Public policy to further youth training – evidence from the Danish apprenticeship system, 1931-2002[§]

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Abstract: This paper provides an overview of the evolution of the apprenticeship system in a country, which provides large-scale employer-provided training for new entrants on the labour market. Several institutional traits of the Danish labour market help sustain the system by alleviating failures in the market for training. The paper reviews these institutional traits, including the role of unions and public policy. In order to uphold the system, apprentice employment is subsidised, financed by levies of all firms. Such a scheme is considered in the theoretical literature as a means for overcoming the failure of markets to provide sufficient incentives to training. The paper contains an empirical analysis of the impact of subsidies to employ apprentices.

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A widely held view is that the free market does not provide the right incentives for firms and youth to invest in vocational training. Remedies for inefficient, low levels of training in the form of government intervention have been considered by governments and in the economics literature. This paper analyses government intervention in a country that has large-scale employer-provided training for new entrants on the labour market.

A number of recent theoretical papers have investigated various types of market failures that might lead to underinvestment in training.[i] The role of firm-based training has been emphasised in OECD (1994) as necessary for providing skills to the workforce. This is especially the case with respect to the school-to-work transition, and the German apprenticeship system was emphasized in the report. In the British public debate, the German apprenticeship system is traditionally mentioned as a model for the training of youth. To some extent, this is also the case in the American public debate. In other countries, the need for further involvement of employers in the vocational training of youth is often mentioned, both in government reports and in the general public debate.

Besides Germany, only three other industrialised countries appear to have full-scale apprenticeship systems, and these are three of her neighbouring countries: Austria, Switzerland and Denmark. In all other industrialised countries, training in schools has to a greater or lesser extent replaced the vocational training of the apprenticeship system, which was the universal system of educating skilled workers before the industrial revolution. To the extent that cross-border comparisons are relevant in the evaluation of the relative merits of educational systems, there are very few countries to look at concerning the apprenticeship system.

The present paper provides an overview of the evolution of the education of apprentices in Denmark between 1931 and 2002. Determinants of the employment of apprentices are considered and their quantitative impact is estimated. The attempt to provide further training in the apprenticeship system through financial incentives to employ apprentices, when wage formation takes place in a collective bargaining system, is assessed quantitatively. A necessary condition for the survival of an apprenticeship system is that the apprentice is paid below the value of his or her marginal product at the end of the contract period. The disappearance of the apprenticeship system in more competitive labour markets has been attributed to problems of enforcing such contracts. A crucial element in

assessing the development of the system is therefore public intervention to make the contracts enforceable. The paper includes a comparison with vocational training in three other smaller European countries, Austria, Ireland and The Netherlands.

The paper makes the following contributions to the literature. Firstly, it provides an overview of the development of the Danish apprenticeship system. The long-term overview is necessary as a background for assessing the reasons for the survival and expansion of the system. Secondly, it discusses the role of public policy in upholding and developing the system. Special emphasis is put on the role of government intervention to correct market failures. Thirdly, it quantitatively analyses the potential for employment subsidies to influence the decisions of firms to provide training for youth. The discussion includes the role of employer and employee representatives in upholding the apprenticeship system. Unionisation is a characteristic of the labour market in Austria, Denmark, Germany and Switzerland.[ii]

The paper is organised as follows. Section 2 presents an overview of the Danish apprenticeship system. Emphasis is on the potential failures of this system with respect to providing youth training and public policy to remedy the failures. Section 3 presents a brief comparison of the Danish system with three other smaller European countries, Austria, Ireland and The Netherlands. Section 4 gives an overview of quantitative entities that are necessary to assess the development of the Danish apprenticeship system. In section 5, the effect of determinants of the inflow of apprentices is estimated. Section 6 concludes.

I. THE DANISH APPRENTICESHIP SYSTEM AND PUBLIC INTERVENTION

A basic rationale for using the apprenticeship system is that it is supposedly more efficient in transferring skills to new entrants on the labour market than is a school-based system. Public schools are supposed to invest in general human capital or skills that are useful in several firms. The same is the case with education in the apprenticeship system, but in this system, the investment in transferable skills gives rise to intrinsic problems. In combination with various institutions on the labour market, public policy might alleviate failures in the market for training. The present section reviews the Danish apprenticeship system from this perspective.

Failures in the market for training can arise for at least three reasons: (1) capital market imperfections due to credit constraints and uninsurable risks, which reduce the incentives of individuals to invest in training, (2) labour market imperfections that give rise to external benefits for firms, and (3) problems regarding information about the inherent productivity of trainees and the quality of training.[iii]

Because apprentices receive wages during their education, the apprenticeship system partly alleviates capital market imperfections compared to a school-based system, where students often are dependent on loans or grants during their education. In the traditional apprenticeship, the worker promises to stay with the employer for a fixed number of years, in the historical period up to 7 years. Stevens (1999), p. 26, calls this a "Bound Apprenticeship". In the early period of the contract, the employer incurs costs of training. In the latter period of the contract, the employer recoups these costs as the apprentice is paid less than productivity. Other types of contracts, which terminate when the apprentice has obtained a required level of qualifications or "competences", have in some countries replaced this type of apprenticeship.

However, the Danish system actually has exactly the traits of the "Bound Apprenticeship" system. It is a time-serving system where the length of the apprenticeship is fixed. The contract period is normally 2 years in the trade and office sector and about 3½ years in the industrial sector, depending on the type of apprenticeship.[iv]

At the end of the contract period, the wage of the apprentice is considerably less than the wage of other workers. Collective agreements specify the minimum wage of each type of apprenticeship. A law extends these wage rates to firms, who are not covered by collective agreements. The statutory wage rates are considerably smaller than the agreed wages for skilled workers, but some employers pay wages to their apprentices in excess of the minimum wage. However, according to statistics for the average wages handed out, a first-year apprentice below the age of 25 gets 41 per cent of the average wage for all blue-collar workers while an apprentice on the fourth year of a contract receives 61 per cent.[v] After certification as a skilled worker, most former apprentices experience a considerable increase in the wage level. At the end of the contract period, productivity thus exceeds wages.

Labour market imperfections arise if all of the benefit of the training is not awarded to the agents who bear the costs of training. Either the trainee or the training firm bears the costs of training in the absence of public intervention in the form of financial support. If the worker after completion of training takes a job in another firm that pays less than the value of the marginal product, this new firm benefits from the training without bearing any of the costs. Imperfect competition between firms in the labour market might thus lead to underinvestment in training; see Stevens (1994).

One reason for wages to be below the marginal product might be wage compression because of unionisation, see Acemoglu and Pischke (1999), and unionisation is characteristic of countries where the apprenticeship system plays a significant role. If the apprentice continues in the firm after the completion of the contract and skilled workers are paid less than their productivity, firms can recoup their training costs during the apprenticeship. According to a related line of thought, large firms can keep the good apprentices after the completion of contracts and thus save the costs of hiring skilled workers educated in other firms.

