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Abstract

For years, Denmark has maintained and developed its apprenticeship system which is comparable to the German system. Today, about 40% of the youth cohorts get apprenticeship training. The paper describes the basic functioning of the labour market of apprentices. It is initially shown how the wage and unemployment rates of skilled workers who have served an apprenticeship differ from those of non-skilled workers. In recent years there have been periods with serious mismatches between the demand for and the supply of apprenticeships. Through the 80's subsidies were introduced to overcome this shortage. The main purpose of this paper is to investigate the possible impact of these subsidies. A unique longitudinal data set that enables us to follow 1000 work places from 1980 to 1991 is applied. This makes it possible to control for observed and unobserved work place effects. The estimates show that the subsidies have had an impact on the supply of places in some industries while others are not affected at all. The total effect has been compared to the costs and it is found that the total costs per extra apprenticeship is about 54,000 DKK. Finally, the results are used to simulate the effects of changing the subsidies.

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1. Introduction

For a long time, Denmark has had a well-organized apprenticeship system. To a large extent, the institutional arrangement is comparable with the apprenticeship system in Germany, see Blechinger and Pfeiffer (1996). The apprenticeship system has traditions that are rooted in the old guild system, it is widely accepted and serves as the most common general vocational training system of the private labour market. The apprenticeship system undoubtedly has a large impact on the quality and productivity of workers and on the rate of youth unemployment.

One of the features of the present Danish apprenticeship system is the dual system of vocational schools and practical training. Nowadays, an apprentice starts with one year at a vocational school. After that he or she has to find an employer who is willing to employ them as apprentices. Since there is almost free admittance to the vocational schools and since most of the apprenticeships are provided by normal profit maximizing firms, the Danish apprenticeship system has in recent years experienced mismatch problems in providing enough apprenticeships. Various schemes of subsidies have been tried in order to make more companies employ apprentices.

In this paper, we have presented a general description of the Danish version of the apprenticeship system. We have investigated what is to be gained with respect to income and employment by completing an apprenticeship compared to remaining unskilled. We have also looked at the demand side factors that might make the employers hire apprentices. Finally, we have estimated a demand function for new apprentices which indicates the effect of the subsidies applied. First, the demand function is estimated as a cross section model as is commonly done. Secondly, we have utilized the panel structure of data to take account of unobserved establishment heterogeneity including a random effect. Finally, we have used the model to analyze the effect of the subsidy, that is, how many extra apprenticeships were created because of the subsidy.

2. The Danish apprenticeship training system

In the old days, apprenticeship training was organized as a master training with the guild controlling the quality. In the beginning of this century, this scheme was supplemented with

periods of vocational school training, where the apprentices were introduced to more theoretical subjects along with new methods and materials. This has gradually become more formalized and more and more emphasis has been put on formal education.

Today, the training starts with one year of basic training at a vocational training centre. To a high extent, this training is a continuation of elementary school but with more emphasis on the practical sides, although it also contains classes in Danish, English and Mathematics. After the first introductory year, the “pupils” are expected to find themselves a company that will employ them as an apprentice; this usually takes 2 to 3 years depending on the field. During the whole practical training period, there are a number of short periods, where the apprentice goes to a vocational school and is trained within his/her special subject. The number and length of the periods and the subject depends fully on the field. Carpenters for example take training at schools for the wood industry, plumbers and auto mechanics at the metal schools, while clerical workers take computer and book keeping courses at special schools.

The curriculum for different apprenticeship training schemes are put together centrally by a board of representatives for the associations of masters, trade unions, the vocational schools and the Ministry of Education. Each trade has its own board. The quality of the training is supervised by regional bodies consisting of masters from the guild, employers' representatives, trade union representatives and teachers from the training centres.

Apprentices get a wage, which starts out at a level of about 40% of the wage of a skilled worker. This salary increases throughout the apprenticeship period, so that the average pay for apprentices is about 50% of that of adult workers. The wage level of apprentices is negotiated together with the normal wage contracts of the area.

3. General school levels and apprenticeships

Elementary school now consists of 1 year of nursery class, 9 years of elementary school and an optional 10th year. In 1972, compulsory school attendance was increased from 7 to 9 years. The youth educations are divided into high school and vocational educations. High school consists of 3 years of general education qualifying the pupils for university.

The proportion of the population who has served a full apprenticeship (and where this is his/her highest education) is around 30%. This has been slightly increasing over the investigated period from 1981 to 1990 when looking at the age group 16-60. In the age group 25-30 the increase has been more than 10 percentage points, see Table 1.

Table 1. Highest obtained educational level in selected years and age groups.

	Age group 16-60		**Age group 25-30**	
Year	1981	1990	1981	1990
7thgrade (%)	30,52	17,73	15,62	
8th grade (%)	2,54	1,83	4,08	
9th grade (%)	5,2	8,54	7,52	12,39
1st year of vocational training (%)	10,98	15,08	14,99	18,46
10th grade (%)	0,9	1,54	1,16	1,68
High school drop-outs (%)	0,4	1,37	0,49	0,98
Apprenticeships (%)	30,48	32,5	30,03	41,01
High school (%)	5,97	6,48	7,97	10,3
Non-university college (%)	5,39	4,78	8,34	5,74
BA (%)	4,58	6,4	5,56	5,74
MA (%)	3,05	3,75	4,24	3,71
Number (total)	28905	22204	3482	4882

The general level of education for skilled workers who have served a full apprenticeship to their trade is graphed in Figure 1 for the investigated period.

Figure 1. General level of school education among blue collar skilled workers (with completed apprenticeships), (age 16-60) 1980-1990.

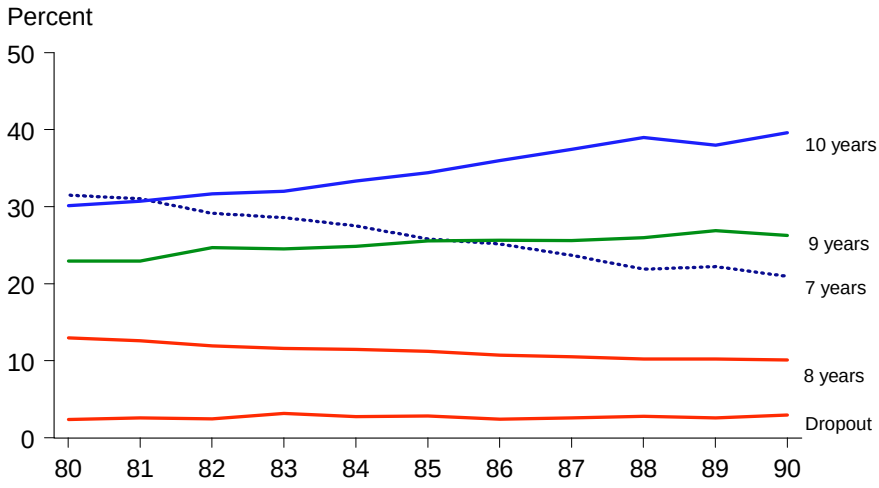
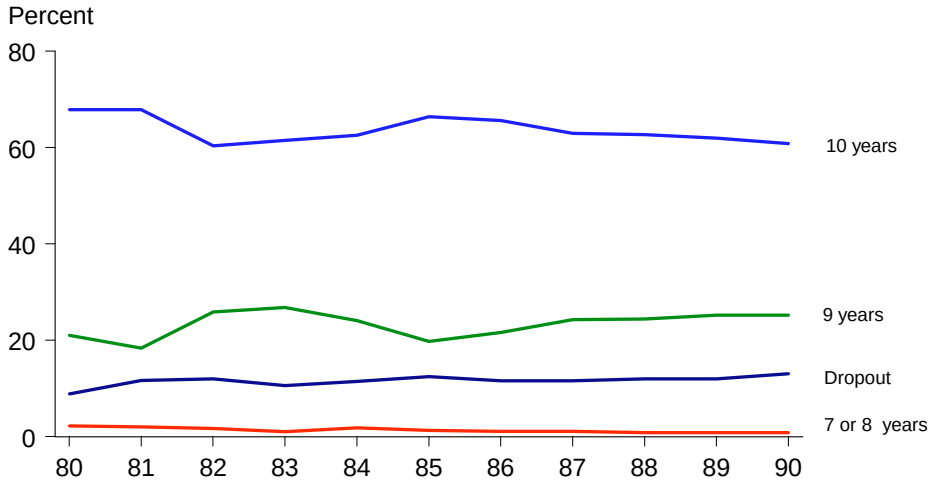


