Labour Force Participation and Education*

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Abstract

A simplistic view of the cross-sectional positive relationship between education and labour force participation would surmise that the historical educational lift across birth cohorts should have increased participation. But instead, participation rates have trended down in recent years – especially for males. In this paper we analyse the development in labour force participation of cohorts of males and females with different levels of education, and how it has been affected by the labour market situation of individual cohort groups. We are particularly interested in the impact of increasing education levels across cohorts and the extent to which this may have affected labour force participation rates of groups with different education levels – and in turn, the overall participation for males and females.

Indeed, despite a huge upwards shift in education levels across birth cohorts, the overall labour force participation rate has trended down. As such, it seems obvious to conclude that the marginal participation effect of increasing the education level of new cohorts is much less than 100 per cent. We demonstrate that an important explanation for the absent increase in labour force participation is the so-called *dilution effect*, whereby increasing the educating level of a cohort by lifting individuals from unskilled to skilled potentially reduce the average participation rates of both the unskilled and the skilled. Using panel data covering three and a half decades, we apply a cohort-based approach that allows us to identify

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and quantify factors that have influenced labour force participation year by year, such as business cycles, labour market policies and administrative practices. We investigate the effects of cohort specific impacts such as the increasing education attainment across cohorts and the potential scarring effects of entering the labour market during times of persistently high unemployment rates. We show through estimated gender and education specific cohort profiles of lifetime participation, that have been thoroughly cleaned from business cycle and other external influences, that only the unskilled and to a lesser extent the vocationally trained males and females have been adversely affected by the dilution effect. In contrast, the labour force participation of the tertiary educated have so far been largely unaffected. These findings contribute to understanding the historical returns to the educational lift of the labour force. However, the findings also provide new insights into the role of education in the size and the composition of the labour force going forward – insights that could be used for the labour force prognostics that feed into the government's budget forecasts and evaluation of fiscal sustainability.

1. Introduction

The study uses the detailed and comprehensive Danish administrative register data to examine the development in labour force participation over almost three and half decades. The approach allows us to identify factors that have influenced labour force participation of the core working-age population during the period from 1980 to 2013 when the birth cohorts from the early 1920s to the early 1980s were 30 to 59 years old.

A new cohort-based method is applied to quantify cohort specific effects for gender and education groups. The method allows us to quantify the impacts of factors that have influenced these cohort effects such as the so-called dilution effect i.e., the phenomenon that increasing the education level from one birth cohort to the next has the potential to decrease participation rates of education groups because the educational lift has reduced the average innate ability of individual education groups. The extent of the dilution effect on individual education groups has important implications for the labour force going forward – both for the size and composition of the labour force, but also for economic factors that relate to the education of the labour force such as productivity, unemployment and work hours.

Using the past to prognosticate the future labour force is fraught with methodological issues (see for example Rees (2006), Hyndman et all (2008) and Url et al (2016)). A main difficulty is how to quantify and account for the effects of the many labour market policies and administrative practices that have affected participation either temporarily or more permanently. It is evident that many of these policies have been overlapping and interacting in ways that hamper at-

tempts to identify effects of individual policies. Adding to that, definitional changes over time have created data breaks that must be accounted for.

While these factors can explain some of the variations in labour force participation over time, they do little to explain the overall trend in participation rates in recent years, which is strongly impacted by cohort specific participation patterns. In the present study, we endeavour to explain these cohort effects, and we do so by identifying the cohort effects separately by gender and educational attainment. Two main findings emerge.

The first finding is a strong negative relationship between the lifetime labour force participation and the educational attainment of birth cohorts of males. The observed positive cross-sectional relationship between education attainment and participation would suggest that increasing education should lift participation rates across the cohorts. Instead, participation rates have decreased across all male cohorts. For females, the picture is more ambiguous, although the younger cohorts of females in our sample display similar patterns as males.[1]

The overall male labour force participation has declined as participation has declined for most educational levels. To explain this apparent conundrum, it has been suggested that the marginal effect on labour force participation of increasing education is decreasing as a result of the dilution effect. A previous study suggests that only around one-third of the full effect of increased educational level of new birth cohorts can be translated into increasing labour force participation – in other words, there has been an average *dilution effect* of 61 per cent or, equivalently, a throughput of 39 per cent of the full effect (Søgaard, 2011).[2]

The present study also finds strong evidence of a dilution effect, which helps explain why overall labour force participation does not reflect the increasing educational attainment across birth cohorts. Historically, however, the dilution effect has predominantly reduced the labour force participation rates for the dwindling group of unskilled, and to some extent for the vocationally trained, while tertiary educations are largely unaffected.

1. The convergence of female labour force participation toward the end of the 1980s meant that the older cohorts in the sample had increasing participation rates concurring with increasing education levels. This changed for the females born after some time in the mid-sixties, whereafter the participation patterns of female cohorts start looking increasingly like their male counterparts.
2. These estimates of dilution have been used in recent years for labour force projections by the Ministry of Finance as well as the DREAM group to calculate fiscal sustainability indices (see also Finansministeriet, 2015 and Hansen, 2016). Søgaard (2011) estimates average dilution effects across all cohorts of gender and education groups by using first differences. In contrast, the present study differentiates between gender and education groups. Importantly, we find that there has been no dilution for older cohorts of females and that displacement is increasing over time for younger cohorts of unskilled males and females.

The results imply that the overall participation effect of increasing the level of education for new cohorts depends on the composition of the changes. To illustrate this, a lift by 1 percentage point of a cohort from ground schooling to secondary schooling is estimated to increase the overall lifetime participation rate for the cohort by 0.05 percentage points for males and 0.12 percentage points for females. This is equivalent to 19 and 43 per cent of the full mechanical effect of 0.24 and 0.27 percentage point increase in the absence of dilution. If instead a 1 percentage point of ground school educated is elevated to vocational educations (assuming that the share for all other educations remain unchanged), then the overall participation rate for the cohort is estimated to increase by 0.08 percentage points for males and 0.18 percentage points for females. The throughput is also higher at 24 and 51 per cent of the full increase (of 0.32 and 0.36 percentage points).

Since the current study was conducted (Bækgaard and Helsø, 2018), there have been two separate studies that specifically set out to measure the marginal employment effect of elevating a person with ground schooling to a vocational education (Danish Economic Councils, 2018 (DØRS) and Arbejderbevægelsens Erhvervsråd, 2019 (AER)).[3] Both studies look at the effect on employment rates and they apply similar identification strategies (probit regressions and propensity score matching respectively). Methodologically, these studies rely on using "enough" background information about individuals to be able to explain who takes a vocational education, and the remaining differences in employment rates are then assumed to be attributable to having a vocational education. This assumption has not been tested empirically. Indeed, it is possible to think of a range of omitted factors that, if included, would likely reduce the estimated throughput of a vocational education on employment. The two studies look at the employment effect at the age of 29 and 30 years respectively. This sets them apart from the current study that quantifies the effect from a whole-of-life perspective (at the age of 30 to 59 years).

Both studies distinguish between the average and the marginal throughput. DØRS find an average throughput of 81 per cent, which is slightly less than the 86 per cent found by AER. The difference can presumably be attributed to DØRS including more individual characteristics than AER. The two studies both set out to estimate marginal employment effects by identifying the unskilled who are most likely (able or inclined) to take a vocational education. By excluding unskilled who are disability pensioners, AER's throughput is reduced to 68 per cent, which

3. These studies only compare ground schooling and vocational education. The partial approach is less useful for the labour force forecasting undertaken by government agencies in Denmark (e.g. Ministry of Finance and the DREAM group). In contrast, Søgaard (2011) and the present study are *global* in the sense that they look at the educational composition of the entire population, which makes them directly applicable for general labour force forecasting.

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is then presented as a marginal effect. DØRS, in contrast, develops an index score that ranks the unskilled 29-year-olds according to their probability of taking a vocational education. They find that the 10 per cent of the unskilled that are most likely to take a vocational education have an average employment effect of 14 per cent, which equates to a throughput of 39 per cent of the full effect. In spite of the methodology differences, this result is quite close to our estimate of the average throughput of 38 per cent (24 per cent for males and 51 per cent for females).

A secondary finding of our analysis is the existence of a strong relationship between the lifetime labour force participation of male education cohorts and the labour market situation when the cohorts entered the labour market. This result is derived using the structural unemployment rate as a proxy for the labour market situation. It demonstrates that males with vocational or tertiary educations entering the labour market during the period of persistently high unemployment in the 1980s and early 1990s have lower lifetime participation than both older and younger cohorts. This result only applies to males as the female labour market convergence process was still in progress up until around 1990.

The results have obvious and profound policy implications. The finding that dilution mainly affects the unskilled is important for at least two reasons. Firstly, it has implications for the educational composition of the labour force going forward, and hence for future skills and productivity growth as higher education is also associated with higher productivity (se for example *Finansredegørelsen (2014)*). Secondly, it is important for the public returns to education, that an increase in the education level of new birth cohorts may reduce participation rates for the smaller group left behind as unskilled, but not the participation rates for the growing group of tertiary qualified. This finding adds important nuance to previous research that averaged dilution across cohorts and across gender and education groups (Søgaard, 2011).

The result that the lifetime participation of cohorts with a tertiary education is impacted by the labour market structures around the time of career start is important for several reasons. First of all, it provides a plausible explanation for the relatively low participation rates of the tertiary educated cohorts born in the 1950s and the early 1960s. Secondly, it adds nuance to the resent finding that starting the career in an economic downturn does not have permanent or scarring effect on implicated cohorts.[4] Finally, the evidence of a scarring effect of prolonged pe-

4. Andersen et al (2016) find that an economic downturn does not have a scarring effect on the employment rates of cohorts. However, the authors relate the employment rates of cohorts to the *output gap*, which "aims to measure the deviation of the level of activity from its structural level" and, like the unemployment gap, the output gap tend to oscillate around zero. In contrast, we use structural unemployment that specifically levels out business fluctuations as it aims to measure the persistent structural status of the labour market. Hence, a scarring effect of "bad" structures does not contradict the absence of business cycle scarring effects.

riods of high unemployment serves to emphasise the importance of maintaining good practices in labour market policies so as to avoid future situations where unfortunate cohorts end up with lower lifetime outcomes.

