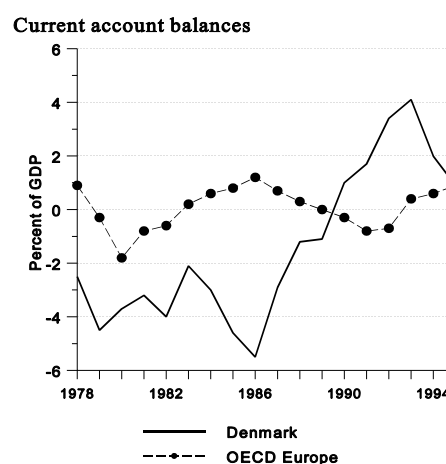


Abbildung 2 Current account balance 1978-1995. Denmark and OECD Europe.



International it seems generally accepted stylized facts that:

1. The demand for low skilled labour are falling in the North (affluent EU-countries, USA etc.)
2. Real wages for low skill workers are declining in countries with free labour markets (like USA and UK) and unemployment are rising in countries with more negotiated wage setting (BRD and Denmark).

This paper explores to which extent these facts and the explanation behind them can be found in the Danish case.

2. Theory of education and economic performance

Education effect the macro economy in three different ways (Hansen 1993) . First and foremost education - as other human capital and as other capital investment - improve productivity. Educated people work smarter, they specialize, work together, innovate and therefore end up with higher production per employee: Education influences *the way of production*. The importance of education, however, goes further than that. Through innovation and specialization regions and countries produces the products in which they can exploit comparative advantages in trade with other regions and countries: Education influences *which products are produced* locally and exported and which are imported. Finally education to some extend only work as a selection device and influences *who is producing what*.

All three sets of explanations can account for the stylised facts 1) and 2) in section 1 above independently and of course combined.

If changes in *the way of production* is important the arguments goes like this: Contemporary technological development (like computers) are biased against low skill workers. The same technology is available in all countries, and affects productivity economy-wide both in agriculture, manufacturing, trade, transport, and service businesses in all advanced countries. Low-skilled (low-educated) are therefore losing jobs economy-wide. They become more abundant. If wages are set on free markets, they will eventually fall (USA and UK), and if wages are inflexible unemployment will grow (Europe). No doubt, trade unions, collective bargaining and the provision to extend the terms of union contracts to non-union workers play in important role in explaining wage inequality (Blau & Kahn 1996).

The number of low skill jobs in advanced countries can also be falling because of increased international competition due to trade liberalisation and improved means of transportation. Low skilled (low educated) are losing because *which products are produced* locally are affected by changes in the conditions for international trade. Changes in the international division of labour for the advanced countries are biased against low skilled. The results for wages and unemployment are as above: falling real wages and/or increasing unemployment. As Freeman (1995) puts it: “Are Your Wages Set in Beijing?”, as free trade means

international factor price equalization. Public and politically much concern are given to this type of negative consequence of internationalization/globalization. The economist view, however, are more “that trade is a moderate contributing source of income inequality; it may not overshadow other sources, but it cannot be shrugged away”, (Ricardson 1995). Similar views can be found in Krugman (1996) and for Germany in Lücke (1996). But the opposite view is strongly represented in (Wood 1994, 1995).

The two sets of explanations above are based on main stream economic theory, and can in principle be tested by means of economic reasoning and economic statistics; Leamer (1996) and Lücke (1996) offer simple models for both. The third type of explanation, education as a selection device or only influencing: *who is producing what*, needs to borrow arguments and theories from sociology, political science etc. No doubt, in the USA and UK which experienced the largest drops in real wages for the low skilled, majorities of the population in the 1970s and 1980s voted in favour right wing political leaders who had inequalities, low taxes, and welfare-cuts as their main objectives. In some European countries voters were in favour of other social-political priorities.

3. Statistics and Account identities

Contrary to “human capital” education is measurable and countable. The number of people who have successfully passed through the formal educational system and it tests and examines can be counted. In Denmark almost all education are public, no or only modest fees are paid and most student receive apprentice wage and/or financial aid from the state. It is the (macro economic) outcome of this system, not human capital, that are the object of this study.

In the population census in 1970 Statistics Denmark collected information about the highest completed education among all Danish residents under 50 years old. This information was associated to the unique Cental Personal Registration Number (CPR) that have been uses in Denmark since 1968. Annually for the years since 1970 Statistics Denmark collected information about completed education (final examination, finished apprenticeships etc.) on CPR-level from educational institutions etc. For 1980 information about education exists for all under 60 years old and for 1992 we have information for all Danes under 72 years old.

Education is classified into several hundred types according to both level and content.

Information about employment/unemployment of the Danish population is registered on an individual CPR-basis. The basis is mandatory supplementary pension contributions, income tax etc., and all information is kept on computer files for administrative purposes. Statistics Denmark run these files with files for education, ending up with statistics for the total population distributed on: age, gender, education (8 digit codes aggregated to 95 types in this study), employment according to industry (5 digit ISSC codes and/or NACE codes aggregated into 117 sectors in this study), unemployed, persons still under education and persons non active on the labour market for other reasons (like housewife or disabled). This statistics have been made on an annually basis for the period since 1980.

Moreover the Danish National account system contains annual input-output tables for the period 1966 to 1992. They include 117 sectors of production. Input-output tables for the period since 1993 were calculated with different (improved) classification and definitions but were not available when this research project was started, and they do not include timeseries. In traditional input-output models output in a country is expressed as the result of final demand. Let $(C+G+I+X)$ be the sum of final demand: private consumption, public consumption, investment and exports. Moreover F is the make matrix and $(I-A)^{-1}$ is the Leontief inverse matrix or production multiplier, and we have production as:

$$Q = (I-A)^{-1} F(C+G+I+X) \quad 1 \text{ Production as a result of demand for goods and services}$$

in which Q is a vector with production in 117 sectors. Furthermore, let E be a matrix with education intensities in different industries, and q^{diag} a matrix with labour productivity in the diagonal and zeros in the off-diagonal. Thus we get E as a vector with employment for different types of education:

$$E = E q^{diag} Q \quad 2 \text{ Use of education as a result of production.}$$

Production can also be written as a result of factor uses. If only labour and education input are considered we have:

$$Q = (E q^{diag})^{-1} E \quad 3 \text{ Production as a result of supply of education.}$$

If all factors of production (V) are included we more general have:

$$Q = P^{-1}V \quad 4 \text{ Production as a result of supply of factors of production.}$$

Of course: $E \subset V$ and $E q^{diag} \subset P$ as labour and education are not the only factors of production.