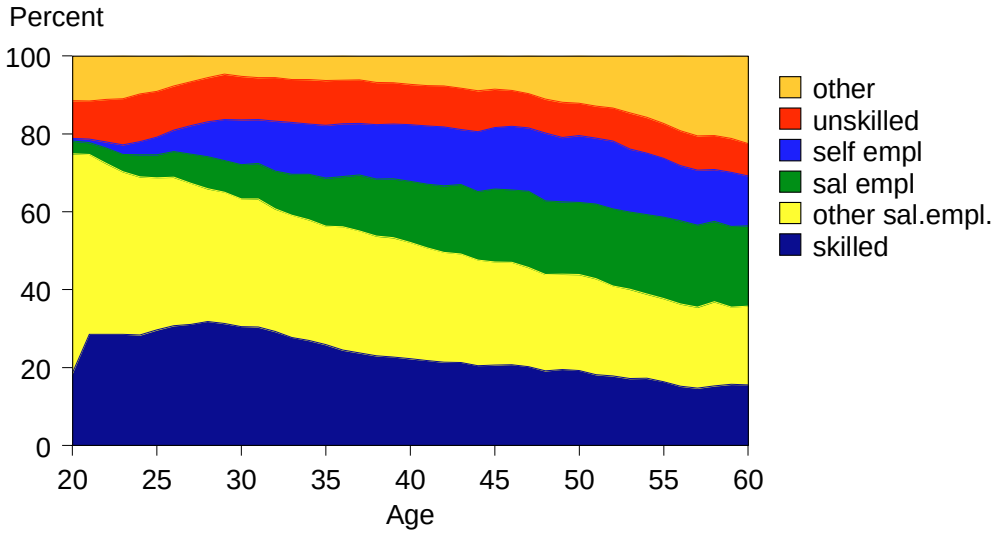
Figure 2. General level of education among people in ongoing apprenticeship training,1980-1990.



The majority of those working as skilled workers has 9 years or less of elementary school, whereas the majority of the younger cohorts in apprenticeship training has 10 years of elementary school. Furthermore, it can be seen that there is a tendency towards spending more years on general education before starting in apprenticeship training.

Another issue is; what do apprentices do after they have completed their apprenticeship? In Figure 3, we have depicted the occupations of people who have completed their apprenticeships across their age. The figure shows that the majority, i.e. 75% starts as skilled workers or as clerical workers (white-collar workers). At the age of 45, there are only 50% left who are still working as skilled workers. About 10% start working as unskilled workers while another 10% start in unspecified occupations. The proportion who become self- employed increases slowly with age and from the age of 32 about 10% are self-employed. This number increases only slightly over the following age groups. It is also found that a percentage increasing with age become white-collar workers with higher charges. Thus, it can be concluded that apprenticeship training leads to a wide range of different careers.

Figure 3. Occupational status for persons who have served a full apprenticeship. Pooled cross section1980-1990.

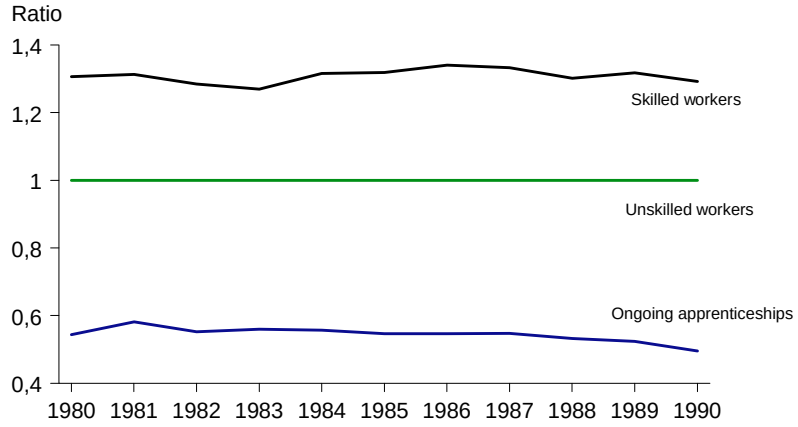


4. The economic incentives for taking apprenticeship training.

In this part, we will investigate the economic incentives for blue-collar workers to serve an apprenticeship[1]. The alternative to apprenticeship training for this group of workers is normally a career as an unskilled worker or getting an education. As we have seen, both careers may lead to other job types. In Figure 4 below, we have first compared the average real yearly wage for an apprentice as opposed to the wage of an unskilled blue-collar worker and that of a skilled worker only looking at those who maintain their status as skilled and unskilled workers. Thus, we have excluded the rather large fraction of white-collar apprentices and have furthermore selected the group of former apprentices who remain skilled workers compared to those who remain unskilled workers. The figure shows that in general the wage of an apprentice is less than 60 percent of that of an unskilled worker and less than 50 percent of that of a skilled worker. It also shows that the apprentice receives relatively less compared to the unskilled worker after 1987. In 1981, the wage for an apprentice amounted to 58 percent of the wage of an unskilled worker, but this percentage was reduced to less than 50 in 1990. In Germany, the wage of an apprentice is approximately one third of that of an unskilled worker (Soskice, 1994).

[1] For simplicity this part of the analysis is only done for blue collar workers.

