

The Danish Labour Force 1980-2015 – and the importance of education

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DREAM Working Paper 2018:1
February 2018

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Abstract

In this paper, we analyse the development in labour force participation of cohorts of males and females with different levels of education. We present a thorough description of the historical development in the participation rate, highlighting the policy changes, data breaks and changes in administrative practices that have affected these trends and that help explain the discrepancies between alternative participation rate measures. Using panel data covering three and half decades we apply a cohort based approach that allows us to identify and quantify the effects of factors that have influenced labour force participation (e.g. business cycles, labour market policies and administrative practices). We investigate the effects of cohort impacts such as the increasing educational attainment across cohorts and the potential scarring effect of entering the labour market during times of persistently high unemployment rates. We show through estimated gender and education specific cohort effects that only the unskilled and to a lesser extent the vocationally trained males and females have been affected negatively by the so-called displacement effect whereby the participation rates may have decreased as a result of increasing educational attainment of consecutive birth cohorts elevating the more resourceful individuals out of the unskilled groups. In contrast, the labour force participation of the tertiary educations have so far been largely unaffected by displacement. These results have important implications for the size and the composition of the labour force going forward. We also find that the vocationally and tertiary educated males who entered the labour market during times of high unemployment rates have low lifetime labour force participation, while unskilled males have been unaffected by such scarring effects.

Keywords: labour force participation of cohorts, education displacement, scarring effect, random effects.

1 Introduction

The study uses the detailed and comprehensive Danish administrative register data to examine the development in labour force participation over the past three and half decades. The proposed modelling approach allows us to identify factors that have influenced labour force participation of the core working-age population during the period from 1980 to 2015 when the birth cohorts from the early 1920s to the mid-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 displacement effect, i.e. the phenomenon that an increase in educational attainment for new birth cohorts may decrease participation rates of individual education groups as increasing educational attainment of consecutive birth cohorts progressively draws upon individuals with more marginal human resources who are less likely to participate in the labour market in spite of achieving an education. The extent of the displacement 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 al (2008) and Url et al (2016)). One 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 attempts to identify effects of individual policies. Adding to that, definitional changes over time have created data breaks that must be accounted for.

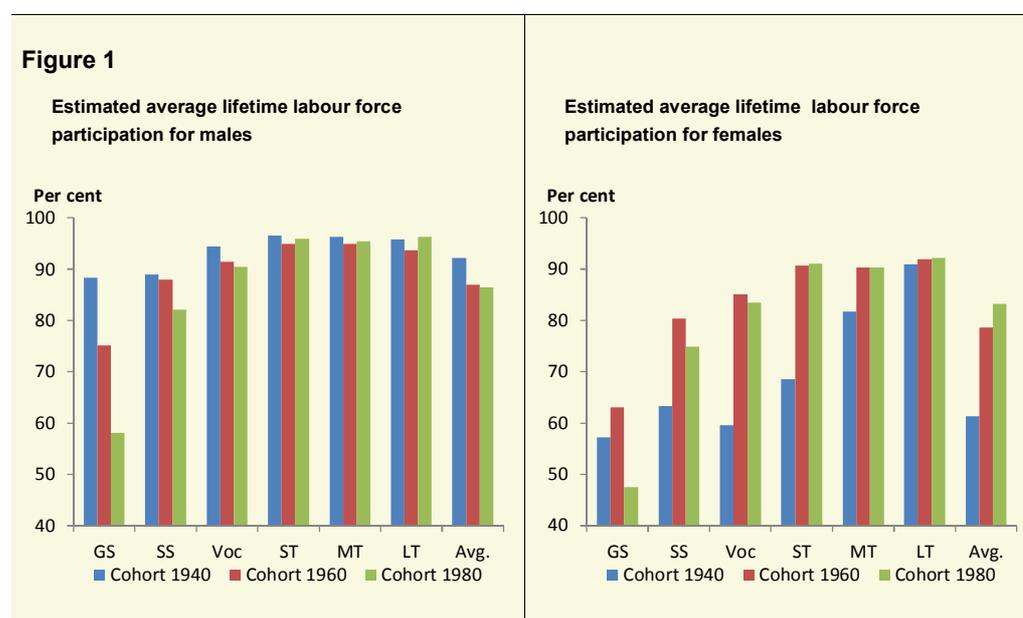
While these factors can explain some of the variations in labour force participation over the years, they do little to explain the overall trend in participation rates in recent years, which is strongly influenced by cohort specific participation patterns. In the present study, we endeavour to explain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

The first result is about the labour force participation effect of the increasing educational attainment of younger birth cohorts over time. Indeed, the positive relationship between educational attainment and participation would suggest that increasing education should lift participation rates for the younger cohorts. Instead, the opposite has occurred for male cohorts, cf. figure 1.¹ 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 displacement 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 *displacement effect* of around two-thirds (Søgaard, 2011).² Our results suggest that, indeed,

¹ The convergence of female labour force participation toward the end of the 1980s is a separate phenomenon that mainly affected the older cohorts in the sample and the unskilled more so than the vocational and tertiary educations.