These aspects of the apprenticeship system are not prominent in the Danish policy debate, and there appear to be two good reasons for this. Firstly, worker flows are much larger in Denmark compared to most other countries in continental Europe, probably because of the low level of employment protection on the Danish labour market. Secondly, Danish firms are much smaller than for example German ones and internal labour markets are a phenomenon generally attributed to large firms. A

major sociological contribution in the analysis of the Danish apprenticeship system, Houmann Sørensen et al. (1983), emphasizes the division of work between firms of different sizes. Small firms typically educate apprentices, and large firms typically recruit skilled workers educated in small firms (employment of skilled workers in large firms is much larger than the number of apprentices they educate and conversely with small firms). Despite the high degree of unionisation on the Danish labour market, the evidence is thus against labour market imperfection as the main reason for training in the apprenticeship system.

Informational problems arise if prospective trainees are uncertain about the quality of training promised by a firm. Consequently, they might be hesitant to enter into a contract where they initially are paid less than their alternative wages, on the promise of wage increases in the future. Furthermore, other firms might be uncertain about the quality of the training and the productivity of the workers. Malcomson et al. (2003) analyse these informational problems in the context of apprenticeship contracts. A successful training system has to make contracts enforceable, which is at the heart of the informational problems discussed in Malcomson et al. (2003).[vi] To what extend has the Danish apprenticeship system overcome these problems?

The Danish system is a dual system that comprises both on-the-job training with the employer and formal schooling in vocational schools. It includes a contract, in which the employer promises to employ the apprentice for a number of years, such that stable employment is secured during the training period. Besides performance tests conducted in the vocational schools, the system involves nationally recognised certification at the end of the contract period. The apprentice thus has proof that he or she has obtained the skills that are generally recognised as necessary to be employed as a skilled worker in other firms.

The examiner at the final examination at the end of the contract period, the masterpiece (or test of practical skills), is a teacher from the vocational school, who participates in the evaluation committee. The two other members of the committee that decides the grade of the apprentice are external examiners (or censors): one person from the employer organisation and one labour union representative. On the national level, committees exist for various trades, which consist of a parity of representatives from the employer and employee sides. The committees monitor the content of programmes and tests of skill acquisition, and are supposed to guide the development of the different

programmes in accordance with technological advances and best practice in the various trades. Programmes are closed down if the skills taught are no longer needed on the labour market. Moreover, new programmes are occasionally initiated if an assessment indicates that there is a great enough need for workers with skills to justify a full-scale apprenticeship programme.[vii]

Employer and employee organisations also play a role in conflict resolution during the contract period. Unresolved conflicts are supposed to be taken to the aforementioned committees. If a contract violation is assessed to be due to an employer, the employer organisation will often find another firm where the apprentice can finish his or her education. If the committee cannot solve problems concerning a contract violation, the case is sent to a special board, whose members make up an equal number of employer and trade union representatives. The arbitrator is a justice on the Danish High Court. The board can fine the employer and the apprentice for violations of contracts. One of the problems that can arise during the contract period is that the apprentice does not learn enough, for example because the apprentice is used as an unskilled labourer. In such a case, the board can fine the employer to pay an amount corresponding to the difference between the wage of an apprentice and the wage of an adult worker. The idea of the arbitration system is to ensure competent and expedient treatment of cases. The costs of bringing a case to court are born by the trade union and the employer organisation, given the employer is a member. In contrast, the costs of bringing a case to court in the ordinary judicial system can often be substantial.

Major stakeholders in sustaining and developing the system are thus employer organisations and labour unions. They play an active role in securing that the apprentice obtains relevant and transferable skills, which are verifiable by other employers. In addition, employer organisations and labour unions are involved in conflict resolution. Thus, care has been taken to make the contracts both verifiable and enforceable to solve or counteract the inherent problems in apprenticeship contracts as discussed in Malcomson et al. (2003).

By the end of the contract period of a "Bound Apprenticeship", the apprentice is at, or close to, the productivity of a skilled worker, but the wage of the apprentice is typically considerably lower than that of a skilled worker. This has given rise to the so-called "runaway problem", when apprentices run away from their masters at the end of the contract period. The apprentice leaves the firm and applies his or her skills with another employer enjoying a wage that reflects the productivity. This

phenomenon diminishes the earnings of the master and thus reduces the incentive of the master to employ and invest in human capital formation of apprentices. Elbaum (1989) suggests that this runaway problem is the prime reason for the disappearance of the apprenticeship system in the competitive labour markets of North America. To the extent that this is a valid factor, the continued existence of the apprenticeship system in some countries implies that market failures in relation to apprenticeship contracts have been counteracted by some features or institutional settings that are absent in more competitive labour markets.

The runaway problem should actually exist in at least some sectors of the Danish apprenticeship system despite the legal setup to enforce contracts. However, several traits of the apprenticeship system combined with the Danish system of labour market relations help alleviate the problem and make the contracts enforceable. Firstly, the wages agreed upon rise during the apprenticeship contract period, partly reflecting a rise in productivity because of training. Secondly, the agreed wage is the minimum; the employer can choose to pay a higher wage. Thirdly, the subsequent wage of the apprentice is contingent upon getting a certificate after finishing the contract period, indicating the fulfilment of the requirements to be a skilled worker. In general, it is required to hold such a certificate in order to be categorised as a skilled worker in collective agreements and therefore getting the wage of a skilled worker in these agreements. Fourthly, if an apprentice "runs away" and wants to have the certificate, he or she has to find another employer certified to educate apprentices for the rest of the contract period. This might be difficult because social norms with respect to employer behaviour exist in a labour market with a high degree of employer organisation.

These important deviations from a competitive labour market help sustain the apprenticeship system. Centralised bargaining between unions and employers is a characteristic of three of the four countries where a full-scale apprenticeship system has survived, and this is probably no coincidence.[viii]

Major reorganisation of the Danish apprenticeship system has taken place only three times during the last half of the 20th century. A system was introduced in the mid 1970s, which meant that apprentices started with one year in either a technical school or a training school for trade and office workers. This was in contrast to the traditional system, in which the apprentices entered school after some time with their employers. One of the reasons for this change was a demand from employers

in the industrial sector. They had found it increasingly less fruitful to take young people directly from primary education and employ them in a work environment with complicated machinery and equipment. Before this reform, there were examples of large firms having special units for educating apprentices in theoretical skills in particular. However, these units were closed down after the reform because of the increased theoretical competence of apprentices in the new system.[ix] The traditional apprenticeship system co-existed with the new one for about 20 years until a reform made a partial unification (apprentices can now choose between starting with an employer or taking a half-year course at a training school). The first reform was instituted in the 1950s, which included the introduction of day schools for apprentices.

These long periods, before one reform is replaced by a new one, is comparable to the German system, where the present "Vocational training act" stems back to 1969. The involvement of employer and employee organisations thus appears to have made the vocational training system robust against attempts by politicians to reform the system. Ertl (2004) has a discussion, in a German context, concerning the potential drawbacks and difficulties when making reforms in a system with many stakeholders.

A major policy measure furthering the education of apprentices in Denmark is employment subsidies to those employers who train apprentices, financed by a levy on all firms in Demark. The levy is proportional to the aggregate number of working hours of a firm's workforce. A general scheme of this type has existed in France since the 1970s; see Greenhalgh (2002) for an assessment.