4. Use of labour 1980-1992: Who is producing what?

All Danish children and teenagers of course receive mandatory teaching, but it is not this education that is subject for this study. Here we only include completed formal education after mandatory school and high school. *Further education* include those with who have finished high school (12 years) and passed successful through additional 3 years (short), 4-5 years (medium) or 6-9 years (long) of mainly theoretical education with final examination. Vocational comprises those who have successfully passed through 3-5 years of theoretical and practical apprenticeship. Those who never started other education after mandatory school/high school and all drop-outs are included in *no formal education*.

The adult population is potential available for the labour market and for the production of goods and services. Education has important implication for being employed as well as for the types of commodities people produce. The more educated are more active, less unemployed and more than half of all Danes with further education produced goods and services for public consumption both in 1980 and in 1992. This is seen from table 1 and 2 showing the use of educated and non educated adults in Denmark in 1980 and 1992.

First of all it is important to note, that the level of formal education is growing. The number of 15 to 59 years old people with no formal education fell from 1.367.000 in 1980 to 1.197.000 in 1992, the number of people with vocational education increased from 858.000 to 1.049.000, and the number with further education rose from 339.000 in 1980 to 478.000 in 1992. Older generations leaving the labour force during the period got less formal education when they were young in the 1940es and 1950es than young people entering the labour force in the 1980es. This is the most important change in the educational patterns in Denmark, and may at least partly reflect a formalization of the transfer of skills between generation from practical

on-the-job training etc. (in agriculture and in households) to classrooms and formal training in public institutions.

Table 1. Use of educated and non educated adults in Denmark 1980 (formula 1 and 2)

1000 persons (whole-year basis)	Production of goods and services for different use				Total emplo yment	Une mp- loyed	Non activ e	Total po- pulati- on
	Private consumpt ion	Public consumpt ion	Investm ent	Export				
No formal education	276	235	115	235	862	110	396	1367
Vocational education	227	161	145	146	680	48	130	858
Further education	50	177	28	36	292	8	39	339
60-74 years	61	44	18	47	171	6	529	706
Students and pupils	52	36	20	19	128	2	307	437
15-74 years total	668	654	327	484	2132	175	1401	3708

Table 2. Use of educated and non educated adults in Denmark 1992 (formula 1 and 2)

1000 persons (whole-year basis)	Production of goods and services for different use				Total emplo yment	Une mp- loyed	Non activ e	Total po- pulati- on
	Private consumpt ion	Public consumpt ion	Investm ent	Export				
No formal education	218	211	86	201	717	160	320	1197
Vocational education	276	213	154	210	853	95	101	1049
Further education	81	243	38	60	422	24	31	478
60-74 years	39	34	12	38	124	7	549	680
Students and pupils	59	38	18	27	141	4	343	488
15-74 years total	673	739	307	536	2256	291	1344	3891

Abbildung 3 Change in education and final uses 1980-1992.

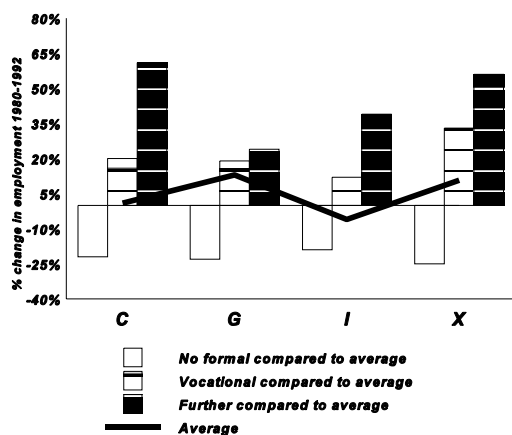
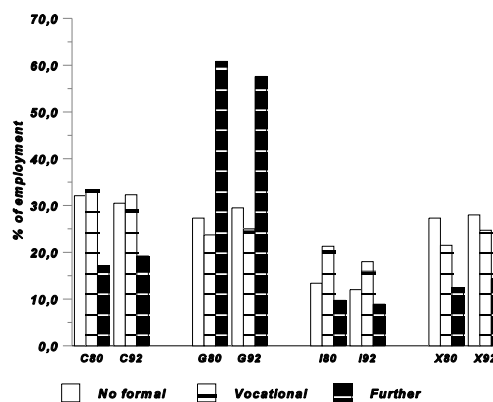


Abbildung 4 Education and final uses 1980 and 1992.



This generation effect alone will generate less employment for non-educated and more employment for educated people, even if there were no other changes in the economy. Even if neither domestic demand for goods and services, productivity and technology, nor foreign specialization and import/export would change, the demographic development will create less unskilled employment and more skilled employment. This appears also from table 1 and 2: In 1992 the production of goods and services for all kinds of uses embedded less input of non-educated and more input of vocational- and further education. From this it is not possible to detect whether education has influenced the performance of the Danish economy.

However we can note an important stylized fact for Denmark: “The **supply** of low educated labour is falling”. This can be seen as a supplement to the international fact about the **demand** for low educated in section 1 above. And it is important to remember, that changes in supply will generate changes in employment in itself (Groes 1982, Groes, Holm & Tranæs 1994). Fitzenberger (1997) notes the changing supply from 1975 til 1990 in Germany; but conclude a little cryptic: “..dass die Veränderungen in der Qualifikationsstruktur der Beschäftigung zum grossen Teil durch Angebotsveränderungen kompensiert wurden und die Veränderung in der qualifikatorischen Lohnstruktur im internationalen Vergleich recht gering ausfallen”. Actual employment is the result of demand and supply factors, and statistical recorded employment for different skill groups can not be interpreted just as a result of the demand for labour. And therefore shift in employment do not only reflect shifts in demand.

The overall picture of the uses of education remained stable from 1980 til 1992 as can be seen from figure 3: People with further education produces goods and services for public consumption (61% in 1980 and 58% in 1992), whereas they are less present in the export sector (12% in 1980 and 14% 1992). Employed with no formal education are more equally distributed: 28% and 29% produced for public purposes in 1980 and 1992 respectively, whereas 27% and 28% produces goods and services for export in 1980 in 1992 respectively.

From 1980 to 1992 total employment in Denmark rose by 5,8%. Employment of people with no formal education fell by 16,8% or 22,6 point less total employment. A similar distance to average of 20 to 25 point goes for all four different final uses, as can be seen from figure 4. In other words: The change in demand for goods and services from 1980 to 1992 in Denmark were not specially biased against non-educated labour. The other side of the same coin of course is, that employment of people with vocational and further education rose for all four uses, least for public consumption and most for exports and private consumption. For groups of people with further education this reflects a large increase in supply that could not find traditional employment in the public sector and a partly new labour market for these groups were created in the private sector producing for consumption and exports.