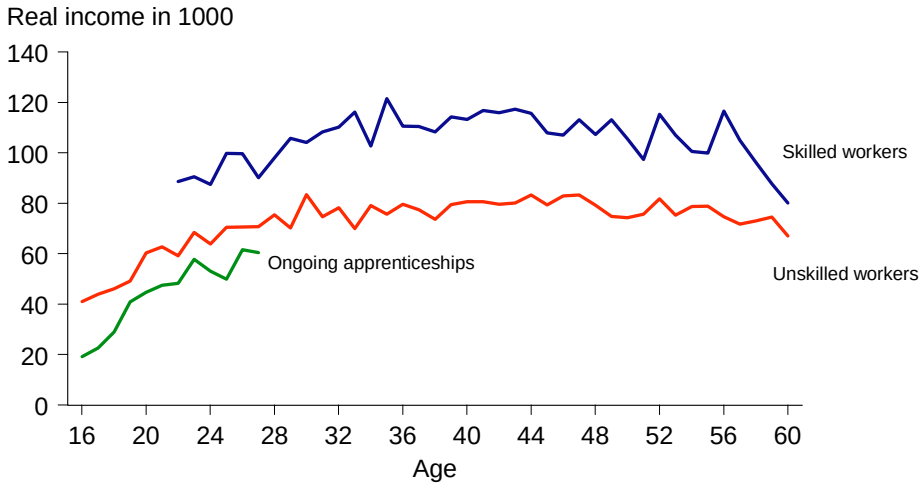
Figure 4. Average real annual income for skilled, blue-collar workers, unskilled workers and apprentices, 1980-1990. (1980 prices)



The wage of skilled workers amounts to 130 percent or more than that of an unskilled worker. This ratio appears to follow the business cycles; the largest ratio is in 1986 where the number of unemployed reaches a minimum and the smallest ratio is in 1983 where the unemployment rate is high.

The income to be gained by serving a full apprenticeship is between 25 and 30 percent of the income of workers with no apprenticeship training and is illustrated as the difference in income profiles in Figure 5 where the wage is plotted against age for apprentices, skilled workers and unskilled workers in 1985.

Figure 5. Earnings profiles for blue-collar skilled workers, unskilled workers and apprentices in 1985. (1980 prices)



Apprentices are seen to start with a total wage way below the wage of unskilled workers. Having served the apprenticeship and working as skilled worker the wage is found to be about

40% above the wage of unskilled workers. Both the profile for skilled and unskilled workers have the typical inverse u-shape.

However, this comparison does not take differences as regards other factors into account. The most important omission is undoubtedly the fact that the category of unskilled workers consists of a high proportion of females earning a low wage, while there are only a few females among the skilled workers. In the following, we have applied an OLS regression to control for these other factors. The log real wage for blue-collar skilled workers and unskilled workers is regressed on experience, experience squared, skill, gender, general educational level and the interaction between these and industry dummies. EXP is a variable which measures the true experience on the labour market[2]. SKILL is a dummy variable taking the value 1 for skilled workers and 0 for unskilled workers. An interaction term including SKILL and EXP is allowed to pick up any differential pay over the working career. TENYEAR and DROPOUT are two dummies that identify the obtained general level of education; the former takes the value 1 if the highest obtained general level is 10 years; the latter takes the value 1 if a person is a high school dropout. The school dummies interacted with SKILL identify a potential difference in the importance of a high level of general education in the two careers.[3] Year dummies with 1985 as the basic year are included in the regression. These are, however, not reported. The data come from a sample of the Danish Longitudinal Labour Market Register, which is based on administrative register data[4]. The result of the wage regression is reported in Table 2.

The most important factors are that skilled workers have a 9 to 13% higher wage than unskilled workers. The SKILL coefficient increases when including industry dummies. Experience (EXP) has a positive influence on the wage, less for skilled workers than for unskilled workers, with a decreasing differential. The industry variation shows higher wages for manufacturing (left out category) and lower wages for construction and trade.[5]

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[2] Unlike most other data on experience this measure is based on true experience measured in time units according to a compulsory pension system.

[3] SKILLTENYEAR, skilled and ten years of education and SKILLDROPOUT, skilled and dropped out of gymnasium (high school).

[4] The Danish Longitudinal Labour Market Register covers a random 5% sample of the Danish population. A 20% sample (.5% sample of the population) has been used for the analysis. (See Westergård-Nielsen, 1984).

[5] Asplund et al. (1996) report lower relative return to skilled training mainly because the low paid white collar workers are included as well.

It is seen that skilled workers with a ten year school education receive about 4.5% lower salary than skilled workers without a 10 year school education. This is partly a cohort effect but it may also be a negative selection effect.

Table 2. Wage regression for blue-collar skilled and unskilled workers. Pooled regression, 1980-91. (Dependent variable: ln(hourly real wage rate).

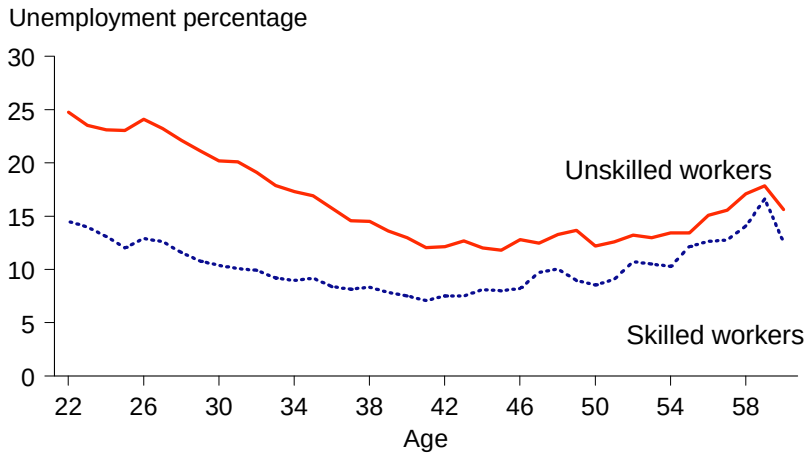
	Parameter estimate	Std error	Parameter estimate	Std error
INTERCEP	**10,4990**	0,0117	**10,5383**	0,0118
SKILL	**0,0924**	0,0144	**0,1273**	0,0144
SKILLEXP	**0,0137**	0,0017	**0,0132**	0,0017
SKILLEXP2	**-0,0004**	0,0001	**-0,0005**	0,0001
EXP	**0,0580**	0,0010	**0,0575**	0,0010
EXP2	-0,0011	0,0001	**-0,0011**	0,0001
MALE	**0,3077**	0,0060	**0,3112**	0,0062
TENYEAR	0,0924	0,0850	**0,0923**	0,0084
DROPOUT	0,0017	0,0158	0,0106	0,0158
SKILLTENYEAR	**-0,0458**	0,0118	**-0,0472**	0,0118
SKILLDROPOUT	-0,0348	0,0279	-0,0460	0,0278
MINING			0,0130	0,0475
HEAT			0,0034	0,0212
CONSTRU			**-0,1350**	0,0065
TRADE			**-0,1052**	0,0066
TRANSPORT			-0,0004	0,0087
BANK			**-0,0705**	0,0134
OTHER			**-0,1369**	0,0114
N	66153		66153	
R^2 (adj)	0,1993		0,2073	

Note: Coefficients in **bold** are significant at a 5% level.

5. Differences in unemployment

Another argument in favour of apprenticeship training is that skilled workers are less likely to become unemployed compared to unskilled workers. In Figure 6 we have plotted the age specific unemployment degrees for skilled and unskilled workers. Skilled workers are found to experience less unemployment than unskilled workers. Unemployment is here measured as the percentage of a working year spent being unemployed.

Figure 6. Age specific unemployment for skilled and unskilled workers, 1980-1990.