2. Data

The focus of the study is the development in the labour force participation for 30 to 59-year-olds with different educational backgrounds. This age group was chosen to limit implications of changing study activity – most 30-year-olds have left school – and changing retirement behavior for the 60+ year olds. We look at the period since 1980 for which detailed administrative records for individuals are available. The main source of information is the Danish administrative register for labour force statstics (Regiserbaseret Arbejdsstyrkestatistik, RAS) with records of labour market status for the full Danish resident population each year since 1980. With data from 1980 to 2013 we have used 34 annual data points.

The information about labour force participation of individuals in the RAS is a summary status of the broader socioeconomic status in the last week of November each year. The information about socioeconomic status has undergone changes over the years, but the main status as either employed, unemployed of out of the labour force has been fairly consistent throughout the period. Nevertheless, there have been definitional changes and data breaks that we need to account for (see below). Additional information about demographics and educational status is drawn from a number of different administrative registers (see also Appendix B).

3. Labour force participation historically

The overall development in labour force participation of 30 to 59-year-old males and females differ substantially, *cf. figure 1*.[5] The series reveal some interesting features that reflect the general labour market trends and policies of the period.

The first thing to note is that while male participation has declined throughout most of the period, there have been ups and downs for female participation. Nevertheless, the convergence of male and female participation rates has continued throughout most of the period, especially during the eighties where the gap between male and female participation narrowed from 17.5 percentage points in 1980 to 7.0 percentage points in 1990. The gender participation gap then shrunk further to 5.7 percentage points in 2000 and 4.0 percentage points in 2015. Initially, the convergence was a result of both an increase in female participation and a

5. The chart also plots the ILO labour force definition based on the Eurostat Labour Force Survey as it shows a somewhat different picture that puts the development in its admin counterparts into perspective (see Bækgaard and Helsø, 2018).

smaller decrease in male participation. While the increase in female participation in the eighties was a completion of an earlier trend, it is harder to explain the ongoing decline in male participation.

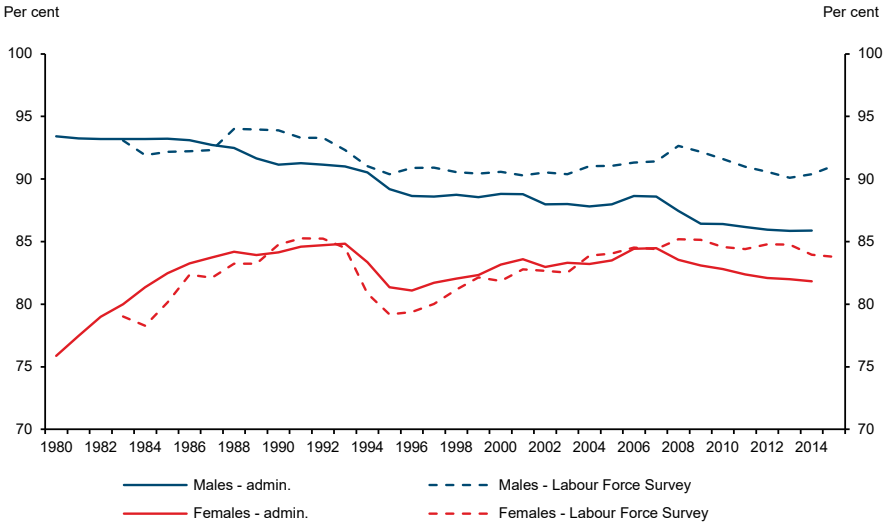

Figure 1 Labour force participation 1980 to 2015, 30n-59-year-old males and females

Note:: The Eurostat-LFS has been conducted in Denmark since 1983. From 1983 to 1993 it was done once a year (in spring) and from 1994 it was conducted continuously throughout the year.

Source: Danmarks Statistik's administrative records (RAS) and Eurostat Labour Force Survey (http://ec.europa.eu/eurostat/web/lfs).

The increasing female participation of the eighties came to an end in the early nineties and reversed sharply towards the midnineties with the introduction of three so-called *labour market leave schemes* (orlovsordninger) and the *transition benefit scheme* (overgangsydelse), which was an early retirement scheme for 50 to 59-year-olds. These programs were temporary measures, specifically aimed at reducing unemployment by reducing labour force participation. They were the main reason for the pronounced decrease in participation in the mid-nineties – for females in particular.

The *transition benefit scheme* was initially available for 55 to 59-year-olds and later extended to 50 to 54-year-olds. The scheme was abolished in 1996 and was fully phased-out by 2006 when the last recipients had turned 60 years. At its peak in 1996 there were more than 46,000 50 to 59-year-olds on transition benefits, which is equivalent to 2.5 and 9.5 per cent of the labour force aged 30 to 59 and 50 to 59 years respectively.

The voluntary *labour market leave schemes* comprised three separate programs for child minding leave, education leave and sabbatical leave. The schemes be-

came extremely popular, and in the first years after their introduction in 1994, participation exceeded more than 70,000 persons, thus effectively reducing the labour force by more than 2.5 percentage points. The leave schemes were phased-out over the following decade.

The years 2002 and 2008 represented two major data breaks that reduced the measured employment and labour force participation. In 2002 the administrative classifications of status as employee and self-employed were revised, resulting in a reduction in the overall labour force participation rate by about 0.65 percentage points (Danmarks Statistik, 2004).

The introduction of a new income reporting system in 2008 (*eIndkomst*) was a major improvement in the registration of salaried employment, which resulted in a significant decrease in registered employment. At the same time, the definition of unemployment was extended to include individuals participating in active labour market programs. The data break is clearly visible as a one-off drop in labour force participation rates in 2008 for both males and females, *cf. figure 1*. For further examples of policy developments and administrative practices that have affected labour force participation refer to Bækgaard and Helsø (2018).

Labour force participation is positively correlated with educational attainment for both males and females. The unskilled have the lowest and long tertiary have the highest participation rates, *cf. figure 2*. For all education levels, participation was increasing for females and decreasing for males in the early part of the period. In the mid-nineties, participation dropped for all groups as a result of a series of new labour market policies, but more so for women and for lower education groups. Since then, participation has either picked up or leveled out for tertiary education groups, while participation rates for unskilled have continued to decline.

As a consequence, the gap between participation for educational groups has increased over time. In 1980, the gap between labour force participation for males with a long tertiary education and males with ground schooling was 8 percentage points. In 2000 the gap had increased to 15 percentage points and in 2015 further to 24 percentage points. For females, the educational gap narrowed in the eighties from 25 to 19 percentage points as a result of the convergence of participation for females with ground schooling and vocational educations. Nevertheless, since the early nineties the education gap has also widened dramatically for females, and in 2015 the participation rate for females with a long tertiary education was 35 percentage points higher than for females with only ground schooling.

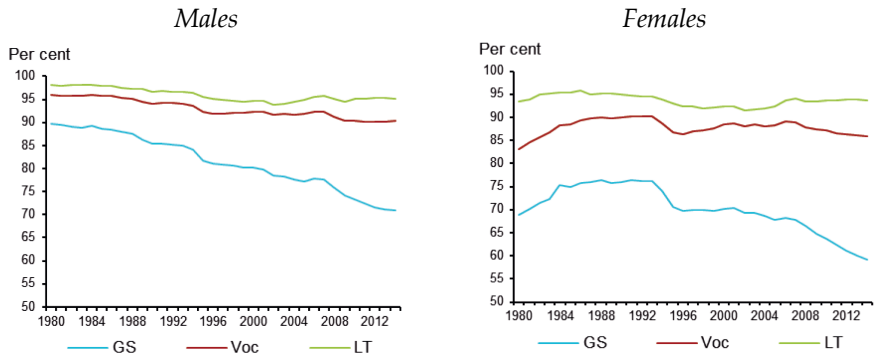

Figure 2 Labour force participation and education

Note: The charts include 30-59-year-old males and females. GS: Ground schooling; Voc: Vocational training; LT: Long tertiary education.
Source: Danmarks Statistik's administrative records (RAS).

The raw data also suggest that the declining participation in recent years is mainly a result of declining participation of the lower education groups – in particular for ground schooling. At the other end, the participation of 30 to 59-year-olds with a long tertiary education has picked up in recent years. In other words, there are no immediate signs of dilution effects in operation at the tertiary level.
Looking instead at labour force participation rates of birth cohorts reveals further insight into the differences between males and females with different education levels, *cf. figure 3*. The participation rates for male cohorts with only ground school education all have similar age profiles with annual linear decline rates of around 2/3 percentage point. For females with ground schooling, the age profiles are similar to those of males except that the older cohorts (1940 and 1945 in the figures) show clear signs of a convergence effect in the eighties, and that the younger cohorts (1960 to 1975) show stronger positive effects of the economic upturn prior to the 2008 economic crisis. The effect of the transition benefits for 50 to 59-year-olds is clearly visible for the 1940-44 cohorts for all the education groups although the effect was stronger for females and for lower education groups.