A more detailed picture of the specialization for different levels and types of formal education can be found in figure 5. In the first part 23 different levels and types of education are sorted according to the share of population employed due to public consumption. Most specialized in production for public consumption are *school teachers*: More than 80% of the total population of teachers produced public service in 1980; all other “uses”: private consumption, investment, export, unemployed and non active accounted together for less than 20%. The share of teachers in public consumption fell slightly from 1980 to 1992, but the group remained the most specialized.

Many types of further education are oriented toward specific tasks in the public sector. On *Short: Other* in figure 5 comprises offices in public security and catering officers. *Long: Human* include high school teachers, professors and ministers of religion. *Medium: Health* are trained nurses at bachelor level and *Long: Health* are doctors and dentists. *Short: Human* include kindergarten teachers. People with all these types of education are mainly employed

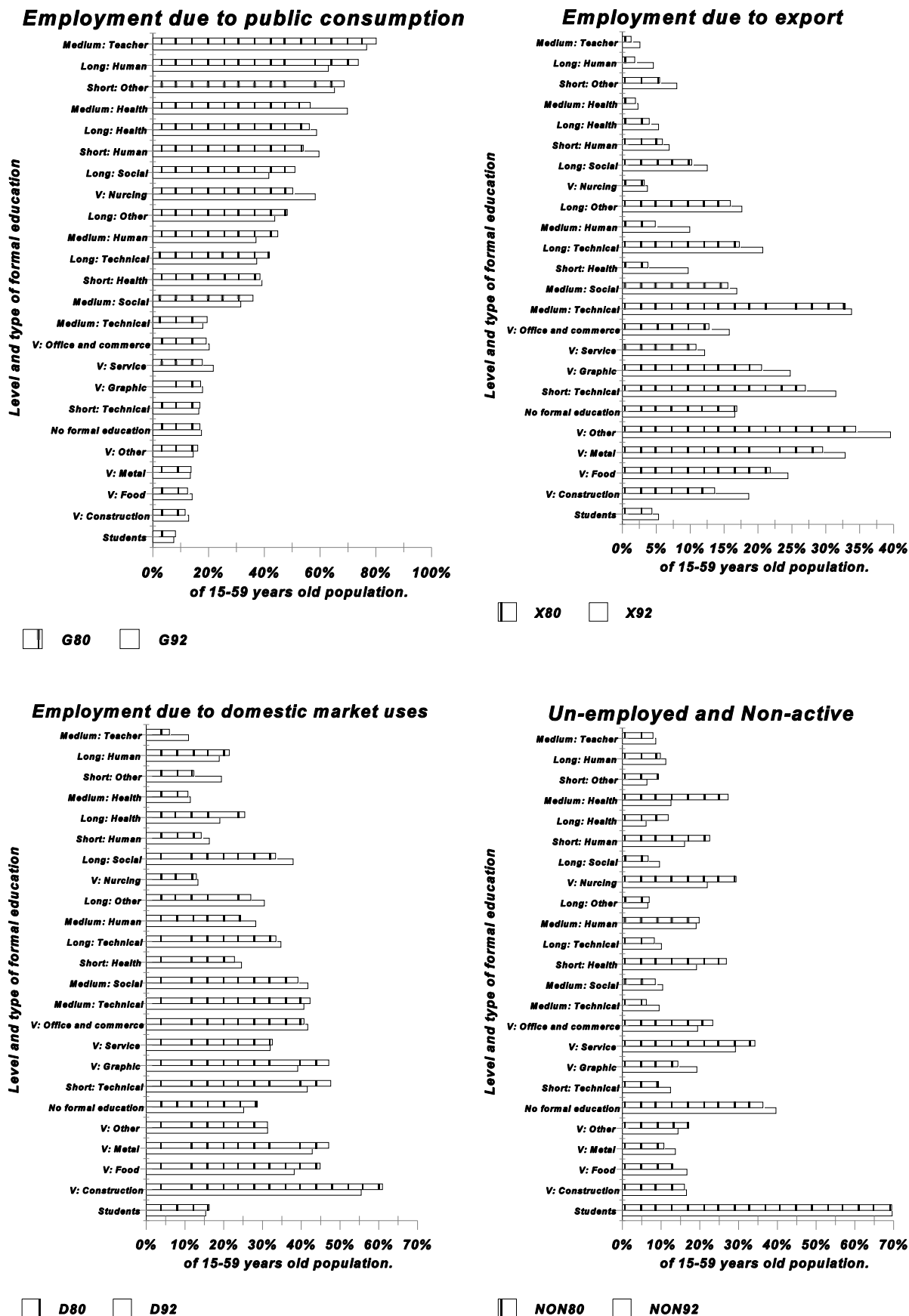
due to public consumption. It was so in 1980 in it remained so in 1992. It should also be noticed, that the share in public consumption for some important groups were higher in 1992 than in 1980. This goes for types of education typically chosen by young females: teaching and nursing at all levels, and it is due to lower shares of un-employed and non-active in 1992 compared to 1980, as can be seen from the bottom right part of figure 5. Danish women receive formal education for specific tasks in the public sector and during the 1980s and 1990s they stayed increasingly active on the labour market throughout periods with children.

The aggregation in figure 5 comprises 14 types/levels of further education. In 6 of them more than 50% of all in 1992 were employed due to public consumption. In another 6 groups between 30 and 15 percent were employed due to public consumption. In the final 2 groups the share in public consumption were at the same level as for people with no formal education. No types/levels of further education were less employed due to public consumption, than the non-educated adults. Domestic, public sector factors are important for the employment Danes with further education, and this of course also goes for their wages.

A little less than 17% of adults with no formal education were in 1992 employed due to exports. This is slightly less than their share in public consumption. All three levels of technical type further education are a relatively more than the non-educated oriented towards exports. Four vocational groups: food, metal, graphic, and other have large shares in export. The latter because *other* include education oriented toward agriculture and transport like agronomists, pilots, trained farmers and -sailors. For almost all types of education larger shares were found in exports in 1992 than in 1980. Compared to average, the non-educated had a little larger drop in export-employment than in domestic employment, and the vocational-level educated had their largest increase in exports, as it is seen from figure 3. This could be a weak sign of crowding out effects for non-educated due to foreign competition.

Most specialized toward domestic market uses (investment and private consumption) are people with vocational level construction types of education: bricklayers, carpenters, plumbers etc. This is the only group where more than 50 percent of all 15-59 years old are employed due to domestic market uses. All levels of technical education are more represented in domestic market uses than in exports. Even for these groups domestic factor are very

Abbildung 5 Uses of 23 different types of education in Denmark 1980 and 1992.



important for employment and wages.

40 percent of all 15-59 years old Danes with no formal education after mandatory school/high school were in 1992 either unemployed (13%) or non active on the labour market (27%). For all levels and types of education the shares were much lower. Only people with vocational level education of service type or nursing type had more than 20 percent non-active or unemployed. From 1980 to 1992 total unemployment increased with 116.000 persons, and the number of non-active between 15 and 59 fell with 113.000 persons, cf. table 1 and 2. The same tendencies are found for all types and levels of education: Registered unemployment rose and the number of non-active (females) fell.