Stevens (2001) analyses the ability of training subsidies to overcome failures in the market for training. Her model suggests that such a scheme is not effective for alleviating the effects of imperfect competition in the labour market. However, it is a purposeful measure against capital market imperfections. One could note that borrowing constraints as a market failure is especially relevant in youth training. It is likely a main reason for providing government funded education in schools. Training in firms is to some extent a substitute for training in schools. Young people might not enter into training in firms because they face a borrowing constraint that prevents them from investing in skills. To the extent that this is the case, the same arguments that support subsidising schools are valid as arguments for subsidising training in firms. In the model set-up of Malcomson et al. (2003), a subsidy actually affects the incentive of marginal firms to initiate training and an explicit recom-

mendation is made regarding a public subsidy to overcome incentive problems inherent in apprenticeship contracts.

II. THE DANISH SYSTEM IN AN INTERNATIONAL CONTEXT

To put the Danish experience into perspective, I undertake a brief contextual comparison to three other small European countries, Austria, The Netherlands and Ireland. This complements the usual comparison in the literature between the UK and Germany. I attempt to make comparisons on various traits of the apprenticeship system, which were emphasised as important in the Danish system.[x]

II.a AUSTRIA

In Austria, the duration of training is between two and four years. In the majority of cases, training lasts three years. Approximately 40 per cent of all young people aged 15 to 18 go through the apprenticeship system. The apprentices spend approximately 80 per cent of the training period in the training companies. The rest is spent in part-time vocational schools. School participation can be on a day-release basis, where the apprentice attends school one or two days per week, or on a block-release basis, where the apprentice spends several weeks in school, normally eight to twelve weeks. Some of the provinces of Austria have the day-release system others have the block-release system. There are about 260 apprenticeships on the list of recognised apprenticeships, which also specifies the apprenticeship periods. For each apprenticeship on the list, there are regulations about the training content. Moves to adapt existing profiles are often initiated by companies or by the representative bodies of employers and employees. The final apprenticeship exam consists of a practical and a theoretical part (if the grades from the part-time schools are satisfactory, the apprentices do not have to take the theory exam). Representatives from trade unions and employer organisations are included on the boards, which examine the students.

The training is open to all young people who have completed their nine years of compulsory schooling. In 2003, steps were taken to help individual disadvantaged young people who cannot complete

their apprenticeship without assistance. The measures included partial qualifications and an extension of the duration of training. If the search for a suitable apprenticeship is unsuccessful, a substitute in the form of training courses is available. A shortage of training places implies that participation in these courses amounts to about seven per cent of the number of young people in regular apprenticeships.

The contracts are standardised and entered into by the apprentice and an authorised apprenticeship trainer. The remuneration is normally in accordance with the collective agreements between the employers and trade unions. Employer subsidies to further employment of apprentices include wage costs for the time when apprentices attend school. A marginal targeted subsidy was in effect in 2005 implying that companies employing a larger number of apprentices than in 2004 receive a premium over three years for each additional apprentice; the monthly amount of the graduated premium ranges from EUR 100 to EUR 400 per apprentice per month. In addition, there are subsides for employing disadvantaged groups as apprentices.

II.b IRELAND

In Ireland, an apprenticeship normally lasts four years. About 10 to 15 per cent of all school leavers follow the apprenticeship routes. The standard-based apprenticeship has seven phases, three off-the-job and four on-the-job. The first phase is on-the-job. The duration of off-the-job phases is approximately 40 weeks. The apprenticeship programmes are divided into 26 different trades. Measures have been taken to expand the apprenticeship programme portfolio. The curricula for apprenticeships are based on standards agreed upon by industry. Experts nominated by employers, trade unions and government agencies write the standards. Representatives for employers and trade unions participate in various committees both at the national and regional levels. Successful completion of an apprenticeship results in the award of a National Craft Certificate. A government agency monitors each on-the-job phase of the apprenticeship.

Apprentices must fulfil a minimum grade requirement from the lower secondary school level (the end of compulsory school). A special programme has been set up for young people who have left school without qualifications or vocations training. This "Youthreach" programme comprises about seven per cent of a youth cohort.

Apprentices are employees of companies with an apprenticeship contract. They receive wages, which in most cases have been agreed upon by employer and union representatives and vary according to the year of apprenticeship. During the periods of off-the-job training and education, a national training fund pays an allowance to the apprentices, equivalent to their agreed industry norm. The revenue of the national training fund stems from a levy on employers of 0.7 per cent of the earnings of employees.

II.c THE NETHERLANDS

In the Netherlands, about 27 per cent of a youth cohort get a diploma from the "practically oriented pathway" of the vocational training system.[xi] The apprentices work in a company for four days a week and go to school one day a week. Attainment targets or exit qualifications have been formulated for all types of training. The exit qualifications are divided up into a number of partial qualifications. The formulation of attainment targets follows a procedure in which employers and trade unions play a role. The assessment of the practical part of the training takes place at the workplace through a practical examination. The educational institution is responsible for the examination, but the practical trainer of the company also plays a role. The method of assessment is regulated in a learning contract between the school, the student and the company. This learning contract also contains information about the part of the exit qualifications, which needs to be satisfied by the students. As the Dutch vocational training system is a "competence"-based system, the length of the apprenticeship contracts does not seem to be specified on the national level.

There are no specific access requirements for apprenticeship training. In addition to the practically oriented pathway to vocational education, a school-based pathway exists (where the percentage of practical occupational training is between 20 and 60). This school-based pathway is the largest; the number of granted diplomas is about 25 per cent larger than on the practically oriented pathway.

Remuneration is not common in all sectors. Health care, for example, does not provide remuneration to apprentices, while sectors as trade and tourism do. Sometimes, regional training centres receive the fees and forward them partly to the apprentices.

II.d SUMMARY

In comparison, the Danish apprenticeship system appears to be close to the Austrian one. Both countries have apprentice systems of the "bound" type. A significant observation is that the test of each single apprentice at the end of the contract period in both countries involves representatives of both employers and trade unions. This indicates the crucial role of employers and trade unions in sustaining the system of apprenticeship training. In addition, both countries have schemes to provide employers financial incentives to employ apprentices. The Danish apprenticeship system also shares many traits with the German system, as described in for example Steedman (1993), Franz and Soskice (1995), and Ertl (2004).

In summary, the Danish apprenticeship system appears to be composed in such a way that it is effective in supporting employer-provided training. Like the German system, it is stable and major reforms are seldom. A major reason is probably the substantial role that employer and employee organisations play in upholding the system. This is in contrast to for example the British system of youth training, which appears to be revised very frequently. In both Austria and Denmark, the incentives to initiate training are furthered by employment subsidies. In Denmark, the scheme is financed by a levy on all Danish firms. Such a scheme has been considered in the recent literature concerning failures in the market for training. In addition, there is an argument for using employment subsidies as a countercyclical device. School-based training is not affected when the economy goes into a slump, but the hiring of apprentices on contracts, which last several years, *is* affected by the business cycle.

III AN OVERVIEW OF THE DEVELOPMENT OF THE DANISH SYSTEM

This section contains an overview of the time series relevant to assess the evolution of the education of apprentices in Denmark. The section conveys information about magnitudes and events, which

are important in their own right, as well as forming the background for an evaluation of the quantitative analyses in the next section.