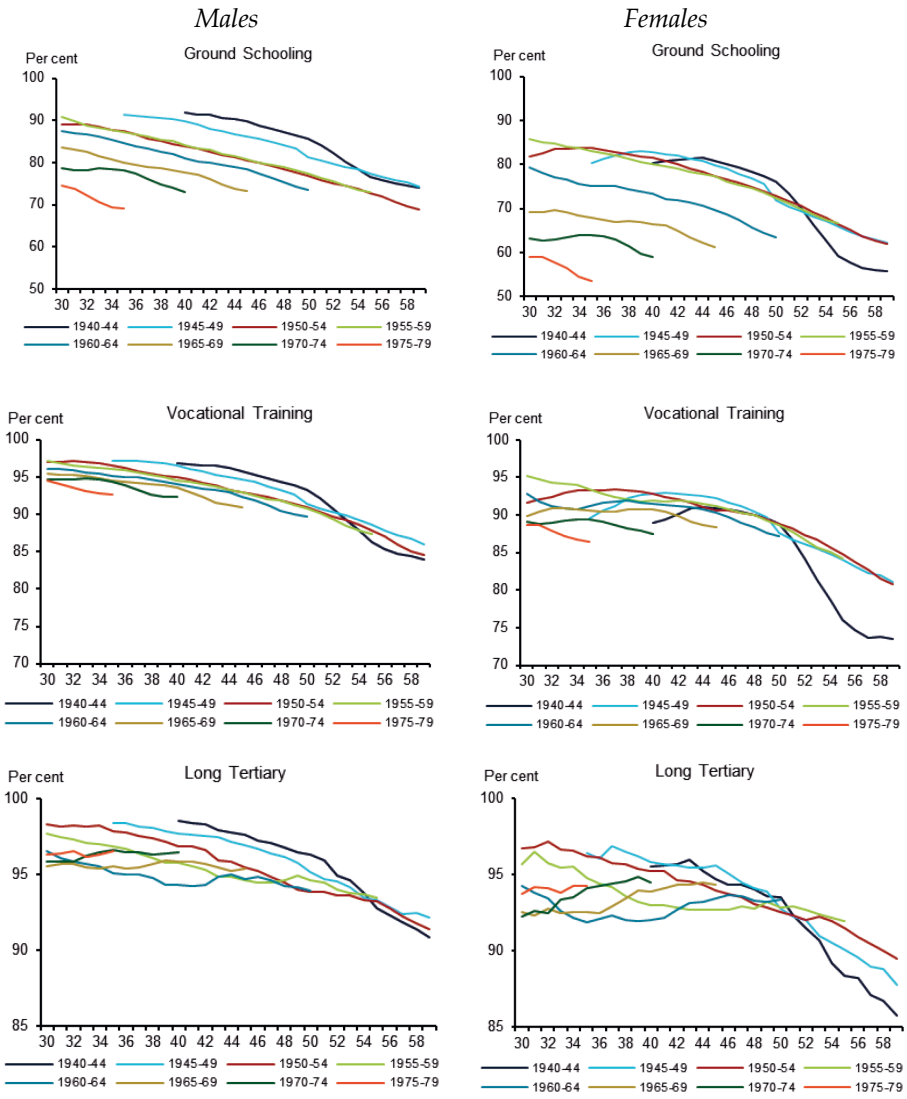

Figure 3 Labour force participation rates for birth cohorts by age

Note: The age profiles are averages for five consecutive birth cohorts. The remaining education groups are shown in Bækgaard and Helsø (2018).

Source: Own calculations based on Danmarks Statistik's administrative records (RAS).

The age profiles for the cohorts with vocational educations also decline across the cohorts, but the decline rates across age and cohort are much smaller than for ground schooling.

The groups with tertiary education – shown here for long tertiary – display some remarkable patterns across the age groups as the participation rates of under 50-year-olds for the cohorts born between the mid-fifties to the mid-sixties are

lower than both their older and younger counterparts. At the age of around 50 years, however, these cohorts have clearly caught up with the older cohorts. Interestingly, these cohorts have typically entered the labour market during the difficult years from the eighties to the mid-nineties where unemployment rates were notoriously high. The raw data show that these cohorts had reduced participation during the years when unemployment levels were high, but as the labour market structures had gradually improved, their participation rates caught up with older cohorts. Indeed, when the cohorts from around 1960 had reached the age of 50, their participation rates were as high as the cohorts from around 1950 when they were at the same age ten years prior. Similarly, the cohorts from around 1950 had caught up with cohorts from around 1940 at the age of around 55 years, but again with a ten-year time delay. If these cohorts were scarred by the labour market state that they experienced when they were young, it appears to be an enduring but not a permanent effect. However, it is difficult on the basis of these charts to separate the scarring effect from the effect of the current structure of the labour market. With the model presented in the next section, we endeavour to quantify what the changing labour market structures have meant for lifetime participation of cohorts.

4. A model for cohort specific labour market participation

We now specify a cohort group model for the lifetime labour market participation of cohorts of males and females with different educational backgrounds. The model consists of two components. As a first step, we estimate group-specific lifetime labour force participation rates for each gender, education and birth cohort group. The first step identifies and quantifies gender and education specific cohort effects on lifetime labour force participation. The second step then relates the estimated cohort effects to the cohort specific quantities that represent the educational composition and the structural unemployment rate when the cohort entered the labour market.

The two-step approach allows us to identify clean cohort effects and to explain the development across cohorts by cohort specific developments in educational composition and labour market structures over time. The cohort specific developments in educational composition are represented by a so-called *Ranking Index*, which represents the ability levels of each education group of a cohort, cf. Appendix C. As such, the Ranking Index provides a direct and tangible way to relate the cohort specific labour force participation to the educational level and composition of each cohort of males and females.

This approach has several advantages. Firstly, the Ranking Index can easily be replicated in the forecasts of the population accounting systems (labour force forecast) that are being used by the Ministry of Finance and others for budget forecasting and fiscal sustainability calculations. Secondly, the two-step method

makes it possible graphically assess the functional relationship between the development across cohorts in the gender and education specific labour force participation and the development in the Ranking Index for the same groups. Here we have chosen a piecewise linear specification based on a "best fit" assessment, although other choices of functional form would, indeed, be possible.

The main model is a group-based random effect regression model for the labour market participation rate ($LFPR_{c,i,t}$) of cohort c in year t, for group i. Group i consists of individuals with gender g, education e and ethnicity l.[6] Educational groups include ground schooling, secondary schooling, vocational training and short, medium and long tertiary qualification. An objective of the main model is to identify the overall lifetime participation rate across groups, accounting for the effects of data and policy changes, business cycles and demographics.

The model has the following specification:

$$lfpr_{c,i,t} = X_{c,i,t}\beta_{g,e} + TBS_{c,i,t}\xi_{g,e} + LLS_{c,i,t}\delta_{g,e} +$$
$$DB_t^{2002}\varphi_{g,e}^{2002,0} + age \cdot DB_t^{2002}\varphi_{g,e}^{2002,1} + DB_t^{2008}\varphi_{g,e}^{2008,0} + age \cdot DB_t^{2008}\varphi_{g,e}^{2008,1} +$$
$$SUE_t\eta_{g,e}^0 + age \cdot SUE_t\eta_{g,e}^1 + age^2 \cdot SUE_t\eta_{g,e}^2 +$$
$$UEgap_{g,t}\mu_{g,e}^0 + age \cdot UEgap_{g,t}\mu_{g,e}^1 + age^2 \cdot UEgap_{g,t}\mu_{g,e}^2 + \tau_{c,e,g} + \varepsilon_{c,i,t}$$
$$\tau_{c,e,g} \sim N(\hat{\tau}_{c,e,g}\sigma_{e,g}^{\tau 2}) \ , \ \varepsilon_{c,i,t} \sim N(0, \sigma_{e,g}^{\varepsilon 2})$$

The dependent variable is the log odds ratio of the labour force participation rate, $LFPR_{c,i,t}$ for each of the groupings of the cohorts in year t:

$$lfpr_{c,i,t} = \log\left(\frac{LFPR_{c,i,t}}{1 - \mathrm{LF}PR_{c,i,t}}\right)$$

$\tau_{c,e,g} \sim N(\hat{\tau}_{c,e,g}, \sigma_{e,g}^{\tau 2})$ denotes a cohort, gender and education specific random effect. The estimated mean values $\hat{\tau}_{c,e,g}$ are utilised to identify the cohort specific lifetime labour force participation rates, which we will explore further in the second component of the model.

The data sources and variables used are described in Appendix B, which also contains a list with variable descriptions. The model is estimated separately for

6. The observations were split-up further in three ethnic groups to improve identification of ethnicity specific effects. There are five ethnic groups in total namely natives, migrants from western countries, migrants from non-western countries, descendants of migrants from western countries, and descendants of migrants from non-western countries, but only natives and descendants are included. There are a few observations for descendants with only participants ($LFPR_{c,i,t} = 0$) or non-participants ($LFPR_{c,i,t} = 1$). These have been collapsed with natives and the relevant background variables have been adjusted accordingly, such that ethnicity dummies in these cases indicate ethnicity shares.

the 12 gender and education specific groups and though not essential, it implies that all parameters are gender and education specific. The observations are weighted by the number of people they represent. The number of years each cohort group is observed depends on their age range in the estimation period from 1980 to 2013. For females, we have only included the birth cohorts from 1940 and onwards so as to avoid complications of the strong influx of females to the labour market for the earlier cohorts. The overlapping generation structure of the panel implies that the oldest males and the youngest males and females are only observed for a few years whereas the birth cohorts in the middle (from 1950 to 1956) are in the sample for the full period from their 30th year until they drop out as 60-year-olds. In the subsequent analysis of cohort effects, the youngest and the oldest cohorts are discarded because they are only in the sample in a single year.