5. Education and trade: What is produced?

Trade is a mean and not an end. Countries export in order to generate income, that can be used for imports of goods and services that are produced better or less expensive abroad (Krugman 1991). Domestic factors or production will be used for export only as long as factor remuneration is not lower than in alternative production for domestic uses. As factors of production is not equal distributed among countries and region, regions and countries tend to specialize in products that require factors of production that are abundant. If consumption (absorption) are equalized across regions they will export goods and services including abundant factors and import goods and services which include scarce factors.

This is formulated in Heckscher-Ohlin-Vanek model. The model is a mainstream of international economics, and even though it often performs purely in empirical tests, it is consistent with contemporary theory, or as Elhanan Helpman and Paul R. Krugman write in the book: *Market Structure and Foreign Trade. Increasing Returns, Imperfect Competition and International Economy* from 1985: *The core of modern analysis of trade is the factor proportions theory - the Heckscher-Ohlin model and its extensions ... Indeed, one of our main purposes is to show that many of the insights gained from traditional theory continue to be useful even in a world where increasing returns and imperfect competition are important.*

The factor proportions theory rest on a set of usual assumptions from neo-classical economic

theory. They are:

- (a1) Constant return to scale
 - (a2) Perfect competition
 - (a3) Free trade and zero transport costs for goods and services
 - (a4) Factors of production are not mobile across borders but perfect mobile within borders
 - (a5) Homogeneous preferences across borders
- which gives
- (a6) Factor price equalization across borders.

Denmarks production in relation to factor endowment are described in formula 4, section 3 above. World production can be described similarly as in relation of worlds endowment:

$$Q_w = P^{-1}V_w \quad 5 \text{ World production}$$

Note that P is the same matrix with factor intensities or production technology like number of unskilled and number high educated labour for the production of one million value TV-sets and one million value furniture. It comes from (a6): Factor price equalization that gives the same points of equilibrium on the same production functions. The production functions are made up by technology, capital equipment and intermediate goods and services, that are available at the same prices because of assumption (a3).

Total absorption in Denmark is a share of worlds total absorption and production:

$$C+G+I = s(C_w+G_w+I_w) = sQ_w \quad 6 \text{ Danish absorption}$$

where s is a scalar for Denmarks share of worlds income (and absorption) adjusted for the trade balance. s is a scalar for all kinds of commodities because of assumption (a5): Homogeneous preferences.

As net export is the difference between production and absorption: $X-M = Q - (C+G+I)$, and combining we have the Heckscher-Ohlin-Vanek model in which trade is expressed in factor service:

$$P(X-M) = V - sV_w$$

7 Trade of factor service

$(X-M)$ is a vector with values of net exports distributed on commodities like million DDK TV-sets and million DKK furniture. V is Denmark's factor endowment like total number of unskilled labour and total number of high educated labour. V_w is world factor endowment and s is Denmark's share of world consumption (absorption). The equation says that net-export reflect relative factor endowment. A country (or a region) with many high educated will export goods and services, that require high educated labour, and a country with many unskilled will export goods and services, that require unskilled labour.

The fact, that intraindustry trade between similar affluent OECD countries accounts for the larges share of world trade, is consistent with this conventional Hecksher-Ohlin-Vanek model, as show by Davis (1997). For regional use of HOV Davis, Weinstein, Bradford & Shimpo (1997) in the Japanese finds that it performs remarkably well. The same goes for regions in USA (Kim 1995). A test in the case of Korea, however, suggest that the revealed factor endowments departed significantly from actual supplies (Ramazini and Maskus 1993).

Tests of HOV requires independent measures of its three concepts: factor intensities, net-export and factor abundance (Leamer & Bowen 1981). Only the two first are available in this study for Denmark. However, the aim of the study is not to test the theoretical model, but to use it, since it is this model and its extensions, that lies behind the belief that low-skilled in the north lost jobs/wages due to international competition. Globalization affects the right side of 7 by an increase in world supply of low-skilled labour. In this study I compute the left side of 7 in order disclose potential influence from changes on the right side for different educational groups in Denmark.

Partial model for education and labour with factor price equalisation

To equations from the matrix expression (7) - the first for pure or raw labour and the second for education - can be written as:

$$\begin{aligned} L^X - L^M &= L - sL_w \\ E^X - E^M &= E - sE_w \end{aligned}$$

in which L^X and L^M express pure labour content in exports and imports of commodities respectively. L is labour endowment in Denmark and L_w is the worlds labour endowment. The E 's similar stands for education.

A country (Denmark) is abundant in education compared to labour if its share of worlds education endowment is larger than it share of worlds labour endowment (left inequality) or expressed in another way: if the average worker in Denmark has more education than in the world as a whole (right inequality):

$$\frac{E}{E_w} > \frac{L}{L_w} \Leftrightarrow \frac{E}{L} > \frac{E_w}{L_w} \quad 9 \text{ Definition of education endowment}$$

Homogeneous preferences mean the same consumption patterns across countries (the number of TV-sets and the amount of furniture per capita are the same in countries on the same income level). The factor content in a countries consumption (absorption) are therefore equal to the factor content in its share of worlds consumption: $L^C = sL_w$ and $E^C = sE_w$ in which top symbol C denotes labour and education contents in consumption. Top symbol Y denotes content in domestic production, and with equilibrium in factor markets we have $L = L^Y = L^C + (L^X - L^M)$ and $E = E^Y = E^C + (E^X - E^M)$. Combining and inserting: Denmark is well endowed with education in relation to labour if and only if (Leamer 1980, 1984):

$$\frac{E}{E^C} > \frac{L}{L^C} \Leftrightarrow \frac{E}{L} > \frac{E^C}{L^C} \quad 10$$

where the second inequality says that education per worker is larger in production than in absorption. Many types of education $E^1, E^2 \dots E^n$ can be ordered after Denmarks relative endowment with different types of education so that:

$$\frac{E^1}{E_w^1} > \frac{E^2}{E_w^2} > \dots > \frac{E^m}{E_w^m} > \frac{L}{L_w} > \frac{E^{m+1}}{E_w^{m+1}} > \dots > \frac{E^n}{E_w^n} \quad 11 \text{ Ordering types of education}$$

which will be revealed in the relationship between production and absorption:

$$\begin{array}{c}
\frac{E^1}{E^{C1}} > \frac{E^2}{E^{C2}} > \dots > \frac{E^m}{E^{Cm}} > \frac{L}{L^C} > \frac{E^{m+1}}{E^{C(m+1)}} > \dots > \frac{E^n}{E^{Cn}} \\
\Downarrow \\
> \dots > \frac{E^m}{E^{Cm}} - \frac{L}{L^C} > 0 > \frac{E^{m+1}}{E^{C(m+1)}} - \frac{L}{L^C} > \dots
\end{array}$$

12 Vanek's chain rule

(11) and (12) are called Vanek's chain rule. As it rest on Heckscher-Ohlin (7) they together constitutes the Heckscher-Ohlin-Vanek or HOV model. Even though there are no information about all factors of production in Denmark the models makes it possible to analyse the relationship between different types of education and total labour input.