² This study estimates average displacement across all cohorts of gender and education groups by using first differences.

there is evidence of a displacement effect, and that overall labour force participation is lower than the increasing educational attainment would suggest. Historically, however, the displacement effect has mainly reduced labour force participation rates for the unskilled, and to some extent for the vocationally trained, while tertiary educations are entirely unaffected by displacement. Specifically, the effect of reducing the share of a birth cohort with ground schooling as the highest qualification by 1 percentage point is estimated to reduce the participation rate for the group by 1 and 1.5 percentage points for males and females respectively. For secondary schooling and vocational training, the displacement effect is significant but much weaker. The estimated isolated effect of reducing the share of a birth cohort with secondary education is to reduce the participation rate for the group by 0.25 per cent for both males and females. For vocational training, the effect is less than 0.1 percentage points for both males and females.



Note.: The figures show simulated average labour force participation rates for 30 to 59-year-olds for selected cohorts by highest education (GS: Ground schooling, SS: Secondary schooling, Voc: Vocational training, ST: Short tertiary, MT: Medium tertiary, LT: Long tertiary).

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

These results imply that the overall effect of increasing the level of education for new cohorts depends on the composition of these changes. To illustrate this, a lift by 1 percentage point from ground schooling to secondary schooling is estimated to increase the overall participation rate for the cohort by 0.06 and 0.11 percentage for males and females respectively, which is only 23 and 38 per cent of the full effect of 0.24 and 0.27 percentage point increase in the absence of displacement. If a 1 percentage point reduction in ground schooling is elevated to long tertiary educations instead (assuming that the share for all other educations remain unchanged) the overall participation rate for the cohort is estimated to increase by 0.17 and 0.27 percentage for males and females respectively, and the throughput is also considerably higher at 44 and 60 per cent of the full increase (of 0.38 and 0.45 percentage points).

The education specific results also have important implications for the effect of education on other economic factors that are correlated with education, such as productivity, unemployment and work hours.

The second main finding is the existence of a strong relationship between the lifetime labour force participation of male education cohorts and the labour market situation when they enter 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.³ This result only applies to males as the female labour market convergence process was still in progress up until around 1990.⁴

Both of these results have obvious and profound policy implications. The finding that displacement mainly affects the unskilled, and not equally across all education groups, as implied by previous results, is important for two main 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 (see for example *Finansredegørelsen (2014)* and *Finansministeriet (2015)*). 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 will not reduce the labour force participation rates of the growing group of tertiary qualified. This result has the profound implication that education is a better investment than implied by previous results.

The result that the lifetime participation of cohorts with a tertiary education is impacted by the labour market structures at young age 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. Second, it nuances the current view that starting the career in an economic downturn does not have permanent or scarring effect on implicated cohorts (Andersen et al (2016)). Finally, the evidence of a scarring effect of prolonged periods of high unemployment emphasises the importance of maintaining good practices in labour market policies so as to avoid future situations where cohorts end up being permanently scarred.

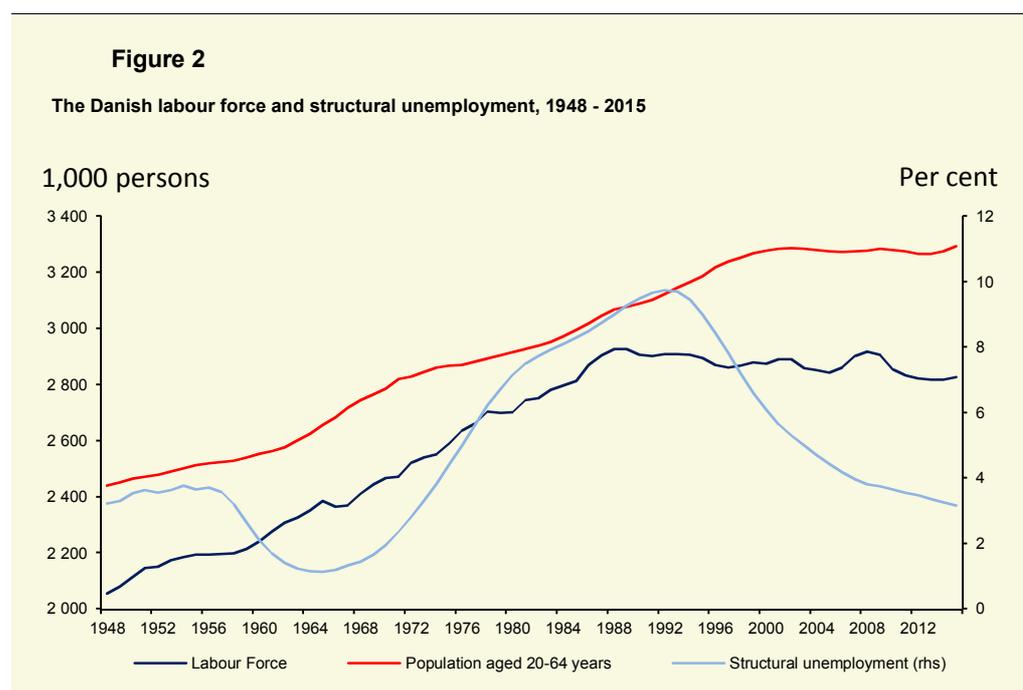
In the next section, we look at the Danish labour force in a historical perspective. In section 3 the focus is on the three decades from 1980 to 2015 and the developments that have influenced the labour force participation of the core working age population. The cohort model is developed in section 4 that also presents the main results of the paper. Section 5 concludes the paper.