The background variables, $X_{c,i,t}$, contain cohort and group specific information in year t. These variables include age and age squared to account for the effect of age on labour force participation. Ethnicity is accounted for by dummy variables. Another set of variables measure the share of the age group attending educations at different levels in each year.[7]

The labour market policies and the institutional settings described in the previous section are accounted for in two different ways. Firstly, we apply dummy and proportion-of-group variables where specific information is available and where it makes sense in a grouped cohort model. Accordingly, we use specific variables that represent the labour market schemes and the two major data breaks in 2002 and 2008. More specifically, we have constructed variables for the share of each cohort group that participate in labour market leave schemes, $LLS_{c,i,t}$, and the transition benefit scheme, $TBS_{c,i,t}$, in a given year. The data breaks in 2002 and 2008 are represented by dummy variables for the years from 2002 (DB_t^{2002}) and from 2008 (DB_t^{2008}) and both are interacted with age to capture that the impact of these changes was age related.

Secondly, we use structural unemployment as a proxy for the effect of the labour market policies of the nineties and beyond that contributed to reduce unemployment by tightening eligibility for unemployment related benefits. As mentioned in the previous section, there have been a plethora of labour market reforms and institutional changes since the early nineties that have had profound impacts on labour market structures. The effects of these changes have been analysed in a large number of studies, but typically at the micro level where it is possible to estimate the impact of policy parameters such as benefit rates, eligibility rules, job search requirements and activation policies on exit rates and the duration of unemployment spells (Danish Economic Councils (2014), Dagpengekommissionen (2015), Finansministeriet (2017), (Rosholm and Svarer (2008)). In most

7. This is to account for the lower participation for the (relatively few) persons who have not completed their highest education when they turn 30.

cases, however, the incentive mechanisms through which these policy reforms work are too diverse to be represented by aggregated cohort groups and instead we use structural unemployment as a proxy for the totality of the effects of these changes.

The idea is to decompose unemployment into its structural and cyclical components and, indeed, the two components have very different impacts on labour force participation.[8] It is commonly observed, and our results broadly confirm this, that a change in the unemployment rate is associated with a reverse change in labour force participation of around 25 per cent of the change in unemployment.[9] This "rule of thumb" is a version of Okun's Law, which states that a given change in employment will result in a smaller change in participation, as the employment change is not fully reflected in changing unemployment – some of those who lose (or gain) employment during a downturn (upturn) will leave (or enter) the labour force. In the past thirty years, however, both unemployment – as measured by structural unemployment – and labour force participation have trended downward, which indicates that this relationship is a short-term rather than a long-term one. Indeed, our analysis confirms this duality between unemployment and labour force participation, that is, a negative relationship between participation and cyclical unemployment and a positive relationship with structural unemployment.

The variables for the data breaks and for structural and cyclical unemployment have been interacted by age and age squared and, by construction, by gender and education as well. There are two separate motivations behind this. Firstly, it is well-established, that the unemployment rates of population groups respond differently to cyclical movement in the economy (Bækgaard and Helsø (2018) and De Økonomiske Råds formandskab (2019)). Similarly, the data breaks in 2002 and 2008 also affected the labour force participation of population groups differently.

Secondly, our approach to measuring cohort specific components of structural labour force participation relies on the model's ability to account for the age effect on labour force participation as well as any shift in the age effect. It is not possible, however, to identify both period and cohort specific age effects. Instead, we allow for cyclical and structural shifts in the age effect, which is then a key identifying assumption for the measurement of structural cohort effects: the cohort var-

8. Cyclical unemployment is the difference between actual and structural unemployment.
9. The interpretation of the phenomenon differs somewhat depending on the definition of unemployment. The job search-based ILO definition invokes the hysteresis argument that some unemployed will not be actively looking for employment (or give up searching over time). In contrast, the administrative definition of unemployment implicates that some employees who lose their jobs will not receive benefits either because they do not qualify or simply chose not to claim.

iations in labour force participation beyond the flexible age effect is assumed to represent structural cohort effects on participation.

The model has been estimated without the foreign-born population in order to confine the cohort effects to a closed population, which will make the overlapping cohorts or generations comparable. The idea is then to relate the trajectory of the cohort effect for different educational groups to cohort specific circumstances that could have contributed to their labour supply performance. Specifically, we will endeavour to quantify an education specific dilution effect of the increasing education level of the consecutive cohorts in the panel.

Table 1 shows the estimation results as marginal effects of the estimated parameter values (the parameter estimates are shown in Appendix A). A first thing to note, is that the effects of the demographic variables are all significant and that the sizes of the effects are generally plausible. The effect of age is mostly negative and increasing with age. The exception is females and males with a long tertiary education aged in their thirties for whom the age effect is positive. Both male and female descendants of migrants from western and non-western countries have lower participation rates than natives for all education levels.

The estimation results for the data breaks in 2002 and 2008 are generally plausible and reflect the nature of these changes to the data collection and registration methods. The data breaks have both resulted in reduced labour force participation rates and as expected, the adjustments in 2008 were the larger of the two breaks. In general, the impact was decreasing with education and with age and larger for females than for males. This makes sense for at least two reasons. Firstly, the adjustments in 2008 to the registration of labour force status were mainly a result of being better able to accurately determine who is employed in the reference week. Since the young and the low educated are generally more in and out of jobs and with more frequent job changes, they are also more likely to be classified as not in the labour force as a result of these changes. Secondly, the larger adjustment for the young and the old and for females is most likely a result of the changes to the registration of maternity leave and sickness benefit (see Bækgaard and Helsø, 2018).

Table 1 Marginal parameter effects in the LFPR model for male and female education levels

	Males						Females					
Percentage point	**GS**	**SS**	**Voc**	**ST**	**MT**	**LT**	**GS**	**SS**	**Voc**	**ST**	**MT**	**LT**
Data break 2002	0.00	-0.57	-0.10	-0.16	-0.51	-0.54	-1.27	-0.36	-1.10	-0.86	-1.09	-0.67
Data break 2008	-2.72	-2.01	-2.01	-1.22	-1.38	-1.14	-3.22	-1.40	-2.24	-1.25	-1.19	-0.44
Descendant non-western	-4.32	-3.72	-5.55	-2.72	-0.90	-3.95	-1.29	-8.82	-7.93	-6.68	-4.45	-8.18
Descendant western	-7.96	-4.63	-4.01	-10.34	-3.66	-6.90	-8.64	-7.33	-4.13	-16.21	-3.19	-7.30
Age	-0.74	-0.12	-0.39	-0.22	-0.25	-0.18	-0.11	0.39	0.19	0.09	-0.10	-0.03
Labour market leave	-0.43	-0.79	-0.62	-0.62	-0.80	-1.23	-1.19	-1.49	-2.08	-1.49	-2.24	-1.49
Transition benefit	-1.07	-0.48	-0.58	-0.52	-0.76	-0.71	-0.92	-0.40	-0.76	-0.77	-1.59	-0.74
Cyclical unemployment	-0.15	-0.22	-0.17	-0.10	-0.05	-0.03	-0.30	-0.33	-0.23	-0.24	-0.17	-0.23
Structural unemployment	-0.21	0.33	-0.05	0.05	0.09	0.07	1.92	1.30	1.75	0.99	0.95	0.37
Child[a]	-	-	-	-	-	-	2.23	2.07	1.60	0.78	0.97	0.67

a. A variable for the proportion of a cohort group at a given age that have small children is included for females. The parameter is highly significant and the fact that it is positive is presumably because it represents an age effect in the group model. Indeed, the parameter is negative in an equivalent random effect probit model. GS: Ground schooling; SS: Secondary schooling; Voc: Vocational training; ST: Short tertiary education; MT: Medium tertiary education; LT: Long tertiary education.

Source: Own calculations based on Danmarks Statistik's administrative records (RAS).

The estimated compound impact of the data breaks in 2002 and 2008 is a negative adjustment of overall labour force participation by more than 2 percentage points on average. This is purely a result of definitional changes. The data breaks have of course only affected the administrative definition of labour force participation, not the labour force survey definition, and, indeed, the estimated size of the adjustments go a long way at explaining the divergence of the two definitions for the data break years seen in figure 1.

The estimated direct effects of the labour market leave schemes and the transition benefits are all negative. This is expected. The effect of participation in the leave schemes is larger for females than for males while the effect of transition benefits is roughly the same for males and females. For some groups the effect of these schemes is less than unity but for others – mainly for the leave schemes and for females – the effect of an additional 1 percentage point of an age group being on one of these benefits is associated with a more than a 1 percentage point reduction in the participation rate for the group (i.e., the parameter is larger than unity).

As expected, the effect on labour force participation of changes in the cyclical component of unemployment is negative for all groups. The average effect of a one percentage point increase in the unemployment rate is an estimated 0.2 per-

centage point decrease in participation. The effect is higher for the young and for the older age groups, cf. table A1 (Appendix A). This concords with the observation, that unemployment rates of the young and the older age groups fluctuate more with the business cycles than unemployment rates of the middle aged (DØRS, 2019). The effect is stronger for females at 0.25 than for males at 0.14, and it is decreasing with education, particularly for males, suggesting that the tertiary education groups are less dependent on business cycles. Indeed, it is estimated that the participation rate for males with a medium or a long tertiary education is only reduced by around 0.05 percentage points given a one percentage point increase in cyclical unemployment.

In contrast, we generally find a positive relationship between *structural* unemployment and labour force participation, which implicates that a decrease in structural unemployment is associated with reduced labour force participation. The effect is generally strongest for females for whom a one percentage point decrease in structural unemployment is typically associated with more than a one percentage point drop in participation. For males, the effect is higher for the youngest and, in fact, it tends to be negative for older males, especially for the unskilled and those with vocational training. This is presumably due to the abolishment of reduced unemployment period exemption for the 50-59 year olds, which was associated with increased employment rates for the affected cohorts, *cf. Finansministeriet (2017)*.

The fact that the improved labour market structures since the eighties have produced lower participation rates is hardly surprising. The reforms of the nineties and beyond have clearly reduced unemployment by improving employment incentives, but the same reforms have also moved people off the benefits that are included in the unemployment statistics. As a result, labour force participation has tended to track the downward trajectory of structural unemployment.