To take other factors into account Table 3 reports the result from a Tobit regression where the individual degree of unemployment during the year[6] is explained by the same variables as in Table 2.

As was expected, skilled workers are less likely to become unemployed even when we take account of a number of explanatory factors. The estimates show that the expected unemployment is about 5 percentage points lower for the skilled workers with all other characteristics equal. The gap is found to decrease slightly with experience. Blechinger and Pfeiffer (1996) report a gap of about one percentage point for Germany when measured at the aggregate level.

Thus, we can see that skilled workers do get a higher wage and are less unemployed than unskilled workers. From other Danish studies we know that they also tend to stay longer on the labour market than unskilled workers.

[6] Degree of unemployment is defined as the number of unemployed days divided with the normal number of working days in that calendar year. Thus, the measure accumulates all spells in a year.

Table 3. Unemployment regression estimates (Tobit) for blue-collar skilled and unskilled workers. The proportion of the year spent as unemployed.

	Parameter estimate	Standard Error	Parameter estimate	Standard Error	Marginal effect	Standard Error
INTERCEPT	**0,2319**	0,0081	**0,2349**	0,0081	**0,1780**	0,0062
SKILL	**-0,0211**	0,0107	**-0,0643**	0,0107	**-0,0489**	0,0221
SKILLEXP	**-0,0088**	0,0012	**-0,0087**	0,0012	-0,0066	0,0050
SKILLEXP2	**0,0003**	0,0000	**0,0003**	0,0000	**0,0002**	0,0000
EXP	**-0,0231**	7,0000	**-0,0231**	0,0007	**-0,0175**	0,0007
EXP2	**0,0003**	0,0000	**0,0004**	0,0000	**0,0003**	0,0000
MALE	**-0,0476**	0,0041	**-0,0831**	0,0042	**-0,0630**	0,0035
TENYEAR	**-0,0559**	0,0057	**-0,0538**	0,0056	**-0,0408**	0,0044
DROPOUT	**-0,0943**	0,0120	**-0,0903**	0,0119	**-0,0684**	0,0093
SKILLTENYEAR	-0,0150	0,0084	-0,0061	0,0083	-0,0046	0,0065
SKILLDROPOUT	**-0,0667**	0,0220	**-0,0633**	0,0216	**0,0480**	0,0168
MINING			**0,0727**	0,0333	**0,0551**	0,0250
HEAT			**-0,2149**	0,0206	**-0,1628**	0,0155
CONSTRU			**0,2027**	0,0044	**0,1536**	0,0031
TRADE			-0,0009	0,0048	-0,0007	0,0036
TRANSPORT			**-0,0192**	0,0065	**-0,0145**	0,0049
BANK			**0,0372**	0,0100	**0,0282**	0,0074
OTHER			0,0157	0,0086	0,0119	0,0065
N	58144		58144			
Sigma	**0,3428**	0,0016	**0,3359**	0,00161		
Log L	-27734,5		-26442,7			

Note: Coefficients in **bold** are significant at a 5% level.

6. The Demand for Apprentices

The motives for employers to employ and train apprentices can be summarized in the following four divisions: First, the relative cost of employing apprentices may be sufficiently low compared to the productivity and compared to other types of labour. The produced surplus may make it profitable to employ and train apprentices. This mechanism probably depends on the production function of the company, so that some companies with given factor prices will choose a production function that allows more apprentices than others.

Secondly, employing apprentices secures the recruitment of the future skilled labour force. The company could, however, cover the need for skilled workers by hiring when they have the need to and let others train them. Half of all firms actually do that. Two reasons for hiring anyway can be mentioned: Even though the apprentice training has a large element of general

training there is also a certain element of specific training involved. Through the apprenticeship programme, the firm obtains this training for a relatively low price.

Thirdly, a certain flow of apprentices through the company allows the company to monitor the apprentices and to pick the best ones and offer them a career in the company. If the company has high hiring rates or high exit rates and high growth we expect it to recruit more apprentices to meet future demands for personnel. This also means that positive business cycles will have a positive effect on the recruitment of apprentices as well.

Forthly, firms may feel an obligation to provide apprenticeships as part of a mutual responsibility for the future of the trade.

In all cases, subsidies will help increase the number of hired apprentices: It makes apprentices relatively more competitive compared to other groups, and it makes it less costly for firms to use apprentices to improve or facilitate their recruitment of new workers.

7. Subsidies.

Since 1977, subsidies have been used to compensate the employers for the time the apprentices spend attending school. Otherwise, employers would have an incentive to limit the so-called school periods during the “master training period”. As described above apprenticeship training has for a long period of time been organized as a mixture of courses at vocational training schools and the more old-fashioned master training at workplace level (the so-called dual principle). The wage system covers the master training periods as well as the periods of school attendance. Since 1977, there has been a subsidy for all employers who employ apprentices so that the subsidy partly covers the wage during periods of school attendance. The subsidy is designed to cover about 70% of the wage costs during school periods, and it is financed via a tax on all employers according to the number of employees irrespective of how many skilled workers they have. The education at the vocational schools is free of charge, which means that it is paid by the State. The effect of this arrangement is that to some extent the general training element is subsidized by the State and by all employers even though the employer’s tax is not addressed directly to those employers who benefit most from employing skilled, trained workers.

In certain periods during the 1980s, there has been a shortage of apprenticeships for the students who finished their first year of vocational school. The reason for this gap is that the mechanisms that determine the supply are different from the determinants of demand for apprenticeship training places, and there is no equilibrating mechanism. Thus, the number of training places is determined by the establishments based on an economic calculus of the firm where the business cycles plays a certain role together with other factors. On the other hand, the demand for apprenticeships is determined by the size of the relevant birth cohort and possibly also by the "taste" or economic conditions for manual training compared to no education or other types of education. It has been claimed (Albæk, 1988) that the shortage of training places was created by a relative increase in the wage of apprentices compared to unskilled workers. On the basis of times series, Albæk, 1988, has also claimed that already the first wave of general subsidies to school periods introduced in 1977 has resulted in higher wages for apprentices as a result of the general wage negotiations. Compared to the German apprentices the Danish apprentices have since the late 60's increased their wage share compared to adult workers. Where the share was about 20% in the 50's and 60's, it had risen to about 40% in the beginning of the 80's. The subsidy helped lowering the costs.

The increased wage level has undoubtedly contributed to the shortage of apprenticeship places that appeared in the trough of the cycle. Different subsidy schemes have been tried during the 1980s to overcome these shortage problems: From 1978, county administrations had the possibility of giving firms an hourly subsidy of 10 DKK per hour they employed an apprentice with a maximum amount of 15,000 DKK per apprentice. In 1980, the hourly rate was increased to 11 DKK per hour (about 38% of the salary per hour for apprentices) and the maximum to 16,000 DKK. But this subsidy was only used in a few cases. In 1982, the subsidy structure was changed and was now given to all firms who maintained or increased the number of apprentices.