³ There are signs that these cohorts “catch up” later in life as they approach 45-50 years of age. Andersen et al (2016) find that an economic downturn does not have a scarring effect on the employment rates of cohorts, but this study measures the employment rates of cohorts up against the *output gap*, which “aims to measure the deviation of the level of activity from its structural level” that, like the unemployment gap and by definition, 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, the existence of a scarring effect of “bad” structures does not contradict the findings by Andersen et al (2016).

⁴ We actually find a reverse relationship between the development in female labour supply and structural unemployment. The possibility of a causal relationship such that the growth in female labour supply up until the late eighties contributed to the rising unemployment rates is a moot but interesting question, which is touched upon briefly in the current study and one that warrants further study.

2 The Danish labour force historically

The decades preceding the period we are looking at was one of unprecedented expansion of the Danish labour force. While the head count of the labour force has increased by almost 50 per cent in the seventy years since the end of WWII, the entire increase occurred during the four decades up until the late eighties, cf. figure 2. Since then the trend reversed, and towards the mid-nineties the labour force had contracted by almost 60,000 persons. The labour force peaked briefly above 2.9 million persons at the top of the business cycle in 2008, but in spite of a continued upward demographic trend, it has dropped back by almost 100,000 persons or almost 4 per cent of the labour force.

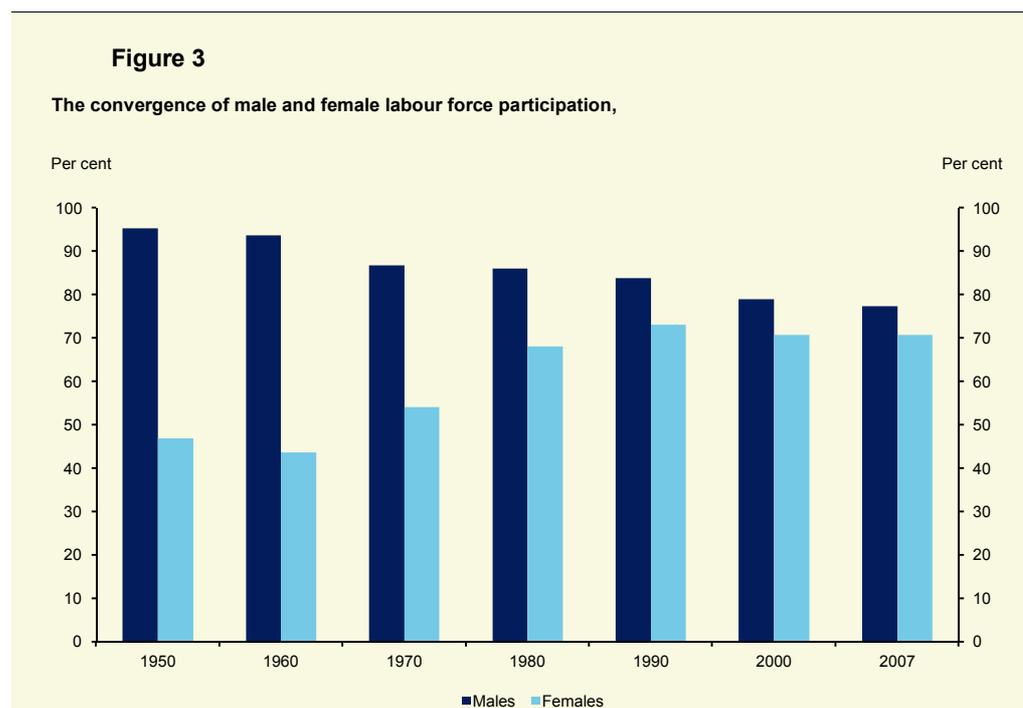


Source: Population and labour force: Danmarks Statistik, Structural unemployment: the Economic Councils.

The expansion of the labour force up until the late eighties was predominantly the result of two concurrent trends; namely, a fast growing working age population and an increasing female labour force participation, which was only partly offset by decreasing male participation, cf. figure 3. Up until the mid-seventies, the increasing labour force was matched by growing demand, and the expansion initially occurred without systematic increases in unemployment rates.⁵ However, by the mid-seventies, the economy had slumped in deep recession following the so-called *oil crisis* in 1973, and the labour market was no longer able to absorb the growing labour supply. Unemployment rates increased to levels not seen since the 1930s. In little more than a decade, structural unemployment increased from around 2 per cent to an all-time high of around 10 per cent in the mid-eighties.

⁵ While there is not an established causal long-term link between public sector employment and total employment, it is evident that, initially, the adjustment process was alleviated by the growing public sector. Indeed, in the two and a half decades from 1960 to 1985, public sector employment increased by more than 500,000 persons while, in fact, private sector employment contracted by around 150,000.