No factor price equalisation

In cases with no factor price equalisation trade patterns will still reveal important information about production factors and factor remuneration in Denmark. This is shown by Leamer 1984.

Let Denmark's export of j different goods to a country (say Germany) be X_j^{dg} . The factor content of this export depends on production technology in Denmark P_d . The factor content of Denmark's export to Germany thus is: $P_d X_j^{dg}$. Let the international determined price of tradeable goods be γ_j and factor remuneration in Denmark w_d and we have the value of Denmark's export to Germany:

$$\gamma_j X_j^{dg} = w_d P_d X_j^{dg} \quad 13$$

The same goods could also be produced in Germany with German technology and German factor remuneration. In the extreme case factor prices are equalized and equilibrium on the productions function will be the same. However if factor prices are not equalized then production in Germany would cost:

$$w_g P_g X_j^{dg} \leq w_d P_d X_j^{dg} \quad 14$$

since the Germans will use production technology P_g if and only if it is not more expensive than the Danish technology P_d . A similar argument goes for the ability of Danish export to

enter the German market. It can only take place as long as Danish exports are not more expensive than domestic production:

$$\gamma_j X_j^{dg} \leq w_g P_g X_j^{dg} \quad 15$$

Combining we get:

$$0 \leq (w_g - w_d) P_d X_j^{dg} \quad 16 \text{ Factor remuneration inequality}$$

Hence d 's exports to g contain more factor content of those factors of production that are less expensive in d than in g and less of those factors that are more expensive. (Helpman and Krugman 1985 p. 175). The factor remuneration inequality (16) holds true even in a world with imperfect competition, intra-industry trade etc. This has important implication for interpretation of wage differences between countries.

Education and Danish foreign trade 1980-1992

From 1980 to 1992 the official Danish trade balance improved from a deficit of 3.7 % of GDP to a surplus of 3.4 % of GDP (OECD, see also figure 2). Some, but decidedly not all of this improvement can be traced back to import and export of goods and services and thus to the labour market and other domestic factors of production. It appears from table 3 that decomposed the current balance in 1980 and 1992 into factor income content in import and exports and other items.

The decomposition of current account has implication for calculation and interpretation of the HOV-model. Domestic factor income earned by exports can be used to purchases of imports, that must remunerate all factors of production abroad. Therefore the interesting comparison goes between domestic factors in export, and global factors in imports for domestic absorptions. The value of exports in addition includes imports used for production of export goods: Some imports are embedded in exports, but this import is irrelevant for comparing domestic factors of production with global factors of production, and are therefor excluded from both sides of the equations.

Danish factor income content in exports of goods and service excl. coal, oil and gas amounted to 71.6 billion DKK in 1980 and 176.1 billion DKK in 1992, corresponding to 21.2% and 22.6% of current gross factor income respectively. This factor income remunerated factor services embedded in Danish export, mainly labour and capital but not natural energy resources because coal, oil, and gas were excluded from the calculation. Labour and capital services embedded in the production of coal, oil and gas are also excluded, but as they are small, this is not important for this analysis. Danish export industries compete for productive resources like educated labour with domestic uses of the same resources like public employment or employment in sheltered sectors of the economy. Resources in the Danish exports of course also compete with other countries resources in export industries for the same international product markets. As can be seen from table 3 Danish resources improved their export position with 1.4 percent point from 1980 to 1992.

Table 3. Decomposing current account balance change 1980-1992

	1980	1992	% of gross factor income		Difference (improvement of current balance)
	million DKK		1980	1992	
Danish factor income content in exports of goods and services, excl. coal, oil and gas	71622	176136	21.2%	22.6%	1.4%
Global factor income content in import of goods and services to final use in Denmark, excl coal, oil and gas	51090	109276	-15.1%	-14.0%	1.1%
Trade balance in factor-prices, excl. coal, oil and gas	20532	66860	6.1%	8.6%	2.5%
Imports to final use of special categories of goods and services	11585	5292	-3.4%	-0.7%	2.7%
Taxes in relation to trade		-4448		-0.6%	
Factor income in net trade of coal, oil and gas	-9893	-1468	-2.9%	-0.2%	2.7%
Official trade balance	-3914	55652	-1.2%	7.1%	8.3%
Tourism income, net	-35	2602	0.0%	0.3%	0.3%
Labour income, net	138	2054	0.0%	0.3%	0.2%
Interest and capital income, net	-9420	-34425	-2.8%	-4.4%	-1.6%
Transfer to EU, net	2286	1488	0.7%	0.2%	-0.5%
Other transfer, net	-2713	-7586	-0.8%	-1.0%	-0.2%
Balance of current transaction, Danish National Accounts	-13658	19785	-4.0%	2.5%	6.6%
Current balance, OECD definitions (figure 1)			-3.7%	3.4%	7.1%

Imports to Denmark in a similar way compete with productive resources that in Denmark

could produce the same products. This is calculated as the global factor content in imports of goods and services to Denmark, and excluding coal, oil, and gas. Danish factors improved their import replacement with 1.1 percent point from 1980 to 1992, which can be seen in the second row of table 3.

Factors of production (mainly labour and capital) excluding oil, coal and gas (mainly natural resources) on a total account for 2.5 percent point improvement of current balance from 1980 to 1992: Sum of growing export and falling import as entered in the third row of table 3.

The total official trade balance, however, improved considerably more, namely 8.3 percent point of gross factor income. Two other items, that are both closely related to energy and exploitation of Danish North Sea oil and gas, are important. The first item is special categories of imports, which improved 2.7 percent point. It comprises imports to oil- and gas activities in the North Sea (2.0 percent point) and Danish ships expenditures abroad (0.7 percent point). The other item is factor content in net trade of coal, oil, and gas (mainly remuneration of natural resources), that fell from -2,9% of gross factor income in 1980 to -0.2 % in 1992, resulting in a contribution to the improvement of the trade balance of 2.7 percent point. Production of oil and gas in the Danish North Sea since the mid 1980es made the Kingdom more self-sufficient among other things due to huge investment in the North Sea in the late 1970es and early 1980es.

The final rows of table 3 shows transfer and factor income flows that are not important for this study, but they are included in order to account for the total official balance of current transactions in the two final rows of table 3.