Apart from being an interesting result in its own right, a strong connection between reduced structural unemployment and lower labour force participation has implications for the interpretation of past developments as well as for the labour force going forward. The result that a one percentage point reduction in structural unemployment is associated with a drop in participation by around 0.8 percentage points (all else equal) suggests that improved labour market structures could account for as much as 3 to 4 percentage points drop in participation – merely as a result of 'transferring' people from unemployment benefits to other benefits such as disability pensions as well as out of the labour force without benefits. Adding to that, the data breaks in 2002 and 2008 account for more than 2 percentage points drop in participation.

In summary, these 'external' causes account for perhaps 5 to 6 percentage points drop in participation, which helps explain the divergence between the two definitions of labour force participation (cf. figure 1). However, it also points to a somewhat more optimistic expectation to the development in future participation rates than suggested by its past downward trajectory.

5. The estimated cohort effects

As shown by the age profiles for the cohorts in figure 3, the development in participation rates differs substantially for males and females and for groups with different levels of education. These age profiles reflect a host of factors that impact on the labour force participation of different groups in a given year such as changing business cycles, labour market policies and changing administrative practices. These factors have been accounted for by the model and the 'pure' cohort effects are captured by the random effect term $\tau_{c,e,g}$. The estimated mean values $\hat{\tau}_{c,e,g}$ of the random effect thus represent adjusted *lifetime participation rates* for the cohorts of males and females with different education levels.[10]

The lifetime participation rates based on the estimated $\hat{\tau}_{c,e,g}$ are shown in figure 4 for each education, gender and cohort group. The marginal cohort effects quantify relativities across cohorts when other factors are held constant. The figures show that the development in lifetime participation across cohorts of different gender and education groups follow very different trajectories. A number of interesting insights emerge.

10. The interpretation of $\hat{\tau}_{c,g,e}$ as a measure of lifetime participation reflects the fact that they represent relative participation rates across all the ages for each cohort, hence the cohort effects quantify the average lifetime participation relative to the other cohorts in the sample.

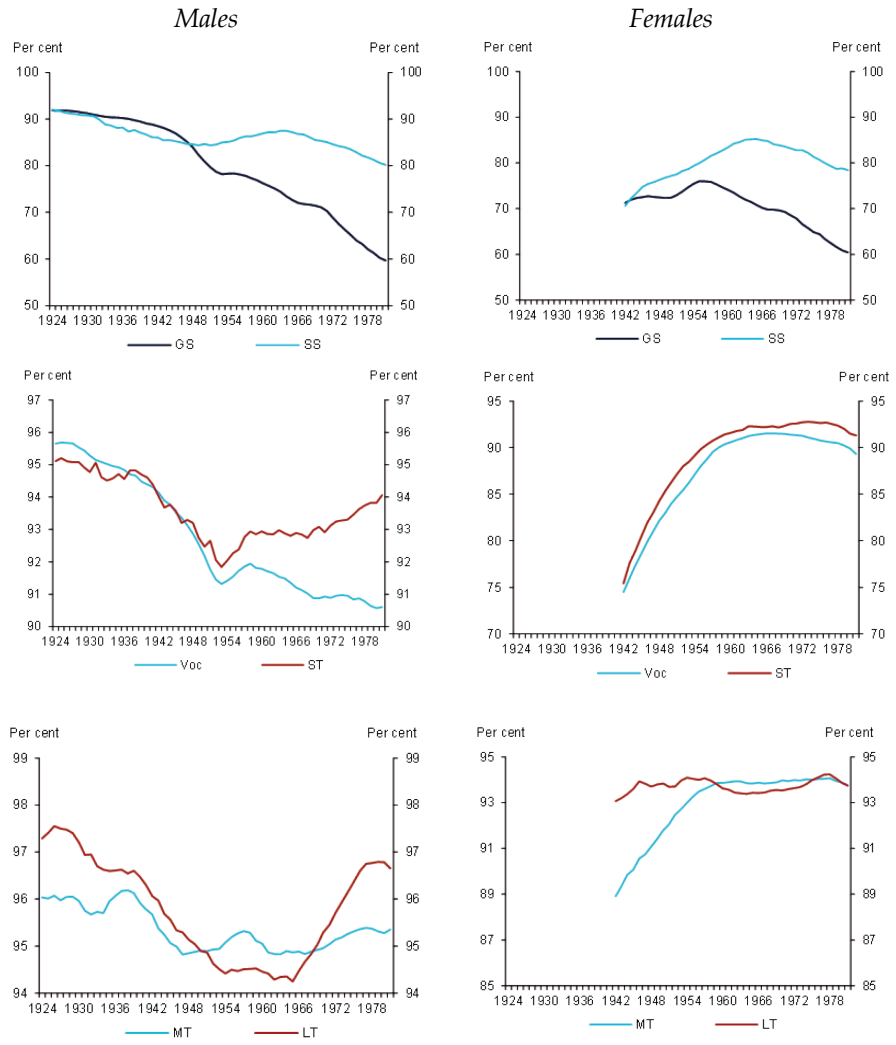

Figure 4 Estimated lifetime labour force participation rates

Note: The average labour force participation rates of the cohorts are five year averages of the estimated marginal cohort effects. The marginal cohort effects are made comparable across cohorts by setting other variables to representative values (dummies for education attendance, ethnicity, labour market programs and cyclical unemployment are set to 0, while structural unemployment is 3.2 percent for all cohorts and ages). GS: Ground schooling; SS: Secondary schooling; Voc: Vocational training; ST: Short tertiary education; MT: Medium tertiary education; LT: Long tertiary education.

Source: Own calculations based on Danmarks Statistik's administrative records (RAS).

A first thing to note is the increase in participation of the older female cohorts in the sample. The convergence is present for almost all female education groups but strongest for secondary schooling, vocational and short tertiary educations. Convergence is also visible for medium tertiary, albeit from a higher starting

point. In contrast, the females with a ground school education only display weak signs of convergence. This is presumably because a dilution effect is in operation, which tends to reduce participation (see below). The lifetime participation rates of female cohorts with a long tertiary education show very little signs of convergence as participation has been consistently high for all cohorts. In fact, less than 1 percentage point separates the cohorts with the lowest from those with the highest lifetime participation rates.

The convergence of female participation rates fades out gradually and, as such, there is not a well-defined cohort for whom the participation rates for all female education groups have fully converged. Generally, however, the convergence has been completed for the cohorts born in the mid-1950s or later. For the subsequent cohorts of females, the lifetime participation rates tend to level out, or even decline as it is the case for the unskilled with ground and secondary schooling, and to a lesser extent for vocational training.

The estimated lifetime participation for cohorts of females with ground schooling dropped by as much as 15 to 16 percentage points for the cohorts born between the mid-1950s and the early 1980s, while secondary schooling dropped by around 7 percentage points for cohorts born from the early 1960s and onwards. The labour force participation of the younger cohorts of unskilled females is very similar to their male counterparts.

There has been a dramatic downward shift in participation rates across all cohorts of males with ground schooling. The decline started at a relatively slow pace of around one quarter of a percentage point per cohort for cohorts born up until the mid-forties. The decline rate then accelerated to around a half percentage point per cohort for the cohorts born up until the early 1950s. The decline then took a small breather before increasing its pace to approximately 1 percentage point drop per cohort for the cohorts born in the seventies. Consequently, the lifetime participation rates for males with ground schooling have declined by more than 30 percentage points across the cohorts in the sample.

Initially, the participation rates for male cohorts with secondary schooling are shifting downward at the same rate as ground schooling, but only up until the cohorts born in the mid-forties, where after they level out and actually increase for the cohorts born from the early fifties to the early sixties. The participation rates then commence a decline parallel to that of females with secondary schooling, and like their female counterparts, the male cohorts with secondary schooling decline by around 7 percentage points from the early 1960s toward the youngest cohort in the panel. The obvious explanation for this striking development is that a dilution effect has been thinning out the proportion of the unskilled who are able to work as the more capable were 'educated out' of the group cohort by cohort.

The participation profiles for the cohorts of males with vocational training and short tertiary educations initially have strong similarities as they both shift down

toward cohort 1953 where after the downward trend is briefly reversed and participation rates increase for the following 4-5 cohorts. As evident from the ranking indexes for the groups (see Appendix C), the revival of participation for these cohorts coincides with a temporary reversal of an otherwise upward trend in education levels – a phenomenon that is also observed for ground schooling. This makes a very strong case for the dilution effect of increasing education at the lower rungs of the education ladder. Indeed, the evidence from the declining education levels for the cohorts born between 1954 and 1958 suggest that the dilution effect works both ways. Nevertheless, for the cohorts from around the late 1950s, the males with short tertiary education go flat and for later cohorts continue to increase, thereby forming a hammock shape and outpacing the male cohorts with vocational educations who continue the downward trend.

The cohort profiles for males with medium and long tertiary educations also display the hammock shape of their short tertiary counterparts, albeit less pronounced for males with a medium tertiary education. After a protracted sequence of cohorts with declining lifetime participation from cohort to cohort, the males with tertiary educations bounce back so that the cohorts born around 1980 are almost back at the levels of their 50 years older predecessors. The decline across the cohorts from the 1920s to the mid-1950s could have supported the notion of a dilution effect were it not for the fact that the participation rates of the cohorts born in the late 1960s and the 1970s gradually return to the levels of the older cohorts of the sample. The hammocks suggest that other factors are behind the transient decline in lifetime participation rates for cohorts of males with tertiary educations.

A plausible explanation for the underperformance of these cohorts is that they entered the labour market during a period with persistently high unemployment rates that made some individuals exit the labour force either permanently or for prolonged periods. In fact, there is a strong positive correlation between the lifetime participation rates for cohorts of males with tertiary educations and the labour market situation at the time when these cohorts entered the labour market in the years after completing their educations (see Bækgaard and Helsø, 2018).