It is well-established that there is a close long-term connection between changes in the size of the labour force and changes in employment (cf. Finansministeriet, 2014). Looking at the years that followed the economic downturn in the mid-seventies, however, the nexus appeared to have been broken as the economy had entered a protracted period of parallel labour force growth and soaring unemployment rates. Many explanations have been proposed for this development and the severity of the downturn was obviously caused by several factors. The fact remains, however, that it has taken more than two decades to fix the structural calamities and for unemployment to return to the structural levels from before the onset of the crisis.



Note: The figure shows labour force participation rates for 15 to 69-year-old males and females

Source: Danmarks Statistik (2008).

There is little doubt, that the persistent increase in unemployment was underpinned by the introduction of generous social security and unemployment insurance systems. The unemployment insurance system had been reformed in 1967, which meant that the government now funded a large proportion of the cost of unemployment. In 1976 a new one-string social security law was introduced and further changes to the unemployment insurance system meant that the benefit period was now unlimited, at least in principle. The situation was aggravated by high compensation rates close to 100 per cent for low income earners, limited focus on active labour market policies and eligibility requirements in terms of job search and sanctions were few.

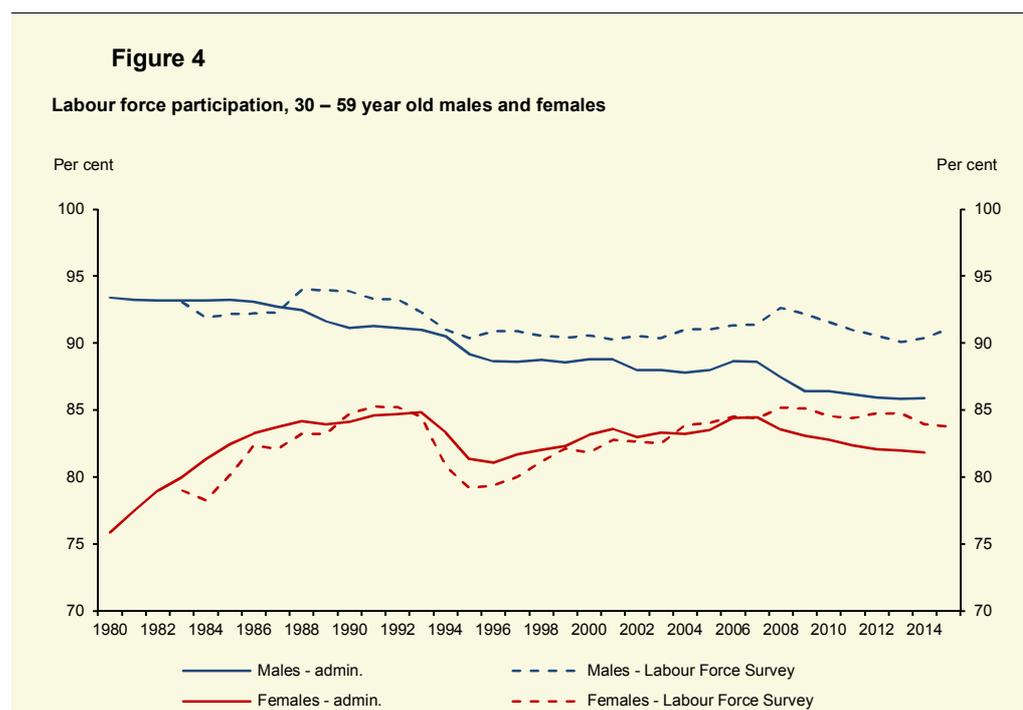
Since the mid-eighties, unemployment rates have gradually declined as labour market conditions have continued to improve. A number of factors have supported this development. A string of reforms of the social security and unemployment insurance systems and increasing focus on active labour market policies have contributed to overall structural improvements in the labour market. However, the end of protracted labour force growth of the previous decades also contributed by gradually absorbing pent-up labour supply and at the same time making it easier for new cohorts to find employment.

The weak labour market conditions up until and after the mid-eighties were not only an impediment to the labour market performance of the age groups that were labour market active at the time, which is evident from the high unemployment rates for all age, gender, and education groups. As we shall see, it is also associated with lower lifetime participation for the birth cohorts that left the education system and entered the labour force during those years of persistently high unemployment rates. Indeed, these cohorts tended to start out with a disadvantage that had the potential to impact on their future careers. The phenomenon that some birth cohorts could be permanently scarred by entering the labour market at a time with high unemployment has been termed by researchers as *the lost generations*. Often the phrase is used to describe the immediate effect of entering the labour market during an economic downturn, while we consider the possibility that protracted periods with high structural unemployment has a long term negative impact on the affected cohorts.

3 Labour force participation of 30 to 59-year-olds 1980-2015

The focus of the study is the development in the labour force participation for 30 to 59-year-olds with different educational background. This age group has been chosen so as to limit implications of changing study activity – most 30-year-olds have left school – and changing retirement behaviour for the 60+ year olds. We consider the period since 1980 for which detailed administrative records on individuals are available. The main source of information is the Danish administrative register for labour force statistics (Regiserbaseret Arbejdsstyrkestatistik, RAS) containing annual records of labour market status for the full Danish resident population for each year since 1980. With 2015 being the most recent available year, we have access to 36 annual data points. The information about labour force participation of individuals in RAS is a summary status of the broader socioeconomic status during 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 or out of the labour force has been reasonably 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.