From late 1982 to 1986 there was a Government financed subsidy of 30,000 DKK for each marginal apprentice (in 1982, this was about 18% of the salary per hour for apprentices) provided that it was a maintenance of the total number of apprentices at establishment level or that it was a net growth, in both instances compared to the average number of apprentices over the last two years. In 1984, financing the subsidy was completely levied on the employers. Each employer paid a tax according to the number of employees. For short apprenticeships, than can be found mainly within restaurants and office, the subsidy was only 18,000 DKK.

The subsidy was halved for all new apprentices from January 1, 1986 (and now made up about 8% of the salary per hour for apprentices) and was completely abolished at the end of 1987. For a short period in 1989 (September 15 to December 31) there was a smaller subsidy that varied with the length of the apprenticeship training and with the length of the periods of school attendance. This subsidy is presumed not to have any substantial effects until the next observation point in November 1990 because it was introduced so late that the employers have not yet reacted in November 1989. This is supported by monthly statistics on new apprenticeships.

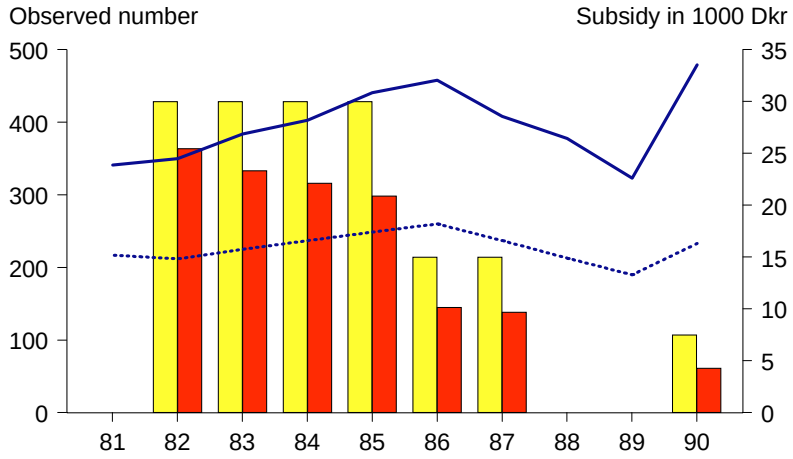
In 1990, the shortage problem was dealt with in a completely different manner. Now the government guaranteed apprentices that could not find a trainee job that they could be trained at a vocational school. This arrangement was financed through a tax levied on all employers. A similar model had been used in West Germany. Due to the high costs per apprentice trained and some doubts about the relevance of school attendance, subsidies for normal training were reintroduced in 1993. At that time, the subsidies were given to all new apprentices and not only to the marginal group in order to simplify the incentive structure for employers. The intention was to make it more attractive to hire ordinary apprentices and thus compete with the use of the overly expensive vocational training schools. That worked to a large extent, but the vocational training schools are still being used and are now a place for those young people who still cannot find an ordinary apprenticeship mostly because of personal appearance, foreign origin etc. or other discriminating factors. Unfortunately, we do not yet have data for this period.

The subsidies described above are summarized together with the number of new apprentices in Figure 7.

When comparing Figure 7 with Figure 4, it is evident that the net cost of employing an apprentice is highly dependent on the subsidy.

For the subsequent analysis of the determinants for the number of apprentices, we will use a different data set that allows us to study the demand for apprentices using panel data on establishments

Figure 7. The potential subsidy per marginal apprentice in real terms (black bars) and nominal terms (shaded bars) and the number of new apprenticeships (line) and plants with a new apprentice (dotted line), 1981-1990.



Note: A new apprentice is defined as an apprentice present in time t and not present in time t-1.

8. Data

The analysis in this chapter is based on a sample from IDA (Integrated Database for Labour Market Research) created by Statistics Denmark. The information comes from various administrative registers that are merged in Statistics Denmark. The specific feature of IDA is that it is possible to associate work places with the identity of all employees at a specific time of the year. Information on these individuals can then be retrieved from the administrative registers and merged. In that way it is possible to get an impression of the characteristics of the entire work force at all work places and to follow workers and work places over time. The information on employees is very comprehensive and contains data on wage rates, number of hours worked, experience, unemployment, demographic variables, education, ongoing information, region, occupation, etc. The information on work places consist of 3 digits of the industry code, (ISIC), composition of work force, total employment over the year, and region. For a more detailed description of IDA, see Leth-Sørensen (1995).

For this study, a sample of 1000 work places and all of their employees has been constructed. The 1000 work places have been chosen randomly among non-public work places with more than 5 and less than 500 employees in 1980 (due to confidentiality concerns). (Bingley and Westergård-Nielsen, 1996 and Albæk and Sørensen, 1995 have used similar data, even though the latter have looked at the manufacturing industry at work place level.). In the subsequent years these establishments have then been followed for as long as they exist. In order to maintain the representative nature of the selection of establishments, the sample has been

supplemented with a sample of new establishments according to the birth rate of new establishments. Bjørn (1992) uses also IDA data to analyze the demand for apprentices for the period 1980-87.

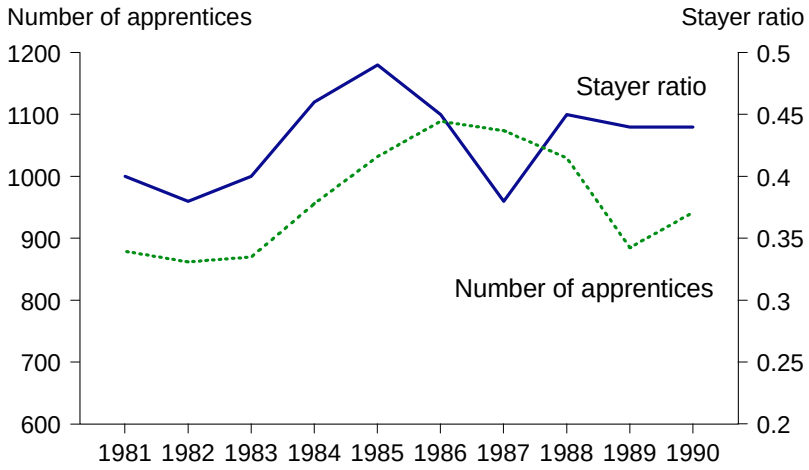
The sample used in this paper has been limited with respect to industry since the educational structure for apprentices is not the same in all industries. Firms belonging to farming, telecom, public administration and teaching institutions have therefore been removed from the sample.

The term *ongoing apprenticeship* is well defined in the educational register in Statistics Denmark. This means that the person has passed an examination after the first year of introductory vocational school, and is now under the supervision of a master and taking supplementary courses at a vocational school. All statuses are measured in a specific week in November.

9. Mobility of apprentices on completion of training

It has often been claimed that masters tend to fire apprentices as soon as they receive their certificate of completion and only keep very few of them. Using the plant level data we are able to follow individual apprentices and their employing plants over time. Figure 9 shows the stayer ratio defined as the ratio of staying apprentices to the number of finished apprentices. Staying is here defined as staying in the same establishment at least one year after completion of the apprenticeship.

Figure 8. The stayer ratio among finished apprentices (full line) and total number of ongoing apprenticeships (dotted line), 1980-1990.