Figure 1 displays the development of the inflow of apprentices between 1931 and 2002. The inflow was slightly above 30,000 in the beginning of the 1990s, later falling slightly below 30,000, and exhibiting a considerable drop in the last year of the observation period, when the Danish economy went into a slump (the absolute numbers can be assessed by noting that the current population of Denmark is about 5 million). However, this variability is of moderate magnitude compared to earlier changes. The figure shows two peaks at about 40,000, one in the mid-1960s and one in the mid-1980s. In the intervening period, the inflow was considerably lower, falling below 20,000 at its lowest in 1975, which was the worst year in the 1970s with respect to macroeconomic performance. The drop in connection with the second oil price shock was considerably smaller. In the 1950s, the inflow was at a level slightly below 20,000, up from a little more than 10,000 in the 1930s and the beginning of the 1940s.

[Figure 1 around here]

The series of numbers displayed in Figure 1 represents the sum of inflow to apprenticeships through different types of apprenticeship systems that co-existed during the same time periods. Part of the substantial recovery of the inflow from 1975 to 1976 was due to an increase in the new type of apprentices, who had one year of schooling before getting a contract with an employer.

Figure 1 also displays the development of the youth cohort, reflecting the number of young people in the age range when apprenticeships begin. The series is constructed as a weighted average of the relevant age groups, where the weights are calculated from the inflow of apprentices distributed by age groups. Because the starting age for apprenticeships has gradually increased, older age groups are included in the more recent estimates, whereas the younger age groups are not.

The size of the youth cohort is about 60,000 in the late 1990s, down from more than 70,000 in the beginning of the 1990s, thus the decrease in the inflow of apprentices during this period reflects a decrease in the size of the youth cohort. Similarly, the two peaks in the inflow of apprentices in

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Figure 1 are a reflection of corresponding peaks in the size of the youth cohort in the mid-1960s and mid-1980s.

Figure 2 displays the inflow of apprentices relative to the youth cohort (the lower graph in Figure 1 divided by the upper graph). This is a measure of the relative importance of the apprenticeship system in the Danish educational system.

[Figure 2 around here]

During the 1990s, the proportion of the youth cohort beginning an apprenticeship increased to a level of about 45 per cent, which is close to an all-time high proportion. The only observations of a similar magnitude are a couple of years in the mid 1960s and in the mid 1980s, where youth cohorts peaked as seen from Figure 1. The two time periods when large youth cohorts entered the labour market coincided with an increase in the inflow of apprentices of such a magnitude that the proportion of apprentices in the youth cohorts were at their peak. The main explanation for this phenomenon is that the Danish economy boomed during these exact time periods. In the 1930s, when Denmark was predominantly an agricultural country, the proportion of apprentices was 15-20 per cent, increasing to about 30 per cent in the 1950s when industrialisation set in.

From the mid-1960s, a gradual erosion of the apprenticeship system began, with the consequence that the proportion of apprentices in youth cohorts was reduced by more than a half over a ten-year period. A major explanation for this development is evident in Figure 3. The average wage of apprentices was about 20 per cent of what unskilled workers were making in the 1950s and in the first half of the 1960s. This was slightly higher than in the last half of the 1930s, when the relative wage of apprentices was 15-20 per cent of what unskilled workers made. However, beginning with a rise in the relative wages of apprentices of 3 percentage points from 1966 to 1967, the relative wage rate for apprentices more than doubled to a peak of 45 per cent of what unskilled workers were making in 1983. After a period of constancy, the wage rate went up again in the mid-1990s and is now slightly above 50 per cent of what unskilled workers make.

[Figure 3 around here]

A portion of the increase in the relative wage of apprentices can be ascribed to composition effects. However, the major factors influencing this change are the increases in bargained wages. The substantial increase in wages starting in the middle of the 1960s is characterised by large biannual increases followed by a smaller drop. Collective bargaining at the national level was undertaken biennially in this time period and the peaks are in the years of settlement. This time period was thus characterised by relatively large increases in the bargained wages for apprentices, followed by a relative drop when the wages of older workers went up during the agreement period due to rises in other wage components. Danish unions bargain jointly for apprentices and other workers, and wage rates and other regulations for apprentices are written into the general contract between unions and employers.

Increases in the cost of employing apprentices was counteracted by the introduction of employment subsidies in 1978, and the development in the costs per hour is displayed in the curve denoted "after subsidy", where the subsidy per hour is deducted from the gross wage. Although there is a permanent subsidy, in addition, temporary subsidies of various magnitudes were implemented during the period. Some of the temporary subsidies have been of the marginal targeted type as the one existing in Austria. The costs indicate a constant level of about 30 per cent of the adult wage rate during the last half of the 1970s and the first half of the 1980s, when the inflow rate of apprentices recovered. In the later period, the costs were somewhat higher depending on the amount of employment subsidy. The relative low level of cost during 1993 and the following years is due to an increase in the subsidy during the severe slump of that period.

It is evident that the role of public policy in supporting the apprenticeship system has been substantial. The same is the case for the financial costs of transfers to apprentices; close to half of the youth cohort of the country pass through an educational system characterised by employment subsidies of the magnitude displayed in Figure 3.

The reasons for the increase in the relative wages for apprentices from 1967 and onwards are not well understood. Two observations might be of relevance. At the last collective agreement (after the sample period of the paper), wages to apprentices went up considerably more than wages for other workers. Some trade union officials are quite explicit about the reason why unions increased the wage for apprentices. It is in order to make this pathway attractive compared to the competitors (the

different types of high schools). This might have been the explanation in the 1960s, where a rapid expansion of the Danish high school system began. A second observation is that a substantial increase in the wages of apprentices took place after the introduction of the employment subsidies. It might be due to incidence of the subsidy implying that unions raised wages as a consequence of the subsidy. Incidence of wage subsidies is the typical result in union models of wage determination. This topic is not pursued further in the present context.

The distance from the upper curve in Figure 3 up to one hundred per cent could be interpreted as an indication of the size of the investment, which the apprentice makes in his or her education. The distance would have been the opportunity costs if the graph had shown the wage rate of an apprentice relative to the wage of a young unskilled worker. However, the wage of a young unskilled worker is lower than the average wage rate for all unskilled workers, and thus the apprentices' investment is somewhat lower than indicated by the magnitudes in Figure 1. As can be seen from the figure, the relative wage of apprentices has gone up over time. This indicates that the relative costs of investing in an education as an apprentice have diminished over time.

The rest of the investment costs include expenditures to operate training schools, which are funded out of general revenue. It also includes the wage subsidies to employ apprentices, as displayed in Figure 3. The main portion of the subsidies has been financed by a tax levy on employment, and to the extent that this tax does not reduce adult wage rates through incidence, the costs of this part of the investment in educating apprentices is thus borne by employers at large. In addition, the single employer of an apprentice might contribute to the investment to the extent that they have net costs from employing the apprentice during the contract period.

Through the whole period in which reliable data have been collected, the number of young people seeking apprenticeships has by far exceeded the number obtaining apprenticeships. Evidence for this is presented in a companion paper, Albæk (2004). A school-based system of vocational training has been set up for those who are unsuccessful in finding an apprenticeship at an employer. Many of these young people are able to find an employer during the education in the schools and thus finish their education in an employment relationship.

Does the relative success of the Danish apprenticeship system have something to do with changes in occupational sectors? Has the demand come from new sectors or are Danish apprenticeships re-

stricted to the traditional manufacturing sectors? To shed light on the sectoral dimension of the apprenticeship system, the inflow of apprentices is distributed on type of education every decade from 1939 to 2000 (1939 is selected instead of 1940 as the inflow that year dropped by one quarter as a consequence of the German occupation). The classification is rather detailed throughout, which makes it possible to reclassify and aggregate up to the major categories in the most recent international classification of vocational education.