The overall development in labour force participation of 30 to 59-year-old males and females differ substantially, cf. figure 4. A first thing to note is that while male participation has generally continued the overall picture of decline from the previous decades, there have been more 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 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 smaller decrease in male participation.



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 series reveal some interesting features that reflect the general labour market trends and policies of the period. It is interesting to note that the alternative measure of labour force participation based on the Eurostat *labour force survey* (LFS) definition shows a somewhat different picture, cf. figure 4. This is particularly true for males, where the survey based definition of participation actually increased slightly from the mid-nineties to 2007 before the onset of the recession reversed the trend. For females, the survey based definition of participation follows a similar pattern as its administrative counterpart, albeit the upward trend since the mid-nineties has been stronger and the decline since the recession much less pronounced. There are a number of reasons for the discrepancies between the two measures of labour force participation, and apart from the fundamental definitional differences, the changes to labour market policy and administrative practices have impacted the two measures differently over the years, cf. box 1.

Box 1

The Danish labour force – two definitions

Danish labour force statistics are based on either the International Labour Organization's survey definition or the administrative register definition. Both definitions of the labour force include people who are characterised as either employed or unemployed in a reference week. Nevertheless, there are a number of important differences between the two definitions:

The Labour Force Survey and the ILO-definition

The Labour Force Survey has been conducted since 1983 – currently by Danmarks Statistik for Eurostat. The survey has changed substantially over the years both in terms of size and scope, but since 1994 it has been conducted continuously with a sample being interviewed every week and currently, it involves around 70,000 interviews annually.

Employed persons include those who worked for pay, profit or family gain during the reference week. It also includes

those who had a job or enterprise but were temporarily absent from that job or enterprise during the reference week due to sickness, vacation, maternity leave, strike or temporary lay-off.

The unemployed population includes persons who are available to, but did not furnish the supply of labour for the production of goods and services. When measured for a short reference period, it relates to all persons not in employment who would have accepted a suitable job or started an enterprise during the reference period if the opportunity arose, and who had actively looked for ways to obtain a job or start an enterprise in the near past.

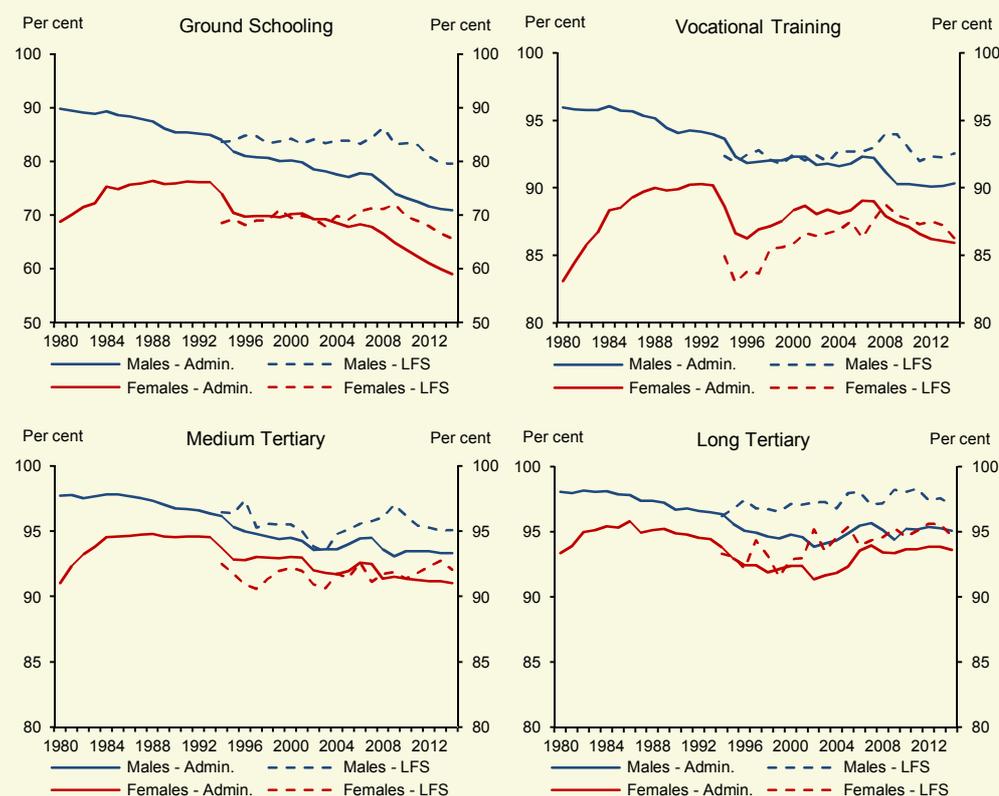
The official administrative register definition

The labour force statistics from the administrative registers are based on a recording of labour market status in the last week of November and are available from 1980 to 2015. It is a full count of the Danish population, which allows for very detailed break down of the labour force statistics for specific subgroups, for example by gender, age, ethnicity, and educational participation and attainment. The size and comprehensiveness of the administrative data make them useful for detailed panel analysis – including the important cohort effects, which are the subjects of the current study,

The administrative definition of labour force participation intends to follow the ILO-definition, but the data have been collected mainly for administrative purposes, and hence the definition deviates from the survey based one in several important ways. Firstly, a person's labour market status in the reference week gives priority to recorded employment in the reference week. Self-employment in a particular week has been difficult to identify precisely and paid employment has also been somewhat imprecise, at least until the introduction of an electronic income reporting system in 2008, the so-called *elndkomst*. Improvements in the recording of employment status have caused noticeable data breaks in 2002 and 2008 where employment – and labour force participation – was adjusted downward.