The stayer ratio is found to vary between 40% and 50% depending on the business cycle. This may seem low, but is almost in line with an overall figure for Denmark of 71% for all age groups and about 60% for the young age groups (Bingley and Westergård-Nielsen, 1996). Furthermore, it is seen that the gradually improving business conditions in 1983-85 seem to increase the stayer ratio at first. Later when we approach the top of the business cycle in 1986-87 the stayer ratio drops, probably because the number of attractive job alternatives increase at the peak of the business cycle.

10. Estimation of a Demand Function for Apprentices

In this section, we will estimate a function describing the number of new apprentices hired. We will in particular investigate the role of subsidies along with the relative price of apprentices, the business conditions and hiring policies of the firms[7].

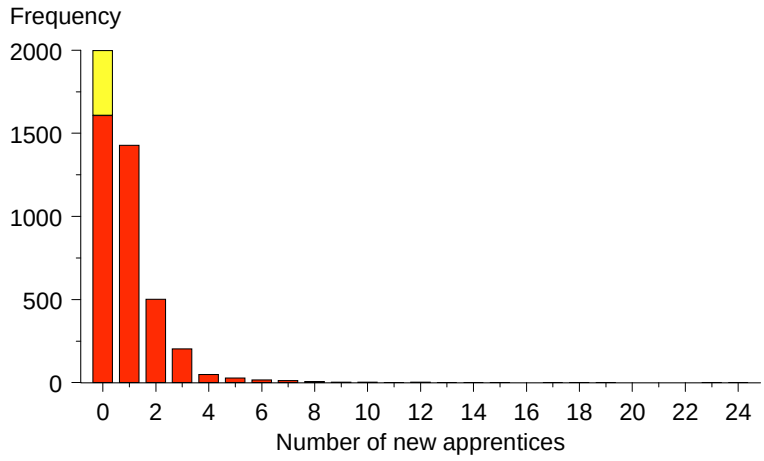
For the estimation we use a subsample of the data where we look only at plants that have employed apprentices during the period 1980-1991. Arguments about technology suggest that some plants may not be able to employ apprentices at all, this may be the case in industries where there is no tradition for apprentices and where there may not be any appropriate apprentice training at all. That restriction leaves us with a total of 720 plants that have all had an apprentice at some point in time.

The specification of the demand function depends on the nature of the dependent variable - the number of new apprentices. The definition of a new apprentice used in this paper is an apprentice who is present in time t and not present in time t-1. The observed frequencies of new apprentices reported in Figure 9 identify a count data process. The Poisson regression model is therefore used to estimate the demand function.[8]

[7] Given the marginal nature of the subsidy, the optimal behaviour of establishments is obviously quite difficult to model. In addition to this, the subsidies have been changed so many times that it is not very likely that the firms will adjust efficiently and fully to these changes. Consequently, we have estimated the true model as a reduced form equation.

[8] Ordered probit models have also been estimated with almost the same results.

Figure 9. Observed frequencies for number of new apprentices.



Note: The frequency of number of new apprentices larger than 8 is very small. It is therefore not possible to spot these observations in the graph. Because the sample has been limited to firms who have employed an apprentices at least once during the observed period, we have removed a number of observations with 0 new apprentices (this is illustrated by the light bar on top of the dark bar in the graph).

For the discrete random variable Y, and observed frequencies, y_i, and regressors $\mathbf{x}_i$ the Poisson model is given as

$$\Pr(Y = y_i) = \frac{\exp(-\lambda_i)\lambda_i^{y_i}}{y_i!}, \qquad y_i = 0, 1, 2, ...,$$

(1)

where λ_i is the mean and the variance of y_i - see (3). The interpretation of λ is the number of occurrences per time unit, in this case the number of new apprentices per year. A more convenient formulation of λ is

$$\ln \lambda_i = \beta' \boldsymbol{x}_i \tag{2}$$

From (2) it follows that

$$E\left[y_i \mid \boldsymbol{x}_i\right] = Var\left[y_i \mid \boldsymbol{x}_i\right] = \lambda_i = \exp\left(\beta' \boldsymbol{x}_i\right) \tag{3}$$

A problem often encountered in the estimation of Poisson models is that the mean and the variance differ - this phenonemom is known as overdispersion[9]. We observe a mean of 1.02 and

[9] For a more detailed description of overdispersion and how to test for overdispersion see Cameron and Trivedi (1990). We have tested for overdispersion and the two possible tests give different results.

a variance of 2.46, but because of the two conflicting test results we have chosen not to take over dispersion into account in our estimations.

Furthermore, we can utilize the panel structure of our sample and estimate a random effect Poisson model. This allows for plant specific effects denoted u_i

$$\ln \lambda_i = \beta' \boldsymbol{x}_i + u_i \qquad (4)$$

Table 4 reports the estimated parameters from a Poisson regression where the number of new apprentices is regressed on plant and industry level variables. NSKILL is the number of skilled workers at the plant. SIZE is the number of primary jobholders at the establishment in November[10]. ENTRYRATE is the ratio of new hires of all other workers than apprentices to the average number of primary jobholders in time t and t-1. Similarly, EXITRATE is the ratio of leavers to the average number of primary jobholders in time t and t-1. These variables are supposed to reflect the impact of business cycles for the plant as well as for the industry on the demand for apprentices. WAGERATIO is the average wage of ongoing apprentices in plant *i* divided with the average wage of the skilled workers in plant *i*. If the number of apprentices or the number of skilled workers in plant *i* is zero then the wage rates are replaced by industry mean values. SUBSIDY is the deflated subsidy (see Figure 7) in DKK 1000. Since we do not have complete information on which apprenticeships only get the low subsidy we have treated all subsidies in the same way. Effects due to industry dummy variables are included to allow for different levels of apprentice hiring in different industries - manufacturing is used as the basic industry.

See the appendix for detailed descriptive statistics of the explanatory variables.

The Poisson estimates in Table 4 show that the number of apprentices is positively related to the number of skilled workers and the size of the plant. The wage ratio comes out with a negative sign indicating that the demand for new apprentices is negatively correlated with their relative wage. The subsidy is found to have a highly significant positive effect, the higher the subsidy the higher the demand for apprentices. Both measures of labour turnover rates are significant but with opposite signs - the entry rate has a positive effect and visa versa with the exit rate. Work places with a high number of hires employ more apprentices, while work

[10] Primary job holder means that the persons with multiple jobs have their most important (highest earnings) employment in this establishment in November.

places with many leavers are demanding less apprentices. This means that establishments with a higher net growth also employ more apprentices. If the hiring is a result of high turnover, there still is a higher demand for apprentices. Construction, trade and restaurant are found to have a higher demand for apprentices than manufacturing, office and other industries. Bjørn (1992) was not able to estimate an effect of the subsidy, because he had fewer years. With OLS he obtained estimates of the same magnitudes as in Table 4.

Table 4. Poisson regression of the number of new apprenticeships, 1981-1990.