According to Table 1, the sectoral composition has been relatively stable throughout the time period. Construction is a classical trade for apprentices and takes 20 per cent of all apprentices in 2000 despite the construction sectors' share of employment in Denmark is only seven per cent. Together with "Manufacturing" and "Commerce and clerical trades", this sector stands for about 80-90 per cent of the education of all apprentices in Denmark. However, in recent time, these sectors experience a relative decline and loose nine percentage points in the share of the intake from 1980 to 2000. A contributing reason is a reduction of the manufacturing sector from 22 per cent of employment in Denmark to 19 per cent during the same time period. The corresponding gain in the share of new apprentices is spread out on the remaining sectors contained in the table. Some of the increase in these sectors is due to new types of apprenticeship programmes.

[Table 1 around here]

In addition to apprenticeships, the other main educational pathway for young people leaving primary school is the three-year high school, which prepares students for higher education. There are two main types of high schools. The common high school ("gymnasium") had an intake of students in 2001 of 70 per cent of the number of new apprentices in year 2000 stated in Table 1. Three-year high schools for trade and technical high schools had a combined intake on 41 per cent of the number of new apprentices in year 2000.

IV. EMPIRICAL MODELS AND RESULTS

This section contains a formulation and estimation of an empirical model describing the demand for apprentices. The assumptions of the empirical model are perfect competition and pay-setting by

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trade unions. These assumptions are reasonable or at least have some credibility according to the discussion of the institutional set-up of the Danish apprenticeship system in section 2.

Main factors, which one would expect to influence the employment of apprentices, are relative costs, the business cycle and the magnitude of the youth cohort. The point of departure is a two-factor CES production function, where the stock of employed apprentices A^s and other workers N produce output Q

$$Q = \left[\delta \left(e^{\mu t} N \right)^{-\rho} + \left(1 - \delta \right) \left(e^{\lambda t} A^s \right)^{-\rho} \right]^{-1/\rho}, \tag{1.1}$$

where t is time, μ and λ represent factor-specific technological progress, δ is the distribution parameter, and the elasticity of substitution is given by $\sigma = 1/(1 + \rho)$.

It is assumed that the equilibrium relation between the inflow of apprentices A and the stock of employed apprentices A^s can be described by

$$A^s = A \exp(\alpha + \beta t), \tag{1.2}$$

where the factor to A on the right hand side represents the average contract period.

The first-order condition for employment of apprentices results in the following equation describing the demand for apprentices

$$\ln A = \sigma \ln(1 - \delta) - \alpha + \ln Q - \sigma \ln w_A^n + \left((\sigma - 1)\lambda - \beta \right) t, \tag{1.3}$$

where w_A^n is the real wage for apprentices, net of wage subsidies. Invoking the analogous condition for other workers gives rise to the equation describing the relative demand for apprentices

$$\ln \frac{A}{N} = \sigma \ln \frac{1 - \delta}{\delta} - \alpha - \sigma \ln \frac{w_A^n}{w_N} + \left((\sigma - 1)(\lambda - \mu) - \beta \right) t, \tag{1.4}$$

where w_N is the real wage for other workers. This equation regresses the relative demand of apprentices on their relative wage, as displayed in Figure 3, while the former equation regresses the demand for apprentices on their real wage.

In the estimation of the first-order condition (1.3) for inflow of apprentices A, the real gross national product, Q, enters as an explanatory variable, and the wage costs of apprentices are deflated by the implicit GNP-deflator in order to get the real wage, w_A^n. Furthermore, the youth cohort U is included as an explanatory variable. The logs of all these variables are $I(1)$ variables according to Dickey-Fuller tests. A regression of A on Q, w_A^n, U and a trend provide residuals, which can be rejected as being $I(1)$. A regression of the change in the residuals from the equation on the changes lagged one and three periods and the lagged level of the residuals give coefficients, which are accepted to be different from zero on a five per cent confidence level according to the critical values of the normal distribution. The coefficient to the lagged level of the residuals has a t-value of -4.54, and McKinnon's five per cent critical value for the rejection of the zero hypothesis of a unit root is -4.12 in this case.

The preferred error-correcting equation for the demand for apprentices based on the first-order condition is

$$\Delta \ln A = -2.702 - 0.291 \ln \left(w_A^n \right)_{-1} - 0.278 \left(\ln A - \ln Q \right)_{-1} + 0.348 \ln U_{-1} + 0.005t \qquad (1.5)$$
$$(1.284) \quad (0.115) (0.103) (0.140) (0.003)$$

$$+0.487 \Delta \ln w_A^n + 0.242 \Delta \ln A_{-1} + 1.400 \Delta \ln Q + 0.323 D76$$
$$(0.111) (0.095) (0.451) (0.072)$$

$$R^2 = 0.661 \quad \hat{\sigma} = 0.060 \quad T = 1950 - 2002$$

$$F_{ar}(2,42) = 2.674 \quad F_{arch}(1,42) = 0.806 \quad \chi^2_{nd}(2) = 0.818$$

$$F_{he}(15,28) = 0.764 \quad F_{RESET}(1,43) = 5.375$$

The coefficient to Q has been restricted to one, as an implication of the assumption of homogeneity of the production function (1.1), and this restriction is accepted at a 5 per cent significance level in the level regression. All of the coefficients are significantly different from zero. Included is a row

of tests for misspecification, which, with one exception, indicate that absence of problems cannot be rejected. F_{ar} is an F-test for second-order serial correlations, F_{arch} is an F-test for no auto-correlated conditional heteroscedasticity, χ^2_{nd} is a chi-square test for normality of the residuals, F_{he} is a test for no heteroscedasticity, and F_{RESET} is Ramsey's test for misspecification. The last test indicates that there are problems with the specification of the model, but this is not the case if the GNP enters in non-restricted form.

Dividing the coefficient to the wage rate by the error correction coefficient yields a long-run wage elasticity of -1.047. The long-run coefficient to the youth cohort is estimated to be 1.252. According to the standard error of U, one cannot reject a hypothesis of a long-run coefficient of one, which corresponds to a percentage increase in the employment of apprentices of the same magnitude as the percentage increase in the youth cohort.[xii]

Moreover, the changes in the explanatory variables are included in order to improve the prediction of the short-run adjustment in the inflow of apprentices. Finally, a dummy is included to describe the extraordinarily high growth rate of the inflow of apprentices from 1975 to 1976, which is not possible to capture with the variables included in the present data set. The inclusion of the dummy has no major impact on the estimated coefficients, but improves the statistical quality of the equation considerably.

When estimating age-specific employment with longer time series, the standard procedure is to include the size of the population in the relevant age groups as an explanatory variable. The proto-typical example is the time-series literature on the effect of the minimum wage in the US, where the primary task is to trace the impact of the minimum wage on the employment of teenagers.[xiii] A prominent example is the analysis in Kennan's (1995) careful review, which builds on the procedures in the literature reviewed by Brown, Gilroy and Kohen (1982). In part because of the expected weak effect of changes in the American federal minimum wage, Kennan (1995) prefers to draw inferences about the issue from cross-sectional variation. This is not possible in the present case, as Danish apprentices are covered by the same agreements, so any inference about the issue must necessarily be drawn from the time-series variation in the wages of apprentices. The results of the present paper with respect to the sign and significance of the wage effect are not sensitive to an omission of the youth cohort in the estimations. However, as is obvious from the description of the

series in the foregoing section, a level regression without U yields residuals, which track changes in the youth cohort, and thus gives rise to problems when drawing inferences about the estimated parameters.[xiv]

An alternative procedure is to estimate the demand for apprentices relative to other workers based on equation (1.4). Also included in this estimation is U/P, the youth cohort relative to the population aged 20-64. One cannot reject that the variables are $I(1)$ according to Dickey-Fuller tests.