The register based definition of unemployment counts persons who are not employed in the reference week and who receive either unemployment benefits or social security and have been deemed *labour market ready* by the case manager. These recipients are required to actively look for work and be ready to accept unemployment offers. The job-seeking requirements have been tightened over the past three and a half decades, which in itself has affected the register based unemployment.

Figure b1. Labour force participation, education and gender (30 to 59-year-olds)



Source: Own calculations based on Danmarks Statistik's administrative records and Eurostat Labour Force Survey.

A number of important insights arise from the differences between the two labour force definitions. The first thing to note is that the downward trend in male participation is not as pronounced in the survey based definition as in the register based definition.

Both measures of female labour force participation increased up until the early nineties, at which point the general increase in female participation had petered out, cf. figure 4. Both measures dropped sharply in 1994 and 1995 in response to the introduction of a transitional retirement scheme and three labour market leave schemes. Since the mid-

nineties, both the survey and register female participation rates had regained what was lost at the peak of the business cycle around 2008 except that the survey based participation rates have fallen by less than the register based labour force due to the data break in 2008.

Looking at the two definitions of participation for the different educational groups, it is obvious that we are facing conflicting messages regarding the development in participation over the last couple of decades. By and large, the individual education groups reflect the overall picture from figure 4, namely, that the downward trend in labour force participation in the Labour Force Survey is weaker than the administrative registers. However, the discrepancy is particularly expressed for the groups with ground schooling where the RAS participation rates are declining for both males and females throughout the period since the mid-nineties whereas the LFS-definition of participation is trending slightly upwards up until the GFC lead downturn in 2008 where after it follows the downward trajectory of its administrative counterpart, albeit at a considerably higher level.

The trends in the two definitions are more in correspondence for vocational training. A flat path for males and an increase for females up until the GFC sets in and a downward tendency thereafter. Across the period, however, the LFS participation rate for vocational training is stronger than the administrative definition for both males and females – much like the ground schooling groups. This is also the case for medium and long tertiary educations.

There is a decline in LFS based participation only for ground schooling and vocational training since the GFC.

The labour market policies since the early nineties have generally reduced the administrative labour force by tightening eligibility rules and increasing focus on active labour market policies. In contrast, the ILO definition of the labour force has tended to increase as a result of the very same policies.

To summarise, the LFS definition of labour force participation is not only stronger than the register definition for most education groups, it also shows stronger development over the period since 1994, for which we are able to calculate education specific rates. These observations confirm that the policy developments since the mid-nineties have contributed to reducing the register based and to increase the LFS based participation rates over the period (all else equal).

The increasing female participation during the eighties came to an end in the early nineties and reversed sharply towards the mid-nineties 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 temporary schemes were specifically aimed at reducing unemployment by reducing labour force participation and were the main reason for the pronounced decrease in participation during the mid-nineties – especially for females, cf. figure 5.

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 in 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.

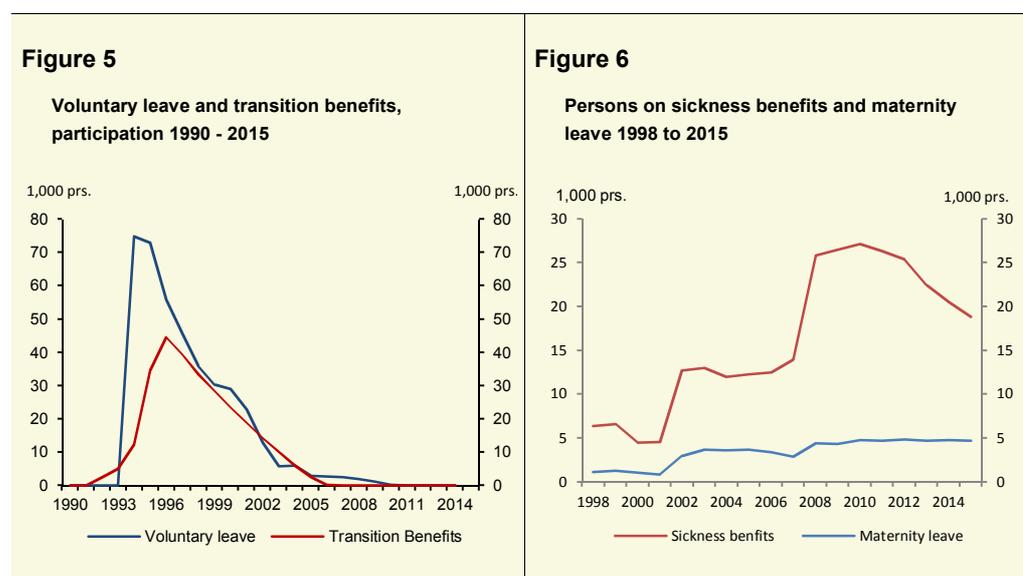
The voluntary labour market *leave schemes* comprised three separate programs for child minding leave, educational leave, and sabbatical leave. The schemes became extremely popular, and in the first years after their introduction in 1994, participation exceeded more than 70,000 persons, thus effectively reducing the labour force by more than 2.5 percentage points. The leave schemes were gradually phased out over the following decade.