To summarise, we have two presumptions about what might have affected the estimated cohort effects. Firstly, the increasing level of education across our sample of cohorts may have had a positive effect on overall labour force participation over time, but due to the dilution effect, the increase is smaller than the direct effect of the cross-sectional differences in participation rates for education groups. Secondly, the lifetime participation of individual cohorts is affected by the general strength of the labour market situation at the time the cohorts enter the labour market – a structural scarring effect with a negative impact on the labour force participation of affected male birth cohorts.

6. Quantifying the dilution and scarring effects

These cohort profiles are used as the independent variables in the following model:

$$\hat{\tau}_{c,e,g} = \sum_{j=1}^{J_{e,g}} 1_{[c_j^{e,g} \le c < c_{j+1}^{e,g}]} [\alpha_{j,e,g} + RI_{c,e,g}\beta_{j,e,g}^{RI}] + SUE_{c,e,g}\beta_{e,g}^{SUE} + e_{c,e,g}$$

This is a linear regression model for the mean of the random cohort effect $\hat{\tau}_{c,e,g}$ for cohort c of gender g and education group e, with piecewise linearity with discontinuities for the so-called Ranking Index, RI, which is an education specific measure of the education level of a cohort, which is designed to quantify the dilution effect of increasing educational attainment across cohorts (see below Appendix C).

The components of the Ranking Index are defined as

$$RI_{c_j,e,g} = \begin{cases} RI_{c,e,g} \; if \; c \in line \; segment \; j \\ 0 \; otherwise \end{cases}$$

For males, the piecewise linearity in the Ranking Index only applies to the unskilled groups, where a shift in the dilution effect can be identified. For males with vocational and tertiary educations we could not identify any shift in the dilution effect. For females, the piecewise linearity also captures the shift from convergence in the earlier years – with increasing participation – to a situation in the later years where the labour participation of cohorts of unskilled females are shifting downward as a result of the dilution effect.

The term $SUE_{c,g,e}$ denotes the structural unemployment in a (predefined) year shortly after a group has entered the labour market. The term is only found to be relevant for the four groups of males with vocational or tertiary educations, for which the year of labour market entry has been defined as the year a cohort group turns 32 years.[11]

A key endeavour of the present study is to examine how the cohort effects develop over time for the twelve groups defined by gender and education. The presumption is that the increasing education levels across the cohorts in the sample have increased the overall labour force participation. However, we have a presumption that participation has increased by less than the full impact of the shift toward higher education with higher participation rates, i.e. a throughput of less than 100 per cent. This presumption predicts a decline in the labour force participation rates of some or all education groups due to the presence of a displace-

11. The average structural unemployment over an age span covering the early career year has also been tested, but without changing the results much. This is probably because structural unemployment is a smooth curve that already resembles a moving average of unemployment.

ment effect. The aim is to estimate education specific displacement effects and to quantify by how much a change in the level and composition in the educations of a cohort will change the participation rates of the education groups. To achieve that, an education specific measure that represents the education level and composition of each cohort has been suggested, a so-called *Ranking Index* that was originally proposed by Jensen at al. (2009). The idea is to stack the educations from bottom to top by education level – thereby assuming a hierarchy of educations with ground school at the bottom and long tertiary education at the top (see details in Appendix C).

Applying the Ranking Index for education groups, as an explanatory factor in a model for the labour force participation of cohorts, postulates that an increase in the education level from one cohort to the next will reduce the average ability for participation in proportion to the reduction in the index. For example, a decline in the share of a cohort with ground school education will reduce the average tendency to participate in the labour force for those who remain because some of the individuals who have been lifted up to a higher education level would have participated without being educated.

We quantify the dilution and scarring effects with the above regression model.

The results are presented in Table 2. The dilution effect is quantified by using the education specific Ranking Index and the scarring effect is represented by the level of structural unemployment at the time a cohort-education group leaves the education system to enter the labour market.[12]

The parameter estimates for the SUE term suggest that a one percentage point drop in structural unemployment at the age of labour market entry is associated with an increase in labour force lifetime participation of between 0.12 and 0.35 percentage points for males with vocational or tertiary educations – with medium tertiary at the low end and long tertiary at the high end. With structural unemployment having increased from 1⅔ per cent in the late 1960s to 9¾ per cent in the early 1990s and then back again to the current levels at just above 3 per cent, the implication is that the labour market situation facing cohorts when they leave the education system is associated with a difference in lifetime labour force participation rates of between ¾ and 2½ percentage points.

The estimated parameters for the Ranking Index quantify education specific dilution effects. The results suggest that while the unskilled and those with vocational educations have been severely affected by dilution, the tertiary educations have been almost entirely unaffected. The results imply that the effect of reducing

12. The *structural* scarring effect is inherently different from the effect of *current* labour market structures on the participation for different age groups, as this effect is already captured by the model. It is also quite different to a potential *cyclical* scarring effect of entering the labour market during an economic downturn as in Andersen et al (2016) who use *output gap* as an indicator for the business cycle.

the proportion of a birth cohort with a ground school qualification by 1 percentage point is estimated to reduce the participation rate for the group by around 1 percentage point for males and 1.5 percentage points and females respectively (half of the parameter estimate for the ranking index at 2.13 and 2.83 for the younger cohorts of males and females). For secondary schooling and vocational training, the dilution effect is significant but much weaker. The estimated effect of reducing the proportion of a birth cohort with secondary education is a reduction in the participation rate for the group by around 0.25 per cent for both males and females while vocational participation is reduced by less than 0.1 percentage points for both males and females (corresponding to half of 0.17 and 0.07 respective).

Table 2 Labour force participation – impact of dilution and structural unemployment

	Males				Females			
	Cohorts	**RI**	**SUE**	**R^2**	**Cohorts**	**RI**	**SUE**	**R^2**
Ground school	1922-52	0.66 (0.06)			1940-52	-0.15 (0.03)	-	0.997
	1953-56	-0.01 (0.56)	-	0.99	1953-71	0.55 (0.02)		
	1957-83	2.13 (0.13)			1972-83	2.83 (0.14)		
Secondary school	1922-52	0.26 (0.01)			1940-53	-0.40 (0.04)		
	1953-62	0.21 (0.07)	-	0.98	1954-64	-0.34 (0.04)	-	0.99
	1973-83	0.63 (0.04)			1972-83	0.48 (0.04)		
Vocational Training	1922-83	0.17 (0.01)	-0.19 (0.02)	0.98	1940-53	-0.74 (0.03)		
					1954-62	-0.57 (0.13)	-	0.99
					1963-83	0.07 (0.02)		
Short Tertiary	1922-83	0.04 (0.01)	-0.27 (0.02)	0.94	1940-53	0.89 (0.05)		
					1954-59	1.30 (0.52)	-	0.99
					1960-83	0.00 (0.02)		
Medium Tertiary	1922-83	0.03 (0.01)	-0.12 (0.01)	0.86	1940-53	-0.45 (0.02)		
					1954-58	1.32 (0.30)	-	0.997
					1959-83	-0.00 (0.00)		
Long Tertiary	1922-83	-0.04 (0.04)	-0.35 (0.02)	0.89	1960-83	-0.04 (0.02)	-	0.37

Note: Standard deviations shown in brackets. SUE is structural unemployment in the year a birth cohort turns 32 years and has been included for the education groups where the parameter is negative and significant. The cohort intervals for each education group have been identified to give the best fit.

Source: Own calculations based on Danmarks Statistik's administrative records (RAS).

The results for ground and secondary schooling show that the dilution effect for these groups has been increasing across the cohorts in the sample. Indeed, the parameter for the Ranking Index for males with ground schooling has tripled from 0.66 for the 1922 to 1952 cohorts to 2.13 for the 1957 to 1983 cohorts. For females with ground schooling, the dilution effect increased by almost fivefold from 0.55 to 2.83 from the 1953 to 1971 to the 1972 to 1983 cohorts. For males with secondary schooling, the RI-parameter increased from 0.21 to 0.26 for the 1922 to 1962 cohorts and to 0.63 for the cohorts born between 1963 and 1983 and to 0.48 for females with secondary schooling born between 1965 and 1983. The increasing dilution effects for the unskilled suggest that the marginal returns to educating are diminishing as the education system digs deeper and deeper into the talent pool of each cohort.

The implication of increasing the level of education for new cohorts depends on both the scale and the composition of the changes. Table 3 illustrates this by some examples that show the simulated consequences of lifting the education level of the youngest cohort in the sample by moving 1 percentage point from a lower to a higher education group. The table shows the immediate or *full education effect* on participation rates for males and females (without any dilution effect), the estimated effect after discounting for the dilution effect, and the estimated throughput i.e. the estimated effect as a share of the full effect.

Some clear patterns emerge. First of all, the full effect is larger for shifts from educations with relatively low participation at the outset (e.g. ground schooling and to a lesser extent secondary schooling and vocational training) to educations with high participation rates (e.g. tertiary educations). For example, the full effect of lifting 1 percentage point of a cohort from ground schooling to long tertiary education is estimated to increase participation by 0.38 for males and 0.45 for females whereas only 0.06 for males and 0.09 for females is gained by lifting 1 percentage point of a cohort from vocational to long tertiary education. This is a mechanical consequence of the differences in labour force participation between educational groups at the outset.

Secondly, the full effect is higher for females than for males. The throughput is also higher for females than for males (i.e., dilution is higher for males). Thirdly, the throughput is lower for changes that shift from educations with high dilution (e.g. ground schooling) and especially when the receiving education group also has high dilution (e.g., secondary schooling and to a lesser extent vocational training).