A regression of A/N on w_A^n/w_N, U/P and a trend gives residuals that cannot be rejected as being $I(1)$. A regression of the changes in the residuals on the lagged level of the residuals gives a t-value of -3.62 and because McKinnon's five per cent critical value for the rejection of the null hypothesis of a unit root is -3.78 in this case, the variables are thus not far from co-integrating.

The preferred result of an autoregressive distributed lag model is:

$$\ln \frac{A}{N} = 1.367 - 0.334 \ln \frac{w_A^n}{w_N} + 0.727 \ln \left(\frac{A}{N} \right)_{-1} + 0.006t + 0.329 \ln \left(\frac{U}{P} \right)_{-1} \tag{1.6}$$
$$\phantom{\ln \frac{A}{N} =} (0.654) \quad (0.111) \qquad\quad (0.088) \qquad\qquad (0.002) \quad (0.142)$$

$$+0.272 \Delta \ln \left(\frac{A}{N} \right)_{-1} + 0.328 D76$$
$$(0.105) \qquad\qquad\qquad (0.073)$$

$$R^2 = 0.911 \quad \hat{\sigma} = 0.0640 \quad T = 1950 - 2002$$
$$F_{ar}(2,44) = 2.210 \quad F_{arch}(1,44) = 0.635 \quad \chi^2_{nd}(2) = 0.527$$
$$F_{he}(11,34) = 0.560 \quad F_{RESET}(1,45) = 2.396$$

All the coefficients to the explanatory variables are significantly different from zero on a five per cent level applying the critical values from the normal distribution. The tests for misspecification indicate that absence of problems cannot be rejected. [xv]

The regression equation can be interpreted as though the inflow of apprentices adjusts towards a long-run equilibrium according to a partial adjustment mechanism, where the estimate of the ad-

justment parameter is one minus the coefficient to the lagged value of the dependent variable. The long-run estimate of the wage elasticity is thus -1.223, while the effect of the youth cohort relative to the population size is 1.205.[xvi]

Even after deducting the wage subsidy, the relative wages of apprentices show a secular upward drift, as seen from Figure 4, but inflow and employment of apprentices also show a secular upward drift to the high present level, as seen in Figure 3. In order to reconcile these developments, consider equation (1.4), where the relative increase in the wages of apprentices draws in the direction of a decrease in the relative inflow of apprentices on the left-hand side. This can be counteracted if the last term in the equation is positive, and as the estimate of the elasticity of substitution (σ) is larger than one, the necessary condition is that the increase in the productivity of apprentices (λ) is larger than the increase in the productivity of other workers (μ).

There are good reasons for the conjecture that the productivity of apprentices has gone up considerably. In the beginning of the estimation period, the apprentices were very young; most of them had only attended the seven years of statutory primary education at the beginning of their contracts. Not only have all current apprentices now completed nine years of statutory primary education, many of them have also participated in further general schooling. In addition comes the increased quality of schooling during the contract period. The apprentices now participate in day schools for several weeks a couple of times during their contracts. Up to the last part of the 1950s, the apprentices went to school at night after working with their masters during the day, which limited the intensity of learning. In addition to the increase in the amount of formal schooling in trade schools and technical schools, these schools have been furnished with an amount of equipment for the purpose of training apprentices that is incomparable with what was available in the 1950s.

From time to time, campaigns have been initiated to persuade firms to employ more apprentices. Experiments with inclusion of dummies in the estimating equations for time periods with campaigns indicate that one cannot reject the hypothesis that campaigns have zero effect on the intake of apprentices. During the sample period, supplementary dummies are on the borderline of significance in two instances with coefficients about two times the root mean square error of the estimating equations (and from the timing, it is questionable to what extent the dummies can be associated

with the effects of campaigns). To the extent that campaigns have had an impact on the intake of apprentices, the magnitude appears to be moderate.

The estimating equations have been developed under simplifying assumptions. Among others, they ignore the possibility that higher wages to apprentices might lead to higher productivity. In the non-competitive framework of Acemoglu and Pischke (1999), higher wages to low productive workers might induce firms to invest in training so that the productivity of the worker increases to the wage level. However, the dependent variable in the present regressions is the inflow of new apprentices. The line of thought is that firms react on the benefits and costs of employing new apprentices during the contract and omit entering into an employment relation if costs exceed benefit. Nevertheless, one might argue that the increased relative pay of apprentices has speeded up the training of the apprentice with the result that firms have a longer period to recoup the training costs. The same is the case with the shortening of contract durations, which has taken place during the sampling period.

In this section, I have presented evidence for the determinants of the aggregate employment of apprentices in Denmark, and the main finding is that employment of apprentices appears to be sensitive to the cost of employing apprentices. The cost variable comes out significantly different from zero in both of the presented equations, and, in both cases, the magnitude of the long-run wage elasticity is not far from one.

The long-run wage elasticity can be interpreted as an estimate of the elasticity of substitution between apprentices and other workers. The elasticity of demand for apprentices can be approximated by the elasticity of substitution, as the employment share of apprentices is below five per cent and the cost share is even smaller. An elasticity slightly larger than one is not out of line with the results in Stevens (1994) for the British engineering industry. According to the survey in Hamermesh (1993), there is a considerable variation in the estimates of elasticities of demand for labour for various groups on the labour market and estimates both below and above one are common.

V DISCUSSION

This paper has presented an overview of the apprenticeship system in a country that has been successful in providing employer-led training on a large scale for entrants on the labour market. The overview contains both policy issues and the evolution of central variables that are crucial for assessing the system.

The proportion of young Danes who enter into contracts as apprentices has shown a secular upward trend from a level below 20 per cent in the late 1930s to about 45 per cent in the late 1990s. This is remarkable compared to many other countries, where the lack of employer-provided training is often lamented about outspokenly.

The development in the inflow of apprentices was analysed in order to assess the magnitude of the impact of the business cycle, the youth cohort and the costs of educating apprentices. The cost variable is of special policy interest, as subsidies to employ apprentices are an integral part of the system. Because the results indicated a highly significant and substantial impact of the cost variable, employment subsidies appear at face value to be effective in furthering training.

Employment subsidies have played a central role in the recent literature about failures in the market for training and the potential remedies for this problem. The absence of apprenticeship systems in most countries is often attributed to the lack of enforceability of such contracts in competitive labour markets. A labour relation system characterised by collective bargaining is a common characteristic in the countries, which have an extensive apprenticeship system.

The system not only exists in large scale, but has also expanded. One could point to two major prerequisites for this successful development.