	Poisson		Random effect	
	Parameter estimate	Standard error	Parameter estimate	Standard error
INTERCEPT	**-0,4499**	0,0622	**-0,6140**	0,0839
SIZE	**0,0040**	0,0003	**0,0041**	0,0006
NSKILL	**0,0098**	0,0009	**0,0081**	0,0024
WAGERATIO	**-0,3760**	0,1256	-0,1949	0,1327
RESTAURANT	0,4302	0,0436	**0,4071**	0,0805
CONSTRUCTION	**0,0914**	0,0534	0,0603	0,0950
TRADE	**0,2210**	0,0545	0,1905	0,1002
OTHER	**-0,1980**	0,0894	-0,2999	0,2149
OFFICE	**-0,2285**	0,0696	**-0,2148**	0,0762
SUBSIDY	**0,0060**	0,0016	**0,0061**	0,0017
ENTRYRATE	**0,7274**	0,0710	**0,8121**	0,0944
EXITRATE	**-0,4677**	0,0807	**-0,3357**	0,0957
N	3882		3882	
Log L	-4768			

Note: Coefficients in **bold** are significant at a 5% level. The reported standard errors for the random effect regression are consistent even if the residuals across groups are not identically distributed or the correlations within the groups are not as hypothesized by the random effect estimator. Subsidy is measured in a unit of DKK 30,000.

Estimating with a random plant effect and thus controlling for unobserved plant effects changes the significance of a few of the parameters but it does not change the signs. The most important change is undoubtedly that the wage ratio here is found to be insignificant indicating that on the plant level the relative apprentice wage does not influence the demand, possibly because unobserved plant specific elements are more important.

In order to investigate how stable these effects are across industries we have run the Poisson regressions separately for each industry. Results are shown in Table 5.

Table 5. Poisson Regressions for each Industry

	Manufacturing	Office	Other	Restaurant	Trade	Construction
INTERCEP	**-0,3384**	**-1,1049**	**-0,4443**	0,0008	**-0,4219**	**-0,6567**
	[0,1218]	[0,2449]	[0,2840]	[0,1048]	[0,1681]	[0,1536]
NSKILL	**0,0127**	0,0044	**0,0457**	0,0012	**0,0155**	**0,0395**
	[0,0014]	[0,0030]	[0,0111]	[0,0018]	[0,0075]	[0,0061]
WAGERATIO	-0,2127	-0,3541	-0,1172	**-0,5710**	-0,3316	0,0330
	[0,2581]	[0,5033]	[0,6465]	[0,2122]	[0,3790]	[0,3067]
SUBSIDY	**0,0070**	**0,0200**	0,0118	0,0004	**0,0122**	-0,0001
	[0,0033]	[0,0066]	[0,0088]	[0,0028]	[0,0043]	[0,0044]
ENTRYRATE	**0,2991**	**0,7786**	**0,9497**	**0,9335**	**1,2170**	**0,7230**
	[0,1502]	[0,3120]	[0,3552]	[0,1322]	[0,1815]	[0,2064]
EXITRATE	**-0,5625**	-0,0045	-0,8803	**-0,3976**	**-1,0618**	-0,3572
	[0,1814]	[0,3380]	[0,4534]	[0,1375]	[0,2769]	[0,1987]
SIZE	**0,0027**	**0,0057**	-0,0081	0,0063	**0,0053**	-0,0069
	[0,0005]	[0,0006]	[0,0024]	[0,0005]	[0,0010]	[0,0043]
No. obs	970	424	178	1054	581	675
Log L	-1163,88	-396,40	-205,81	-1442,11	-719,96	-744,47

Note: Coefficients in **bold** are significant at a 5% level. Standard errors in brackets.

As expected the results appear to be less significant when splitting the observations into industry groups. The signs are, however, consistent across industries. It is remarkable that the coefficient to *entry rate* is significantly positive with a size around 1 for all industries except manufacturing, where it is smaller. This result is only to some degree counteracted by the exit rate. This means that plants with a net growth (entry rate is larger than exit rates) and plants that are just about maintaining their workforce are demanding more apprentices.

Subsidy is found to have a significantly positive effect in *manufacturing*, *office* and *trade* and is insignificant in the other industries. As in the industry pooled regression reported above plant size and the number of skilled workers have a positive effect on the number of apprentices.

Table 6 reports in the first column the expected number of new apprentices per year at each employer in the sample using the estimated coefficients of Table 5 and the level of subsidies in 1983-86, see Figure 7. The largest expected number of apprentices is found for *Restaurants* trailed by *Manufacturing* and *Trade* and the smallest for *Construction* and *Other*.

To investigate the *effects of changes of the subsidy* we have subsequently predicted what would have happened if the subsidy had been eliminated as one extreme and what would have happened if the actual subsidy had been increased with 50% as the other extreme. If the subsidy is eliminated the expected number of apprentices drop from an average of 1.02 to 0.95 which is -7%. For 1983 we can calculate the demand elasticity for a 3 year apprenticeship including the subsidy to about -.34 assuming that the total wage cost for a 3 year apprenticeship including the subsidy is 139,000 DKK and the total subsidy also in real prices is 32,328 DKK. The change in the number of apprentices is largest for Offices with -23%[11], Trade with -17% and Manufacturing with about -8%. The effect of eliminating the subsidy is either very small or insignificant for the other industries.

Similarly, it is found that an increase in the subsidy of 50% would result in an overall increase in the number of apprentices of about 5%. The largest increase in the number of apprentices is found for Offices where the effect is an increase of 22% in the number of apprentices compared to 12% for Manufacturing and Trade and non-significant or small reactions for the other industries. Thus, the analysis has shown that the impact of the subsidy is limited to Offices, Manufacturing and Trade, whereas Construction, Restaurants and Other industries do employ the number of apprentices they are used to irrespective of the subsidy system.

[11] The duration of an apprenticeship within Office and Trade is shorter (2 years) and the subsidy is 60% of the full subsidy. Correcting for this the demand elasticity for Office and Trade is about -.8, or nominally much higher than within Manufacturing.

Table 6. Predicted average number of apprentices per employer for different levels of subsidy looking at all the years.

	Average number of apprentices with actual subsidy	Elimination of the subsidy	No. of observations
Manufacturing	1,03	0,94	970
Office	0,67	0,52	424
Other	0,83	0,72	178
Construction	0,85	0,85	675
Restaurant	1,31	1,31	1054
Trade	0,98	0,84	581
All	1,02	0,95	3882

From the above we can infer that the actual subsidy described in Figure 7 has increased the number of apprentices with 7% compared to a situation without any subsidy. 7% is similar to 276 more apprentices in the sample over the whole period.

We can now try to estimate the costs of the actual subsidy over the investigated period and within the sample to see how expensive it has been to create 7% more places for apprentices. Applying the rules for calculating the actual subsidies on the observed distribution of apprentices we find that subsidies have been paid to 192 apprenticeships in 1985 based on 2/3 of the sample while 195 have not been eligible, see Table 7 and the note. The total number of eligible apprenticeships is 3/2*192 employed at the sampled firms and the total costs are therefore about 3/2* 2.63 million DKK. This is about 3.9 million DKK. For the whole period it is 3/2*10 million DKK or 15 million DKK. Each new apprenticeship created by the subsidy has therefore on average cost about 54,000 DKK. It is interesting that a system was introduced in 1990 that provided school based training for those otherwise qualified who could not find an apprenticeship. This arrangement was considered to be immensely expensive with costs of more than 150,000 DKK per year and per apprentice covering school costs and wage to the apprentices. The differences between the two systems of subsidies is however, that the school based apprentice teaching does not create any value added. So even with a substantial dead weight loss it is preferable to use a subsidy compared to the school based system.