The decline in structural unemployment since the early nineties was further facilitated by a series of labour market reforms that fundamentally changed the structure of the labour market system. A combination of tighter eligibility criteria for unemployment benefits and intensified active labour market policies has verifiably improved the work incentives of the labour force and stimulated job search and labour force participation.

At the same time, however, the changes have also had a negative impact on the size of the labour force as tighter controls have moved people off the benefits that count recipients as unemployed in the administrative definition of unemployment, cf. *box 1*. Indeed, while the labour market reforms of the nineties strengthened the incentives for the unemployed to find

and retain paid employment, the reforms also had a negative effect on the official definition of the labour force, as tightened eligibility requirements made it harder to qualify for unemployment benefits and, consequently, many unemployed were literally reclassified out of the official labour force.

The compensation rates associated with Danish unemployment benefits are relatively high by international standards, especially for people with low incomes (DØR E14 (2014), Dagpengekommissionen (2015)). Since the mid-nineties, however, the net compensation rates for both unemployment benefits and social security have been reduced substantially as a result of dampened indexation, and from 2004 by the introduction of an earned income deduction (beskæftigelsesfradrag) that effectively acts as a wedge between the disposable income in employment and unemployment (Økonomi og Indenrigsministeriet, 2017).



Note: Both figures include 30 to 59-year-olds and refer to the last week of November.

Source: Own calculations based on the DREAM database, Styrelsen for Arbejdsmarked og Rekruttering (figure 5) and Danmarks Statistik's administrative records, RAS (figure 6).

The labour market reform of 1994 introduced a maximum duration of unemployment benefits of 7 years and abolished participation in active labour market programs as requalification towards a renewed benefit period. Prior to that, it was in principle possible to receive benefits indefinitely. In subsequent years the unemployment period was reduced further:

- In 1996 the unemployment period was reduced to 5 years. Persons aged above 50-59 years were exempt.
- In 1999 the unemployment period was reduced to 4 years. Persons aged 50-59 years were exempt.
- The exemptions for the 50-54 and the 55-59 year olds were abolished in 1999 and 2006 respectively.
- In 2010 the unemployment period was reduced to 2 years (effective from 2013) and the employment requirements for renewed eligibility were increased from $\frac{1}{2}$ to 1 year.
- In 2015 the unemployment period was increased to 3 years, but only for unemployed fulfilling a minimum employment criteria.

Adding to that, the eligibility requirements for receiving unemployment benefits and social security have been tightened considerably since the eighties. Increased focus on documented job search activities and active labour market policies have contributed to the gradual reduction in structural unemployment rates since the early nineties.

Prior to these changes, many long term unemployed were not job ready and available for work as prescribed by the ILO-definition of unemployment, cf. Finansministeriet (2010). By making it harder to qualify for unemployment benefits, these changes have in fact 'trimmed' the labour force by moving the previously unemployed onto other benefits or off benefits altogether.⁶

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 around 0.65 percentage points, see Danmarks Statistik (2004).

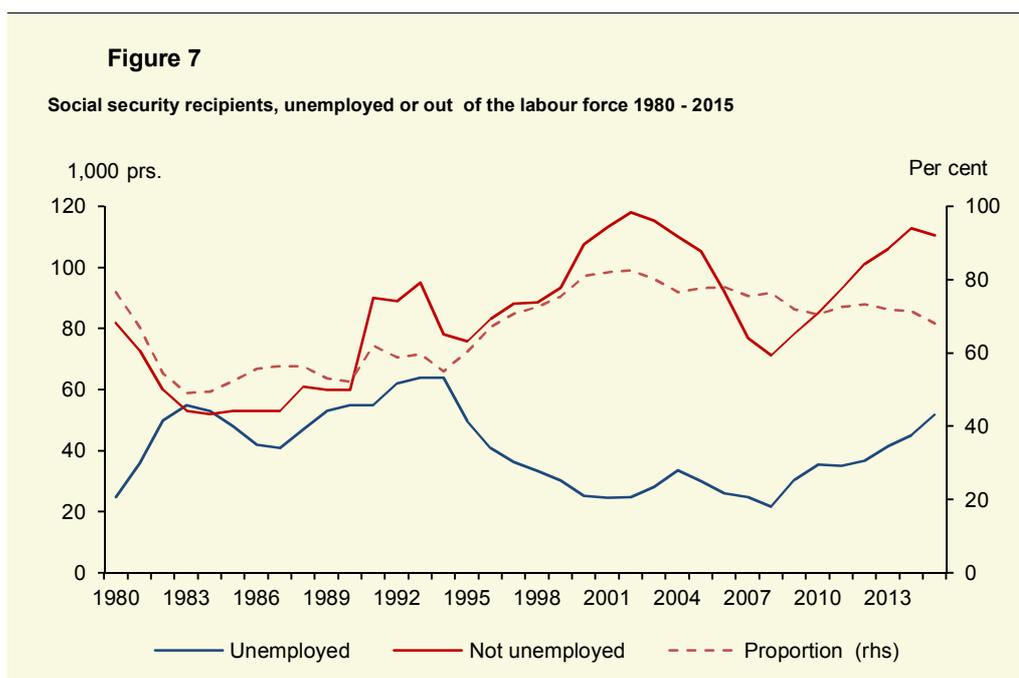
The introduction of a new income reporting system in 2008 (*eIndkomst*) was a major improvement in the registration of salaried employment, which resulted in a significant decrease in registered employment. Unfortunately, the 2008 data break coincides with a significant cyclical drop in employment in the wake of the global financial crisis, which complicated the assessment of the isolated effect of the data break. Nevertheless, the data break is clearly visible as a one-off drop in labour force participation rates for both males and females, cf. figure 4.