Table 3 Estimated effect on lifetime labour force participation of increased education levels

	Full effect		Estimated effect		Throughput (%)	
Change	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
from -> to	---------- *percentage points* ----------				----- *Per cent* -----	
GS -> SS	0.24	0.27	0.05	0.12	19	43
GS -> Voc	0.32	0.36	0.08	0.18	24	51
GS -> LT	0.38	0.45	0.10	0.26	26	58
SS -> LT	0.14	0.17	0.05	0.14	37	83
Voc -> LT	0.06	0.09	0.02	0.08	34	88
ST -> LT	0.00	0.01	0.00	0.01	-11	100
MT -> LT	0.01	0.02	0.01	0.02	83	100

Note: The estimates are based on the estimated average lifetime participation of cohorts 1979 to 1983 and the estimated dilution effects for the youngest cohorts in table 2. GS: Ground schooling; SS: Secondary schooling; Voc: Vocational training; ST: Short tertiary education; MT: Medium tertiary education; LT: Long tertiary education.

Source: Own calculations based on Danmarks Statistik's administrative records (RAS).

If, for example, the education of a cohort is lifted by elevating one percentage point from ground schooling to secondary schooling it is estimated to increase the overall participation rate for the cohort by 0.05 percentage points for males and 0.12 percentage points and females. This is equivalent to a 19 and 43 per cent throughput of the full effect (0.24 and 0.27 percentage points for males and females).

A one percentage point shift from ground schooling to vocational educations will increase the overall partiicipation rates by 0.08 percentage points for males and 0.18 percentage points for females. Equivalently, the throughput is estimated to be 24 and 51 per cent respectively, or at 38 per cent on average. This result is very similar to DØRS (2018) who estimate an average throughput of 39 per cent from elevating the 10 per cent of the unskilled that are most likely to take a vocational education. In contrast, Arbejderbevægelsens Erhvervsråd (2019) find a throughput of 68 per cent, of elevating unskilled (non-disability pensioners) to a vocational education.

If instead one percentage point is elevated from ground schooling to long tertiary educations (assuming that the share for all other educations remain unchanged) the overall participation rate for the cohort is estimated to increase by 0.10 and 0.26 percentage points for males and females respectively. The throughput is also considerably higher at 26 per cent for males and 58 per cent for females of the full effect at 0.38 and 0.45 percentage points respectively.

These examples suggest that the dilution effect is generally stronger for males than for females, and it is relatively strong for lifting people from ground schooling to secondary schooling and beyond. Dilution, however, is much weaker when

the share of secondary school leavers that also complete tertiary educations is increased. Previous research estimated the *average* dilution effect at around two-thirds of the full effect of increased educational level of new birth cohorts (Søgaard, 2011). The results presented above suggest that, indeed, there is evidence of a *dilution effect* at that level, and that overall labour force participation rates are lower compared to the predictions assuming a full effect of increasing educational attainment. However, the dilution effect depends on the compositional nature of the change and it predominantly affects the participation rates of the unskilled, while tertiary educations are unaffected.

7. Concluding remarks

In this paper we identify two important drivers that contributed to the development in the labour force participation of cohorts since the early 1980ies. Firstly, the increasing education level across cohorts has increased overall labour force participation by less than the direct compositional effect of moving people to higher educations with higher participation rates. This is a result of the so-called dilution effect from elevating the more resourceful individuals from the unskilled group to the skilled groups, which has the potential to reduce participation of both groups. However, we also show that, historically, dilution has only reduced participation for the diminishing group of unskilled and to some extent the vocationally trained – and dilution is occurring at an increasing rate. In contrast, the tertiary educated have so far been largely unaffected in spite of having increased their share of the birth cohorts over time. A profound implication of these results is that lifting education for new cohorts has reduced participation for the unskilled, but not for the tertiary educated. The dilution effect is the main reason for the plummeting labour force participation rates of the unskilled as the more resourceful people have been lifted out of the group.[13]

The second main finding is that the protracted period of high unemployment from the mid-1970s to the mid-1990s has had a scarring effect on lifetime labour force participation of the cohorts of vocationally trained and tertiary educated males that entered the labour market during that period. In contrast, there are no signs of such structural scarring for the unskilled or for tertiary educated females, presumably because these cohorts of females had increasing participation rates across cohorts as part of the general convergence of female labour force participation.

The study provides some answers but also leaves many questions unanswered about the past and likely future labour force developments. Firstly, while the di-

13. A tell-tale sign of the displacement effect is an equivalent dramatic increase in the incidence of disability pensioners among the unskilled.

lution effect is a likely driver of the decreasing labour force participation of the unskilled, we have an incomplete understanding of the interaction between supply and demand factors as expressed, for example, by the notion of a race between education and technology (see Acemuglu and Autor, 2012, and Goldin and Katz, 2007). Related to that, we know very little about the effect of increasing education on the development in productivity and the wage distribution – to what extent does increasing education across cohorts cause dilution of productivity and how does it affect the relative wages of groups with different educations. Secondly, we do not know to what extent the development in labour force participation of cohorts has been affected by changing compositions of education subgroups such as arts, medical and engineering degrees. Cross-sectional evidence suggests that labour force participation and wages differ substantially across educational subgroups, but it is unclear how this may affect the relative labour market performance across birth cohorts.

We now have a better understanding of how the educational composition of new cohorts is likely to affect labour force participation going forward. The results presented in this paper about the effect of education policies on labour force participation offer new insight and detail for the labour force projections used by the government long-term budget projections (DREAM, 2015, Hansen, 2016, Finansministeriet, 2014).

References

Acemoglu, D. and D. Autor (2012) *What Does Human Capital Do? A Review of Goldin and Katz's The Race between Education and Technology*, Journal of Economic Literature 2012, 50:2, pp. 426–463.

Andersen, T. M., J. Maibom, M. Svarer and A. Sørensen (2016) *Do business cycles have long term impact for particular cohorts?* Department of Economics and Business Economics, Aarhus University, Denmark, April 2016.

Arbejderbevægelsens Erhvervsråd (2019) Fra ufaglært til faglært forbedrer de offentlige finanser.

Bækgaard, H. and A-L Koch Helsø (2018) *The Danish Labour Force 1980-2015 – and the importance of education*, DREAM Working Paper 2018:1, February 2018.

Danish Economic Councils (2018) *Dansk Økonomi*, Efterår 2018.

Danish Economic Councils (2019) *Dansk Økonomi*, Efterår 2019.

DREAM (2015) *Long-term economic projection 2014*, DREAM January 2015.

Finansministeriet (2014) *Finansredegørelse*, January 2014.

Hansen, J. Z. (2016) *Fremskrivning af befolkningens arbejdsmarkedstilknytning, DREAM rapport*, October 2016.

Goldin, C., and L. F. Katz (2007) *Long-Run Changes in the Wage Structure: Narrowing, Widening, Polarizing*, Brookings Papers on Economic Activity 2: pp. 135–65.

Hyndman, R. J. and M. S. Ullah (2008) *Robust forecasting of mortality and fertility rates: A functional data approach*, Computational Statistics & Data Analysis 51 (2007) 4942-56.

Jensen, M. U., Pedersen, L. H. and P. P. Stephensen (2009) unpublished mimeo.

Rees, E. W. (2006) *Forecasting Labor Force Participation Rates*, Journal of Official Statistics, Vol. 22, No. 3, 2006, pp. 453-485.

Rosholm, M. and M. Svarer (2008) *The Threat Effect of Active Labour Market Programmes*, The Scandinavian Journal of Economics, Vol. 110, No. 2 (Jun., 2008), pp. 385-401.

Søgaard, J. E. (2011) Sammenhængen mellem uddannelse og erhvervsdeltagelse, Arbejdspapir nr. 24/2011, Finansministeriet.

Url, T., R. J. Hyndman and A. Dokumentov (2016) *Long-term forecasts of age-specific participation rates with functional data models*, Department of Econometrics and Business Statistics, Monash Business School, Working Paper 03/16.

Økonomi og Indenrigsministeriet (2017) *Fordeling og Incitamenter 2017*. Økonomi og Indenrigsministeriet.

Appendix A Estimation results

Tabel A1

	Estimation results: Grouped Random Effect model											
	Males						Females					
	GS	**SS**	**Voc**	**TS**	**TM**	**TL**	**GS**	**SS**	**Voc**	**TS**	**TM**	**TL**
Inrercept	1.16	3.44	4.31	5.05	4.47	-2.17	-1.93	-3.37	-0.63	2.50	-2.25	-3.31
Data break 2003	-0.14	-0.01	-0.36	-0.36	-0.16	-1.06	-0.11	0.02	-0.22	-0.23	-0.36	-0.60
Data break 2008	-0.49	-0.30	-1.01	-0.92	-0.58	-1.09	-0.13	-0.21	0.02	-0.17	-0.19	-0.51
Data break 2003 x Age	0.00	0.00	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01
Data break 2008 x Age	0.01	0.00	0.02	0.01	0.01	0.02	0.00	0.00	-0.01	0.00	0.00	0.01
Desc. Non-west	-0.28	-0.34	-0.72	-0.58	-0.22	-0.74	-0.07	-0.51	-0.66	-0.70	-0.53	-0.96
Desc. West	-0.49	-0.41	-0.56	-1.46	-0.71	-1.10	-0.42	-0.43	-0.38	-1.34	-0.40	-0.88
Age	0.04	-0.04	-0.01	-0.01	-0.01	0.29	0.09	0.21	0.08	0.02	0.24	0.29
Age squared	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Labour market Leave	-2.97	-7.93	-10.41	-15.86	-19.73	-28.68	-6.13	-9.57	-20.43	-19.33	-29.38	-23.78
Early retirement	-7.34	-4.83	-9.79	-13.45	-18.77	-17.41	-4.76	-2.61	-7.84	-10.36	-21.51	-12.52
Unempl. Structural	0.17	-0.39	-0.04	-0.32	-0.17	0.61	0.22	0.33	0.34	0.18	0.77	0.63
Unempl. Structural x Age	0.00	0.02	0.00	0.02	0.01	-0.02	0.00	-0.01	-0.01	-0.01	-0.03	-0.03
Unempl. Struct. x Age Sq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unempl. gap	-0.05	-0.25	-0.17	0.06	-0.18	0.15	-0.12	-0.42	-0.44	-0.49	-0.47	-0.44
Unempl. gap x Age	0.00	0.01	0.01	-0.01	0.01	-0.01	0.01	0.02	0.02	0.02	0.02	0.02
Unempl. gap x Age Sq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Child	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.14	0.17	0.11	0.14	0.12

Appendix B Data and variables

We use Danish full-population register data from Statistics Denmark, containing information on each individual's personal characteristics and labour market status from 1980-2013. The data cover 100 per cent of Danish residents aged 30 to 59 during the years from 1980 to 2013, hence covering male cohorts born between 1922 and 1985. We disregard the earliest female cohorts in order to avoid complications of the strong influx of females to the labour market up until the late 1980s.