The aim of this study, as mentioned, is to analyse education in relation to imports and export, and only those parts of trade where labour play more than a marginal role should be included. This trade balances - in factor income terms for 1980 and 1992 - are included in the first three rows in table 3. For the period as a whole it should be noticed that only about one third of the improvement in current balance can be traced back to imports and exports other goods than natural energy and thus potentially to the domestic labour market.

In figure 6 the trade balances with and without natural resources respectively, are shown in income as well as in labour terms for the whole period 1980 til 1992. The slim dashed curve shows factor income content in net exports as entered in official trade balance: It fell from 3.1% of GDP in 1980 til 1.3% in 1986 and increased hereafter to 8.4% of GDP in 1992. Trade balance in factor income terms excl. oil, gas, and coal have a somewhat different path: From 6.1% of GDP in 1980 to 3.0% in 1986 and improvement to 8.6% in 1992, as shown in the bold dashed curve. Both production and absorption of oil, gas, and coal changed in the period i.a. due to huge investment in the energy sector. Moreover international prices and the international value of US\$ changed during the 1980s. The energy sector have little to do with the domestic labour market. In the 1980s the curve for total labour (slim dotted) are therefore different from the curve for total factor income.

The two bold curves in figure 6 for income and employment balance excl. oil, gas, and coal, however, take the same course. The employment content balance is below the factor income content balance, due to differences in factor income per employee in imports, export, and domestic uses, presumably because of differences in capital input. These differences however seem stable throughout the investigated period from 1980 to 1992. Conditions on the labour markets in relation to foreign competition from im- and exports may therefore contribute to explain the trade balance excl. oil, gas, and coal, and differences between types and level of education can be analysed, and interpreted in relation to this part of Danish foreign trade. This is done in table 4.

From table 4 it appears that the number of people with no education fell from 1980 to 1986 and again from 1986 til 1992 both for production, exports, imports, and absorption. As mentioned: The supply of low-educated Danes is falling and this affects all parts of the labour market. The supply of medium and high educated on the other hand is growing. This also affects all types of production. Comparison between the different types can be done by means of the Vanek chain in formula 12 as calculated to the right column of table 4.

Table 4. Factor content of production, trade and absorption, excl. oil, gas and coal. 1980, 1986 and 1992.

	Production E in formula 2	Export P X in formula 7	Import P M in formula 7	Absorption P(C+G+I) = E-P(X-M)	Vanek chain, formula 12
1980					
No formal education	860	234	174	800	7,5%
Medium, technical	386	101	83	368	4,9%
Medium, other	374	56	43	361	3,6%
High, technical	61	17	13	57	7,0%
High, other	149	7	5	147	1,5%
Students / over 60	299	66	42	274	9,0%
Total labour content, 1000 persons	2129	482	360	2007	6,1%
Factor income content, billion DKK	336	72	51	316	6,5%
Factor income per employee, DKK	158004	148477	141843	157394	
1986					
No formal education	840	228	207	819	2,5%
Medium, technical	448	122	129	455	-1,7%
Medium, other	462	70	65	458	1,0%
High, technical	69	19	20	70	-1,0%
High, other	182	10	8	180	0,7%
Students / over 60	301	71	53	283	6,3%
Total labour content, 1000 persons	2301	519	484	2265	1,6%
Factor income content, billion DKK	594	129	111	576	3,1%
Factor income per employee, DEK	258250	248733	230082	254416	
1992					
No formal education	715	199	135	650	9,9%
Medium, technical	462	144	104	423	9,3%
Medium, other	520	85	56	491	5,9%
High, technical	78	24	18	72	9,1%
High, other	208	14	9	202	2,8%
Students / over 60	266	65	35	236	12,6%
Total labour content, 1000 persons	2250	532	357	2075	8,4%
Factor income content, billion DKK	770	176	109	703	9,5%
Factor income per employee, DEK	342262	331239	305944	338836	

Vanek-chains for the whole period 1980 to 1992 are show in figure 7. If low skilled Danes lost jobs due to foreign competition compared to educated Danes this would cause the curve for low educated in figure 7 to fall. It do not for the investigated period from 1980 to 1992.

In figure 7 the curves for technical type education (dashed) both at the medium level (slim) and at the high level (bold) probably reflect the business cycle: Top in 1986 with high investment and private consumption that could not be met with domestic production. The result was a huge balance of payment deficit, and figure 7 shows that net imports in particular grew for products that require technical skills.

Abbildung 7 Relative balance for different types of education 1980-1992 (Vanek chain formula 12)

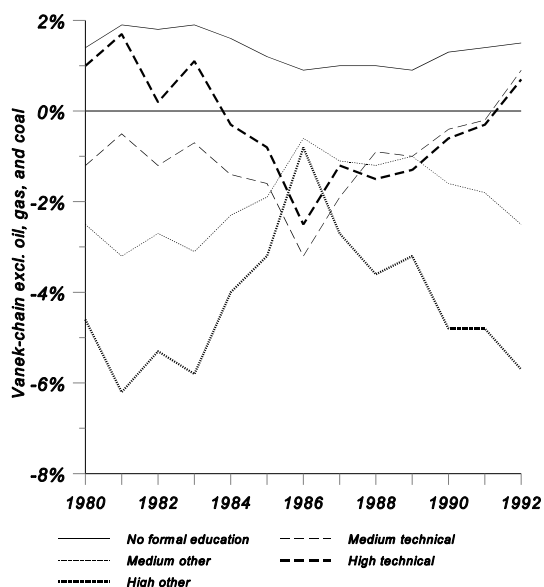
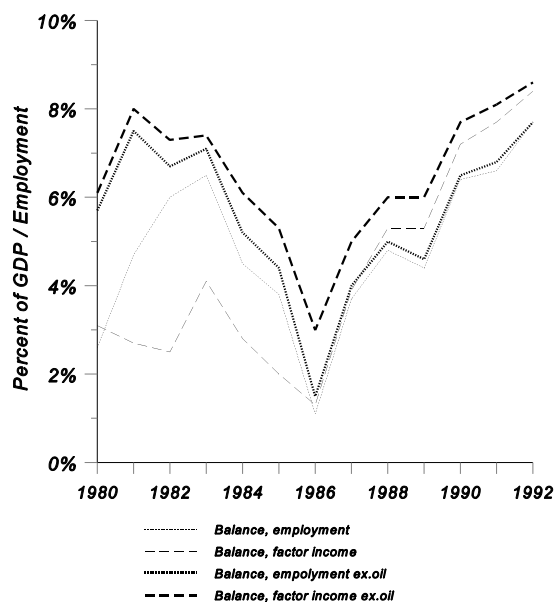


Abbildung 6 Trade balance with and without coal, oil and gas and balances for employment.