The first is that apprenticeship contracts must be enforceable so that both apprentices and employers have sufficient incentives to fulfil the contracts. Elements in making contracts enforceable are standards of certification, which are recognised nationally, and a collective bargaining system in which certification is necessary to obtain a wage rate as a skilled worker. In addition, a legal system has

been created in which apprentices and employers who violate contracts are fined in a smooth and expedient manner. However, this is not enough to explain the expansion of the system.

A second prerequisite for the increased supply of new skilled workers is that adjustment of the apprenticeship programmes has to take place according to the development of skill requirements on the labour market. Supply and demand for training takes place within an institutional framework. Major adjustments or reforms have taken place only three times during more than half a century and the main content of the reforms was concerned with the amount of formal schooling either before or during the contract. The adjustment of existing apprenticeship programmes and the establishment of new ones have taken place in this stable institutional framework. Representatives of employer and employee organisations are not only responsible for the certification of each apprentice, but the organisations are also major shareholders in the fine-tuning of the system of different apprenticeship programmes.

The involvement of employer and employee organisations in the operation and gradual adjustment of the apprenticeship system is comparable to the German experience. However, it is in sharp contrast to e.g. the British policy in the area of vocational training, which has been characterised by an array of major changes and reforms initiated by various governments. This underscores the crucial role of institutions in the operation of youth training in the form of apprenticeship programmes.

Data

The data for the current analyses have been pieced together from various sources by the author. Inflow of apprentices is published by Statistics Denmark. The inflow before the start of the registry-based statistics in 1974 is reduced by five per cent, corresponding to the drop in the ratio to independent statistics collected by the Directorate of Labour. The wages for apprentices is comprised of the average wages published by the Confederation of Danish Employers. The amount of the permanent subsidy is calculated as the total amount of money paid out according to the accounts of the institution, which administer the system, divided by an employment measure calculated by the author. Subsidies on top of the permanent subsidy have taken various forms, and for some of them the amount per hour has been calculated from the total amount of money paid out, while others have been a fixed amount per apprentice. The major source for the rest of the data is a macro-economic database run by Statistics Denmark. Readers, who master one of the Scandinavian languages, have the option of consulting a more detailed description of the construction of the data in Albæk (2004).

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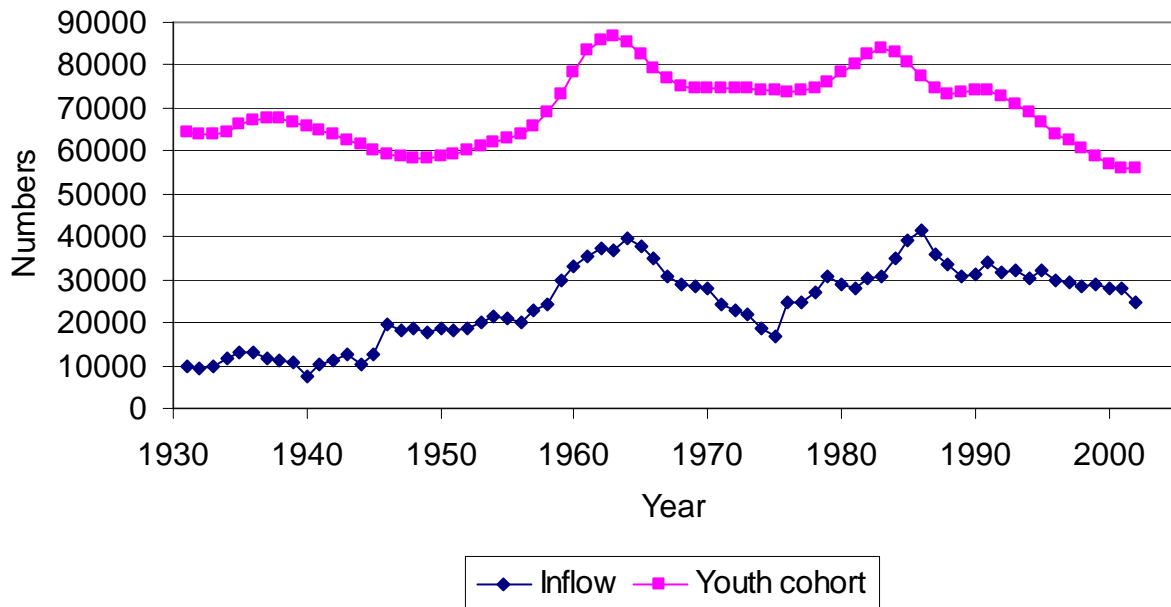**Figure 1. The inflow of apprentices and the youth cohort, 1931-2002**

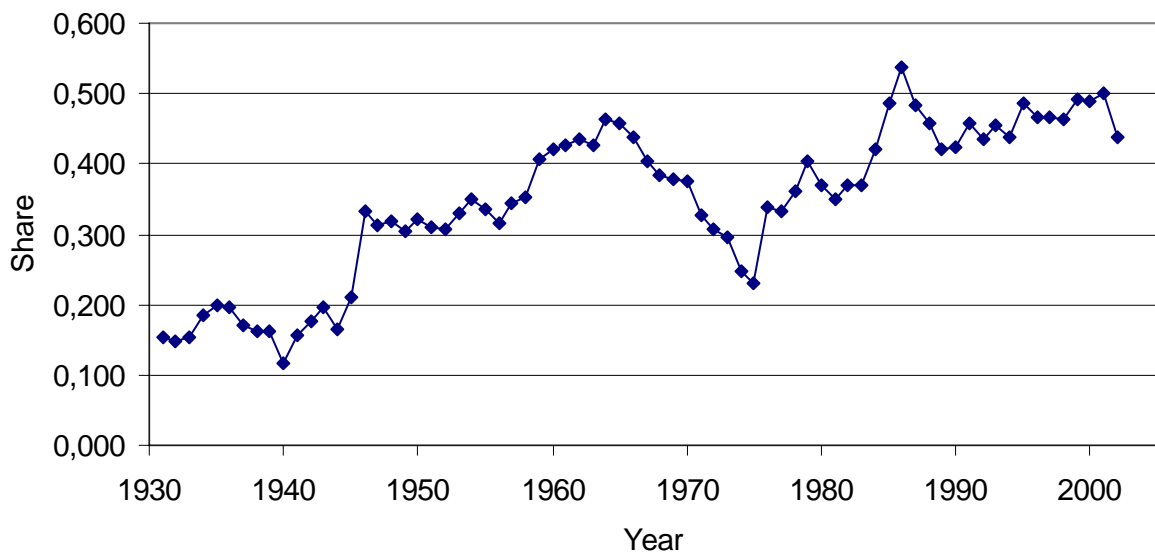**Figure 2. Inflow af apprentices as a proportion of the youth cohort, 1931-2002**