The RAS register is used to identify an individual's labour force status each year in the last week of November, where the definition of labour force participation approximates the ILO definition. We group the individual specific data by gender, education, birth cohort and ethnicity, counting Danish, non-western and western descendants, thereby excluding the foreign-born population. For each year, we compute the group-specific labour fource participation rates. For some of the smaller descendant groups, the computed labour force participation rate is either 0 or 1. We collapse these groups with the corresponding Danish group and adjust the ethnicity dummies to group proportions accordingly. We compute variables for the share of each group attending educations at each education level.

From the *DREAM database*, containing weekly information on each individual's transfer receipts we compute the share in each group on labour market leave and transition benefits in the last week of November. We use annual structural and actual unemployment rate estimates computed by the Danish Economic Councils.

Table B1 – Variable definitions

Variable	***Definition***
$lfpr_{c,i,t}$	Log-odds-ratio of labour fource participation rate of cohort *c*, group *i* (gender-education and ethnicity specific) in year *t*
$X_{c,i,t}$	Cohort- year- and group (gender- education and ethnicity) specific variables: age, age squared, ethnicity dummies (or shares in case of mergers due to 0/1 labour force participation groups), share of group attending each type of education: ground school, secondary school, vocational training, short, medium or long tertiary
$TBS_{c,i,t}$	Share of cohort *c*, group *i* on transition benefits in year *t*

Variable	*Definition*
$LLS_{c,i,t}$	Share of cohort *c*, group *i* on labour market leave in year *t*
DB_t^{2002}	Dummy indicator equal to 1 if $t > 2002$
DB_t^{2008}	Dummy indicator equal to 1 if $t > 2008$
SUE_t	Level of structural unemployment in year t
$UEgap_{g,t}$	Unemployment gap in year *t* for gender *g*, difference between gender specific unemployment rate and the structural unemployment rate in the year
$RI_{c,e,g}$	Ranking Index of birth cohort c, education group e and gender g, denotes the mean ranking in the overall education distribution, see Appendix C.
$SUE_{c,e,g}$	Structural unemployment in a year shortly after a group has entered the labour market, e.g. at age 32 for the three groups of males with vocational or tertiary educations

Appendix C The Ranking Index

The analysis covers more than 60 birth cohorts born in the years from 1922 to 1983. One of the most important developments that have occurred across this panel of birth cohorts is the increase in educational attainment. Where 57 per cent of Danish males and 75 per cent of the females of the birth cohort from 1922 only had a ground school education (most of them only 7 years of schooling), this share had decrease to 17 per cent for males and 11.5 per cent for females for the 1981 birth cohort. At the upper rung of the education ladder, only 3.8 per cent of the males and as little as 0,2 per cent of the females of cohort 1922 had a long tertiary education. By the time the 1981 cohort turned 35 years in 2016 and most had left the education system, 16 per cent of the males and 19 per cent of females had completed a long tertiary education.

To capture the effect of the increasing education attainment on the labour force participation of the cohort groups with different levels of education, we apply a so-called Ranking Index based on an idea originally proposed by Jensen, Pedersen and Stephensen (2009). The Ranking Index represents an average ability score and is derived by stacking education groups from bottom to top with ground schooling at the bottom and long tertiary educations at the top.

The construct is illustrated by the following figure that shows the Ranking Index for males with a vocational education born in 1960 and 1975. Of the males born in 1960 35.5 percent had either ground or secondary schooling while 40.9 per cent had a vocational education.

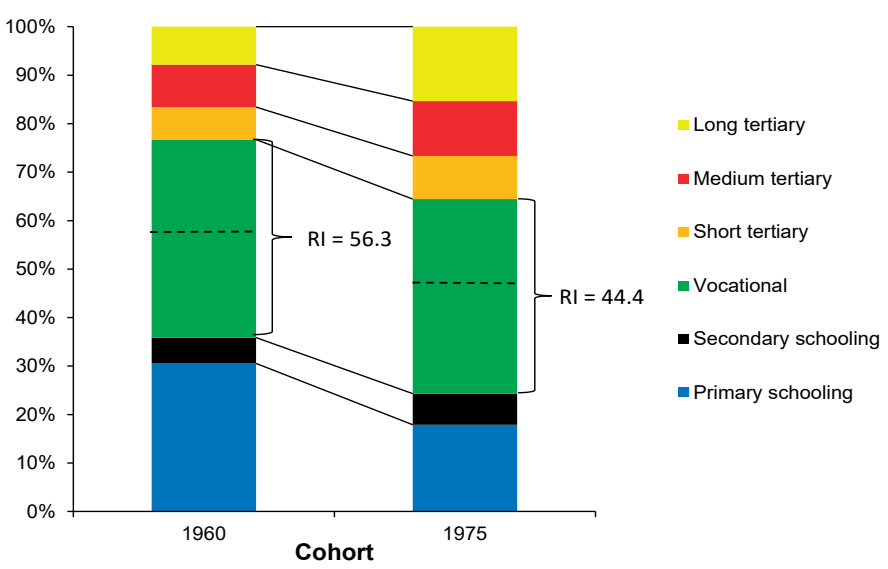

Figure C1 The Ranking Index for male cohorts 1960 and 1975, vocational training

Source: Own calculations based on Danmarks Statistik's education register.

The Ranking Index for is calculated as the midpoint that is RI = 35.5 + 40.9/2 = 56.3. For the cohort born in 1975, only 24.3 per cent had secondary schooling as their highest education while 40.1 percent had a vocational education (RI = 24.3 + 40.1 = 44.4). The Ranking Index for males with a vocational education has therefore declined by almost 12 points even though their share has only decreased marginally by 0.8 per cent.

The thinking is, that the declining Ranking Index indicates that vocational education on average will draw on individuals with lesser abilities as an increasing share of each cohort obtain educations that are above vocational educations in the hierarchy, and that the innate ability of people with vocation educations, as a group, will decrease.

The following figure shows the development in the ranking index for the six education groups for all birth cohorts of males and females born between 1924 and 1980. The general picture is that the Ranking Index declined as the general education levels increased for the cohorts over time. The cohorts born in the early to mid-1950s are an exception to that, as the general lift in education level temporarily reversed and fewer obtain an education beyond ground schooling, secondary schooling and vocational training. The Ranking Index also reflects that the development in educations for females has been stronger than for males. Indeed, while the older female cohorts had much lower education levels than their male counterparts, the picture has turned around for the younger cohorts of the sample so that females now have higher educations than males at all levels.

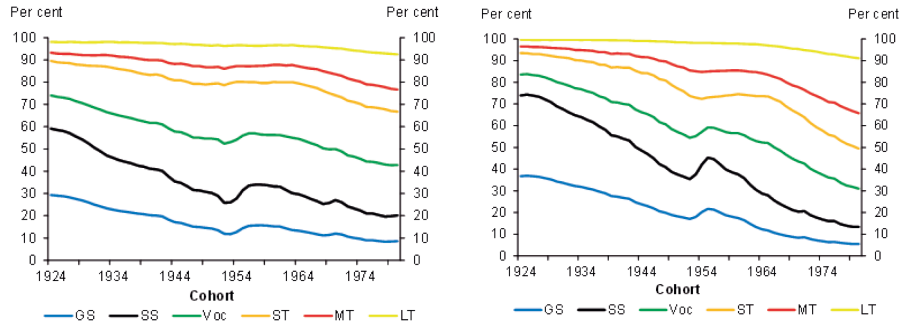

Figure C2 The Ranking Index for males and females, cohorts 1924-1980

Source: Own calculations based on Danmarks Statistik's education register.

The intuition behind the mechanism that a general lift in education will reduce the Ranking Index for all educations is slightly different for the educations at the top and bottom versus those in the middle. A decrease in the share of a cohort with only ground schooling will reduce the average (innate) ability of those that are left in the groups as the more capable have moved up a rung or more. Likewise, an increase in the share with a long tertiary education will potentially reduce their average ability because their average innate ability has decreased as a

group. For an education in the middle, for example vocational education, the ranking index may decrease as a result of a general lift in education for two reasons: the group may receive individuals with less ability from below and deliver individuals with more ability to the groups above.

The use of the Ranking Index as an indicator for average innate ability of education groups is based on a several important assumptions. First of all, it is assumed that the relationship between ability and education is hierarchical by nature. Second, we assume that individuals achieve an education according to their position in the ability distribution and that the average ability of an education group can be approximated by the midpoint of this distribution. Third, the ability distribution is assumed to be uniform.[14]

14. Søgaard (2011) applies a normal distribution as an alternative to the uniform distribution thereby assuming a different functional form for the relationship between participation and the educational composition as represented by the Gaussian Ranking Index. However, by applying a flexible piecewise linear specification for the Ranking Index in our 2nd stage model, the choice of functional form of the Ranking Index has very little bearing on the estimated dilution effect.