The curves for non technical types of education in figure 7 are more difficult to expound: The two dotted curves for medium and high level non-technical types of education in general have the same course, but they have the opposite course than the technical ones. Especially for high educated the absolute figures behind the curve are small: 7.000 persons, 10.000 person and 14.000 persons in exports in 1980, 1986 and 1992 respectively. This should be compared to total employment for other high educated of 149.000 in 1980, 182.000 in 1986 and 208.000 in 1992. Exports and imports have only marginal influence on the labour market for this group.

Trade and wages

The factor remuneration inequality (16) is in table 5 illustrated with numerical examples.

Table 5: Numerical samples of factor content of exports and possible differences in cross country wages.

	Factor content in Denmark's export (calculated)	Factor remunerations (assumed)			Product
		Denmark wd	World wg	Difference wg-wd	
CASE 1: Full factor price equalisation	A			B	B*A
Capital	Unknown	10	10	0	0
No formal education	266	80	80	0	0
Vocational	210	100	100	0	0
Further	60	120	120	0	0
SUM	536				0
CASE 2: Compressed Danish wage structure	A	wd	wg	B	B*A
Capital	Unknown	10	10	0	0
No formal education	266	90	80	-10	-2660
Vocational	210	100	100	0	0
Further	60	110	100	10	600
SUM	536				-2060
CASE 3: De-compressed Danish wage structure		wg	wg	wg-wd	
Capital	Unknown	10	10	0	0
No formal education	266	70	80	10	2660
Skilled, technical	210	100	100	0	0
Skilled, other	60	130	120	-10	-600
SUM	536				2060

Factor content in Denmark's export $P_d X_j^{dg}$ are calculated on the basis of Danish input-output-tables and labour force statistics. The result for three types of education in 1992 are seen in this first column of table 5: 266.000 persons with no formal education, above 60 years or still students, 210.000 with vocational education, and 60.000 with further education, cf. also

table 2 above.

Case 1 contains assumed factor remunerations for all factors in Denmark and in the rest of the World. For people with vocational an of index 100 is assumed and for no education 20 less and for further education 20 more). Factor prices are equalized which means:

$$0 = (w_g - w_d) P_d X_j^{dg}$$

and we have the standard HOV model where factor content of net trade reveals factor endowment.

Case 2 assumes compressed Danish wage structure compared to average Danish export counties: Higher Danish wages for people with no education (only 10 less than for those with vocational education) and lower wages for people with further education (only 10 more). Remuneration of capital are assumed equal across countries. Applying right side of formula 16 to this yields:

which is contradictory to the inequality in formula 16. Assuming a compressed wage structure between groups of education in other words are not in accordance with the empirical disclosed export patterns. The assumption is rejected by export data for 1992.

Case 3 show calculation for the opposite assumption: Relatively low wages for low educated and relatively high wages for high educated in Denmark. The result is:

$$2060 = (w_g - w_d) P_d X_j^{dg}$$

which correspond to the theoretical prediction in formula 16. Therefore assuming comparable low wages for low educated Danes and high wages for highly educated is not rejected by export data for 1992.

6. Education and productivity: How is produced?

Empirical inquiries into the impact of education and technology on productivity is perhaps one of the most difficult tasks for regional economists. Estimation of economy-wide production functions is data demanding and difficult (Hansen 1993), and is so far outside the scope of this study. However previous Danish studies did not reveal strong and statistical significant influence from education to productivity.

Moreover, Erich Gundlach (1997) from the Kiel Institute of World Economics gives an overview of empirical production functions with the attempt to assess the macroeconomic impact of human capital for economic development. Production functions with education and human capital are difficult to estimate, and he ends up with the conclusion, that “..economic theory has to carry the bulk of the argument which favours the view that human capital formation is one of the most important determinants of economic development.”

7. Conclusion

The level of education is growing, and the supply of low-skilled workers are falling in Denmark. Types of education oriented toward specific tasks in personal service and welfare service are important in the overall educational pattern of the Danish labour force. This includes teachers, nurses, doctors etc. In Denmark welfare and personal service mainly belong to the public sector, and as the public sector accounts for about 1/3 of total employment, traditions, political priorities and negotiation with professional associations and trade unions are important for employment and wages for large groups of high educated Danes. In general the picture remained stable in the investigated period from 1980 to 1992.

Comprehensive investigations into labour market performance in relation to import and export, show that low skilled Danes performed relatively well compared to high skilled Danes. Thus import and export data do not support the hypothesis that low skilled lost jobs and relative income due to foreign competition from 1980 to 1992.

The technological development could be biased against low skilled. Economy wide macroeconomic studies of the impact of technology requires estimation of production

functions for all economic sectors. This is an extremely data demanding exercise, that the time period and types of data used in this study did not allow.

In the mind of this author, however, there are no doubt, that domestic supply as well as institutional and political factors must play an important role in explaining trends in low-skill employment, inequality and unemployment. If technology were dominating, income trends, inequality, and return to education in Denmark should be more like in USA, UK, and other countries. Denmark is as open to foreign trade as other small affluent societies, and much more open than USA. Technology available in USA and UK are also available in Denmark, and it can be used if it improves productivity and rises income. In addition, nothing prevents high educated Danes from leaving the public sector, starting high-tech export businesses in order to rise their level of income. Almost the opposite, however, is revealed by data: Danish exports preformed relatively well from 1980 to 1992 with the use of primarily low and medium educated labour. On the other side of the same coin: Nothing prevents importers from importing goods from foreign low-wage firms, and nothing prevent Danish firms from out-sorting low-skill production to other countries. Data reveals that they don't.

In this study *no formal education* include all Danes who did not complete formal education after mandatory school/high school and they were also named *low-skilled* or *un-skilled*. These labels are strictly relative to other Danish educational groups. Within the group of Danes with no formal education there are large differences in real human capital. Most Danes with no formal education know very well to read, write, do arithmetic, operate computers, and many of them speak foreign languages. The fact that they perform better on the labour market than their US and UK counterparts may indicate that Danish mandatory schools/high school do better than the US and UK schools. It may be the educational achievements at the bottom of the distribution that count, as also indicated by Nickell and Bell (1996) in a comparison of US/UK wages and employment to their German counterparts. This however, is an issue beyond the scope of this study.

Inequality in US compared to Europe especially goes for the bottom of the distribution; lower 10 percent compared average (Blau & Kahn 1996). As more than 40 percent of all 15-59 year old Danes (excl. students and pupil) belong to the group with *no formal education* it may be

within this group we should look tendencies toward lower wages, crowding out due to foreign competition and/or technology. However, people with *no formal education* are definitely **not** more sheltered than the high educated in the large public sector in Denmark.