Figure 3. Wages of apprentices as a proportion of wages for unskilled workers before and after employment subsidies, 1936-2002
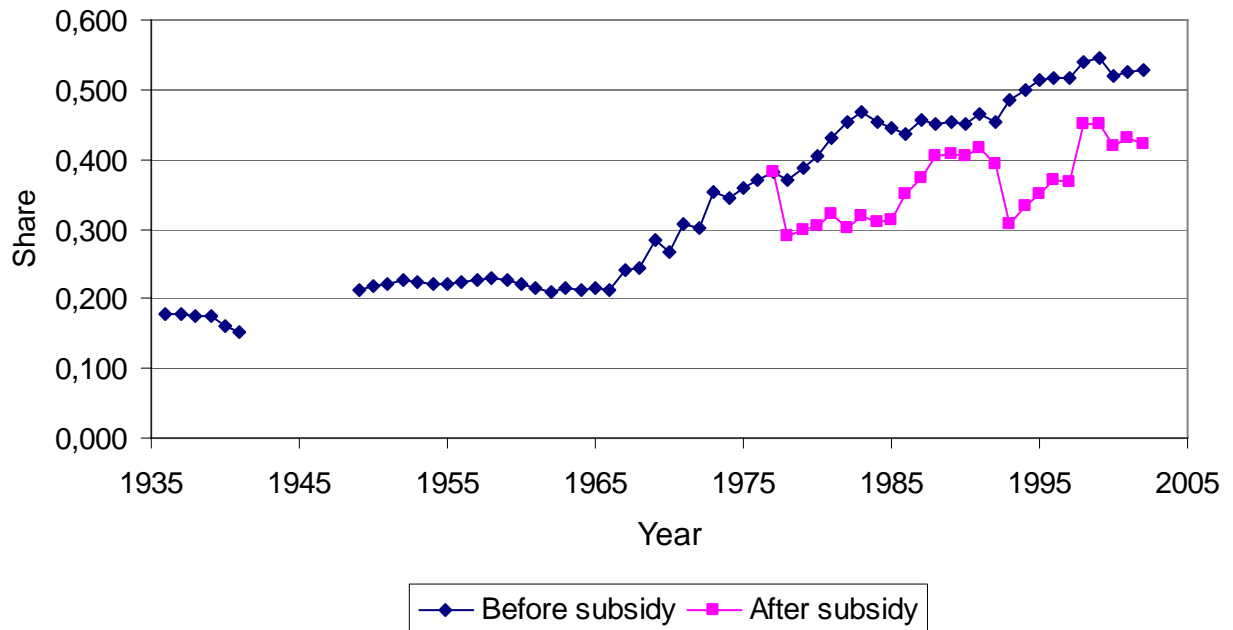
Table 1. The inflow of apprentices distributed according to type of education, 1939-2000. Per cent.

Year	1939	1950	1960	1970	1980	1990	2000
Type of education							
Commerce, clerical trades	34	34	39	41	42	44	40
Construction	22	22	19	25	20	15	20
Iron and metal	26	23	23	25	24	21	17
Graphic	3	3	3	2	2	2	2
Technical and other industry	4	5	1	0	0	0	1
Service	3	5	6	2	2	2	3
Food industry and home economics	7	7	6	4	9	12	10
Agriculture and fishing	0	2	1	1	1	2	2
Transportation, etc.	0	0	0	0	0	1	3
Health	0	0	0	0	0	0	1
Public security	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100
Numbers	10856	18856	30931[*]	27092[*]	28817	31284	27846

Notes: [*] These numbers are smaller than the inflow as not all new apprentices were classified according to type of education.

The classification is in accordance with UNESCO's International Standard Classification of Education (ISCED) of 1997. The detailed vocational classifications in the previous years are rearranged and aggregated to fit the 1997 classification. Source: Statistics Denmark.

Endnotes:

[i] See for example Stevens (1994), Booth and Chatterji (1998) and Acemoglu and Prishke (1999).

[ii] The union density in Switzerland is not much below the one in Germany according to OECD (1994), Table 5.8, p. 10.

[iii] See Stevens (1999) for an assessment of the UK vocational training policy in light of these problems on the market for training, including the role of the apprenticeship system.

[iv] In addition, the required levels of qualifications are also specified. Ministerial orders from the Ministry of Education specify both the length, the qualifications, the amount of schooling and the examination system for each type of apprenticeship.

[v] These figures are calculated from the Confederation of Danish Employers (2000).

[vi] Malcomson et al. (2003) note on p. 224: "The extensive use of institutions to set and monitor standards of training is also indicative that contractual enforcement of standards by individual trainees appealing to courts is not straightforward." They furthermore state on p. 216 that if "… regulating the curriculum of training programmes and setting tests of competence"… "were 100% effective, it would make the amount of training verifiable and the issues discussed here would go away."

[vii] Recent examples include programmes training data mechanics, plastic operators, and a programme in which the apprentices acquire knowledge about the various types of concrete used in the industrialised building industry. In Germany, there has been considerable updating of existing programmes and the creation of new training programmes during the late 1990s, see Ertl (2004), pp. 124-125. This has included new programmes for training event managers, automobile dealers and stage designers.

[viii] For evidence on the lack of trade union influence on apprenticeship trainin in Britain see Gospel (1994) and Ryan et al. (2007).

[ix] The author has not heard of any Danish firms that have special units for educating apprentices nowadays. Special units for educating apprentices in larger firms play a role in both the German and the English debate about the apprenticeship system, see e.g. Franz and Soskice (1995), p. 214.

[x] Unless otherwise is stated, the exposition is based on material from the EC institution, The European Centre for the Development of Vocational Training, abbreviated Cedefop. The material is the yearly country reports, Cedefop (2006b), and the reports on Austria, Cedefop (2006a), on Ireland, Cedefop (2004a), and on the Netherlands, Cedefop (2004b).

[xi] The number of diplomas in 2003 was 54,700. This figure is divided by the approximate size of a youth cohort on 200,000, as assessed from the homepage of Statistics Netherlands.

[xii] Omission of the youth cohort in equation (1.5) leads to a pure demand relation and this gives a long-run wage coefficient of -1.100.

[xiii] The minimum wage in the US is in some respects analogous to the apprentice wage. In both cases the major effect is expected to arise in specific younger age classes and the agreed wages for apprentices are extended to employers who are not covered by collective agreements. This effectively makes the agreed wage a state-enforced minimum wage for apprentices.

[xiv] Extending the level regression to be an augmented distributed lag model is a remedy for the serial correlation in the residuals. In some instances, the dynamics do a good job mimicking the effect of the omitted youth cohort, especially for estimations over a shorter time span. A prominent example is Stevens (1994), where the dependent variable is the recruitment of first-year craft apprentices by the engineering industries divided by craft employment for the sample period 1966 to 1988. The explanatory variables include the lagged dependent variable but not a measure of the youth cohort. From the "Statbase" at the homepage of the UK National Statistics, one can obtain the number of live births in England and Wales and thus construct an approximate series of the number of 16 year-olds in residence between 1966 and 1988. From visual inspection, there appears to be a clear positive correlation between this series and the recruitment series of apprentices displayed in Figure 1 in Stevens (1994).

[xv] According to tests in recursive estimation, the parameters are stable from the mid-1970s and there are no problems with structural breaks (the break-point Chow test rejects breaks and the same is true with the one-step Chow test, with the exception of one year when the test statistic is on the one per cent significance borderline). In the previous model, (1.5), parameter instability and structural breaks are rejected if the trend were omitted, but this renders some of the explanatory variables insignificant.

[xvi] An alternative to estimating single equations is the multivariate co-integration method of Johansen (1996). When such a system is estimated on the variables in levels, the result is that one co-integrating relation cannot be rejected. The outcome is thus an error correction model analogous to the single equation (1.5). The variables entering the ratio regression (1.6) do not lend themselves to analysis of co-integration, which is rejected also in the multivariate setting. Omission of the youth cohort in equation (1.6) leads to a pure demand relation and this gives a long run wage coefficient on -2.164.