Table 7. The potential subsidies at the plant level 1983-1990 and the estimated cost within the sample.

	1983	1984	1985	1986	1987	1988	1989	1990
0	191	188	195	208	240	247	268	221
1	65	72	78	87	74	57	42	72
2	19	31	32	31	28	17	10	13
3	3	9	15	10	3	11	1	10
4 or more	2	3	1	4	1	4	0	3
Estimated cost in mio	2,0762	2,5442	2,6341	1,3424	1,0285	0	0	0,4202

Note: Number of observations = 2566. It is not possible to get information about the other 1316 observations in the sample as the calculations have to be based on observations of at least 3 consecutive years.

In Table 8 we have finally looked at the predicted number of apprentices in different years and with different sizes of the subsidy. The second column shows that the business cycles actually do matter for the total number of new apprentices. Thus, it shows that the number of apprenticeships would have increased more in 1990 without a subsidy than with the full subsidy in 1985 because of a better demand situation. Finally, the table shows what would have happened in specific years if we had either eliminated the subsidy or increased it with 50%. For 1985 it is seen that an elimination would have meant a decline in the number of apprentices of about 12%. On the other hand, a 50% increase in the subsidy would only mean a 6.8% increase in the impact. Similarly, it is found that an elimination in 1987, where the subsidy was only 50% of the level in 1985, would have had a much smaller impact.

Table 8. Predicted average number of apprentices per employer for different levels of subsidy looking at specific years.

	No. of observations	Average number of apprentices with actual subsidy	Elimination of the subsidy	50% increase of the subsidy
1985	388	1,0819	0,9553	1,1513
1987	412	0,9680	0,9137	0,9964
1990	372	1,1624	1,1331	1,1773

Finally, it is worth mentioning that the efficiency of the subsidy could have been improved by only giving subsidies to industries where there was a significant impact. These industries are Trade, Office and Manufacturing according to the results of Table 5.

11. Conclusion

This paper has given a description of the Danish apprenticeship system. It has quantified the benefits of having served an apprenticeship with respect to both wages and future unemployment. Thus, it is found that blue-collar workers who have served an apprenticeship (skilled workers) earn about 10% more than unskilled blue-collar workers. Their total unemployment is about 1/3 lower.

The main findings of the paper are on the determinants of the demand for apprentices. It appears that the demand is positively related to the net and gross entry rate of employees, the number of skilled workers and the size of the plant. Furthermore, we find that demand is positively related to the size of the subsidy. A high exit rate of employees also means that the plant is less likely to employ apprentices. A higher relative wage for apprentices compared to workers in general also means a lower demand. However, this latter result is only found to be significant for restaurants.

Comparing the magnitudes of the different factors we find that the entry rate of employees clearly dominates the other factors. This means that it is hard to compensate a good business cycle by offering subsidies. The analysis also shows that the variables have a different impact on different industries. Thus, it is found that a relatively high (or low) wage rate for apprentices within restaurants have a significant negative impact on the demand. This effect is not found in other industries. Similarly, it is found that the subsidy only has an impact on manufacturing, offices and trade. The entry rate is found to be significantly positive for all industries with a varying impact. The main conclusion is therefore that the main determining factor for the demand for apprentices is the rate of actual hirings of other groups of personnel and to a lesser degree the job separations of a given firm. The other factors are inferior to these two variables.

Nevertheless it is interesting to see what has been accomplished with the subsidy used in the 80s and what could have been the result of a larger subsidy. First, it is found that the actual subsidy has meant that the total demand was 7% larger than it would have been without a subsidy. Secondly, it is found that each newly created apprenticeship has cost DKK 54,000. This appears to be cheap compared to the alternative of school based apprenticeships (PKU).

However, a higher efficiency could have been obtained if the subsidy had been limited to a few industries.

After 1993 it was decided that all apprenticeships should be given a subsidy irrespective of the number employed in the past, the subsidy should then not only be given to marginal apprentices. Thus, large firms got a subsidy for all of their apprentices contrary to the situation up to 1993. The subsidy scheme was almost abandoned from 1997. Subsidies are now only given to those who cannot find a regular apprenticeship and who are placed via the apprentice schools. It would be highly interesting to compare the efficiency of the two different subsidy systems.

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Appendix

A1. Wage ratio by industry and year

	Manufacturing	Restaurant	Construction	Trade	Other	Office
1981	0,35	0,42	0,36	0,35	0,37	0,31
1982	0,33	0,41	0,41	0,35	0,44	0,35
1983	0,35	0,41	0,39	0,36	0,43	0,37
1984	0,38	0,41	0,34	0,33	0,39	0,35
1985	0,36	0,41	0,35	0,36	0,31	0,40
1986	0,35	0,44	0,33	0,33	0,38	0,43
1987	0,36	0,43	0,32	0,34	0,31	0,43
1988	0,36	0,39	0,30	0,32	0,34	0,38
1989	0,34	0,41	0,40	0,30	0,27	0,37
1990	0,40	0,41	0,38	0,34	0,38	0,41

A2. Average number of skilled workers by industry and year

	Manufacturing	Restaurant	Construction	Trade	Other	Office
1981	12,34	4,33	8,37	1,95	7,76	0,20
1982	12,18	4,65	8,35	3,30	9,19	0,64
1983	12,03	4,35	9,52	2,77	9,93	1,15
1984	13,43	3,49	10,30	2,77	9,31	3,52
1985	14,54	3,83	11,45	3,02	10,33	3,42
1986	12,47	4,94	11,60	3,63	10,19	1,09
1987	11,94	4,58	11,81	3,79	7,05	0,51
1988	12,69	3,79	11,98	3,77	6,95	1,80
1989	13,86	3,64	9,66	3,65	9,79	2,93
1990	13,56	6,93	10,41	4,26	12,25	1,45

A3. Average plant size by industry and year

	Manufacturing	Restaurant	Construction	Trade	Other	Office
1981	35,56	21,62	13,62	27,89	36,47	22,09
1982	38,24	24,17	12,47	34,45	41,13	28,91
1983	37,24	22,90	13,34	34,36	51,00	31,53
1984	41,60	19,48	16,02	34,98	39,38	40,71
1985	44,62	21,01	17,03	34,79	35,44	37,37
1986	39,42	24,78	18,81	33,98	41,76	29,09
1987	37,69	25,24	18,39	36,08	31,30	33,76
1988	38,49	24,20	18,81	37,40	38,95	39,71
1989	40,72	27,46	16,66	37,43	61,21	52,66
1990	42,57	30,85	17,31	40,47	67,65	48,77

A4. Average number of new apprentices by industry and year

	Manufacturing	Restaurant	Construction	Trade	Other	Office
1981	92	121	53	43	11	21
1982	94	105	53	63	11	24
1983	93	139	56	56	20	20
1984	107	116	55	70	10	45
1985	121	117	58	64	18	63
1986	100	145	77	73	28	35

1987	98	146	60	69	15	20
1988	111	128	61	46	9	23
1989	78	138	45	37	7	18
1990	103	228	57	52	20	19

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