In an attempt to: *Explaining International and Intertemporal Variations in Income Inequality*, Li, Squire and Zou (1998) find that initial equality affects the political economy. It could be preventing the rich from lobbying in favour of for their own interest alone, like low taxes and high quality pay-schools for their own children. Moreover efficient capital market makes it possible for all talented people to undertake productive investment such as education, and capital markets are likely to be effected by initial equality. In Denmark mandatory schools / high schools have the same (high) standard all over the country. Vocational education as well as further education are available for all. High income, high equality economies are reproducing themselves both through the political system and through the capital market. In a theoretical framework the latter is also shown by Chiu (1998). Persson (1995) shows that if pre-tax wage inequality is low, all agents will unanimously be in favour of tax on labour income, and there will be a tendency for taxes to be high. This most indeed goes for Denmark. Moreover, as shown by Evans and Karras (1994) for 48 U.S. states, public educational services are productive to the private sector.

Litterature

Ashenfelter, Orley & Cecilia Rouse (1998): Income, Schooling and Ability: Evidence from a new Sample of Identical Twins. *The Quarterly J. of Economics* February 1998.

Belzil, Christian & Jørgen Hansen (1997): *Estimating the Returns to Education from a Non-Stationary Dynamic Programming Model*. Working Paper 97-06, Centre for Labour Market and Social Research, Aarhus.

Blau, Francine D. & Lawrence M. Kahn: International Differences in Male Wage Inequality: Institutions versus Market Forces. *J. of Political Economy* Vol. 194 no. 4.

Chiu, W. Henry: Income Inequality, Human Capital, Accumulation and Economic Performance. *The economic Journal* 108 44-59.

Davis, Donald R. (1997): Critical Evidence on Comparative Advantage? North-North Trade in a Multilateral World. *J. of Political Economy* vol. 105 no 5.

Evans, Paul & Georgios Karres (1994): Are Government Activities Productive? Evidence from a Panel of U.S. states. *The Review of Economics and Statistics*. Vol LXXVI no 1.

Fitzenberger, Bernd (1997): Aussenhandel, Technischer Fortschritt und Arbeitsmarkt in Westdeutschland von 1975 bis 1990. *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 3/99.

Gundlach, Erich (1997): *Human Capital and Economic Development: A Macroeconomic Assessment*. Intereconomics, Vol. 32 no 1.

Groes, Nils (1982): *Fleksibiliteten på arbejdsmarkedet. Oplæg til undersøgelser af arbejdskraftens fleksibilitet betinget af uddannelse*. Modelpapir nr. 12. Danish Institute for Border Region Studies.

Groes, Nils, Anders Holm & Torben Tranæs (1994): A Forecast Model for Unemployment by Education. *Labour* 8 pp. 317-330.

Hansen, Christian (1993): *Uddannelse som produktionsfaktor. Formelle uddannelsers betydning for økonomien i 1980'erne*. Danish Institute of Border Region Studies and University of Copenhagen.

Hansen, Christian (1994): Formelle uddannelsers betydning for Danmarks internationale konkurrencedygtighed. *Nationaløkonomisk Tidsskrift* 132: 299-317.

Hansen, Christian & Mads Jacob Norup Grønnet Hansen (1998): *Fremtidens arbejdskraftbehov i Sønderjylland*. Danish Institute of Border Region Studies.

Hansen, M.J.N.G. (1998): Estimating and Forecasting the Labour Market Imbalance by Education for the County of South Jutland. *Paper to ERASs 38th Congress*.

Helpman, Elhanan & Poul R. Krugman 1985: *Market Structure and Foreign Trade. Increasing Returns, Imperfect Competition, and the International Economy*. MIT

Kim, Sukkoo (1995): Expansion of Markets and the Geographic Distribution of Economic Activities: Trends in U.S. Regional Manufacturing Structure, 1860-1987. *The Quarterly J. of Economics* Vol CX:4.

Hummelgaard, Hans & Leif Husted (1994): *Den ulige indkomstfordeling*. AKF-Nyt nr. 2. Copenhagen.

Krugman, Poul (1991): *Geography and Trade*. MIT.

Krugman, Poul (1996): *Pop Internationalism*. MIT.

- Leamer, Edward E. 1980: The Leontief Paradox Reconsidered. *J. of Political Economy*, Vol. 88. No. 3.
- Leamer, Edward E. (1984): *Sources of International Comparative Advantage*. MIT.
- Leamer, Edward E. (1996): Wage Inequality from International Competition and Technological Change: Theory and Country Experience. *The American Economic Review* Vol. 86 no. 2.
- Leamer, Edward E. & Harry P. Bowen (1981): Cross-Section Test of the Heckscher-Ohlin Theorem: Comment. *The American Economic Review*. Vol 71, no 5.
- Li, Hongyi, Lyn Squire and Heng-fu Sou: Explaining International and Intertemporal Variations in Income Inequality. *The Economic Journal* 108. 26-43.
- Lücke, Matthias (1996): *Has Trade with Low-Wage Countries Hurt Unskilled Labour in West Germany?*. Kiel Institute of World Economics.
- Nickell, Stephen & Brian Bell (1996): Changes in the Distribution of Wages and Employment in OECD Countries. *The American Economic Review* Vol. 86 no. 2.
- Ramazani, Reza M. & Keith E. Maskus (1993). A Test of the Factor Endowments Model of Trade in a Rapidly Industrializing Country: The Case of Korea. *The Review of Economics and Statistics*.
- Pedersen, Peder J (1996).: *The Nordic Labour Markets in an International Perspective*. In: Wadensjö (ed): The Nordic Labour Markets in the 1990's. North-Holland.
- Pedersen, Peder J. & Nina Smith (1997): *Trends in Danish Income Distribution 1976-90*. Working Paper 97-11CLS, Aarhus.
- Persson, Mats (1995): Why are Taxes so High in Egalitarian Societies?. *Scand. J. of Economics* 97 (4).
- Reich,, Robert B. (1993): *The Work of Nations*. Simon&Schuster, London
- Richardson, J. David (1995): Income Inequality and Trade: How to Think, What to Conclude. *J. of Economic Perspectives* Vol.9 No. 3.
- Stewart, Mark (1996): *Nordic Wage Differentials: A View from Outside*. In: Wadensjö (ed): The Nordic Labour Markets in the 1990's. North-Holland.
- Westergaard-Nielsen, Niels (1996): *Introduction to Wage Differentials in the Nordic Countries*. In: Wadensjö (ed): The Nordic Labour Markets in the 1990's. North-Holland.
- Wood, Adrian (1994): *North-South Trade Employment and Inequality. Changing Fortunes in a Skill-Driven World*. Clarendon Press. Oxford.
- Wood, Adrian (1995): How Trade Hurt Unskilled Workers. *J. of Economic Perspectives* Vol.9 No. 3