Adding to the 2002 and 2008 data breaks, there were changes to the registration of maternity and sickness benefit and the way the recipients were classified, cf. figure 6. These changes reduced labour force participation in the two years, which add to the one-off drop in the overall participation rates. The impact varied across different groups of gender, age and education, which is captured in our model by inclusion of detailed interaction terms.

The administrative definition of unemployment includes social security recipients that have been classified as labour-market-ready by their case manager⁷. Non-labour-market-ready social security recipients are classified as outside the labour force, whereas labour-market-ready recipients are counted as unemployed and in the labour force. Hence changes to the administrative practice will impact on labour force participation. Figure 7 shows how the number of non-labour-market-ready recipients of social security almost doubled from around 55,000 persons in the mid-eighties to almost 120,000 in the early 2000s. At the same time, the number of unemployed social security recipients decreased substantially. Part of the decline is clearly due to the improved state of the labour market, but the coinciding increase in non-labour-market-ready recipients suggests that many individuals were simply reclassified from labour-market-ready to non-labour-market-ready.

⁶ These reforms have had the opposite on the labour survey definition of unemployment and the labour force, cf. box 1.

⁷ The practices regarding the classification of social security recipients has changed over the years, but the overall structure whereby recipients are classified as either unemployed or not remains intact.



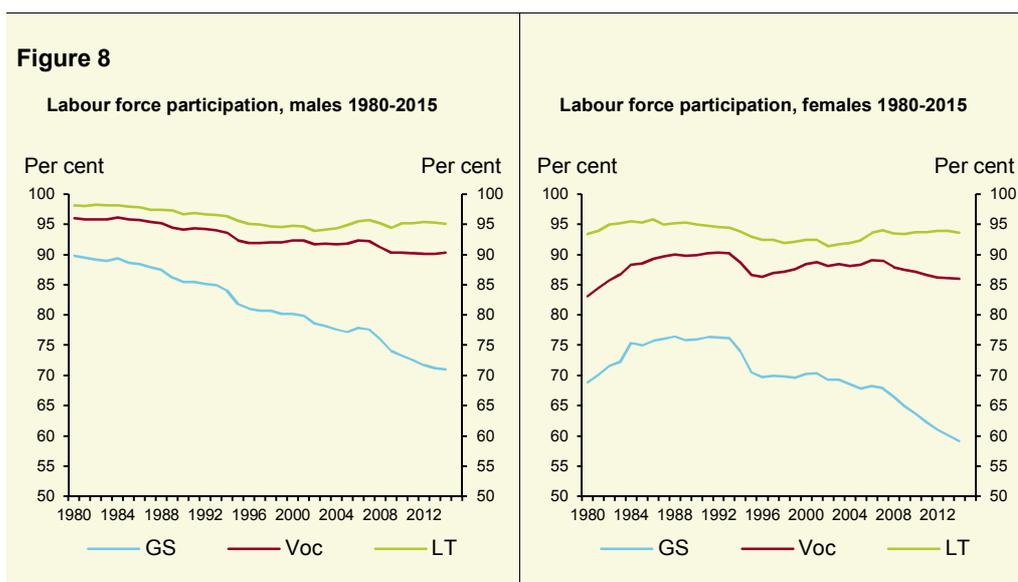
Note: The proportion shows the development in share of all social security recipients that are not registered as unemployed.

Source: 1980-93: Danmark som foregangsland (1998), 1994-2015: the DREAM database, Styrelsen for Arbejdsmarked og Rekruttering.

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 8. 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 (and females with vocational education) while participation rates for unskilled have continued to decline sharply.

As a consequence, the educational gap in participation has increased over time. In 1980, the participation gap between 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 unskilled females. 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.

The development in education specific labour force participation reveals further interesting insights. Firstly, there are signs that the decline in overall 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, participation of 30 to 59-year-olds with tertiary educations has picked up in recent years. In other words, there are no immediate signs of noteworthy displacement at the tertiary education level.



Secondly, the development in the labour force survey definition of participation exhibits some remarkable differences from the administrative definition. Notably, and with few exceptions, the labour force survey participation has trended up since the mid-nineties when administrative participation has been much more subdued.

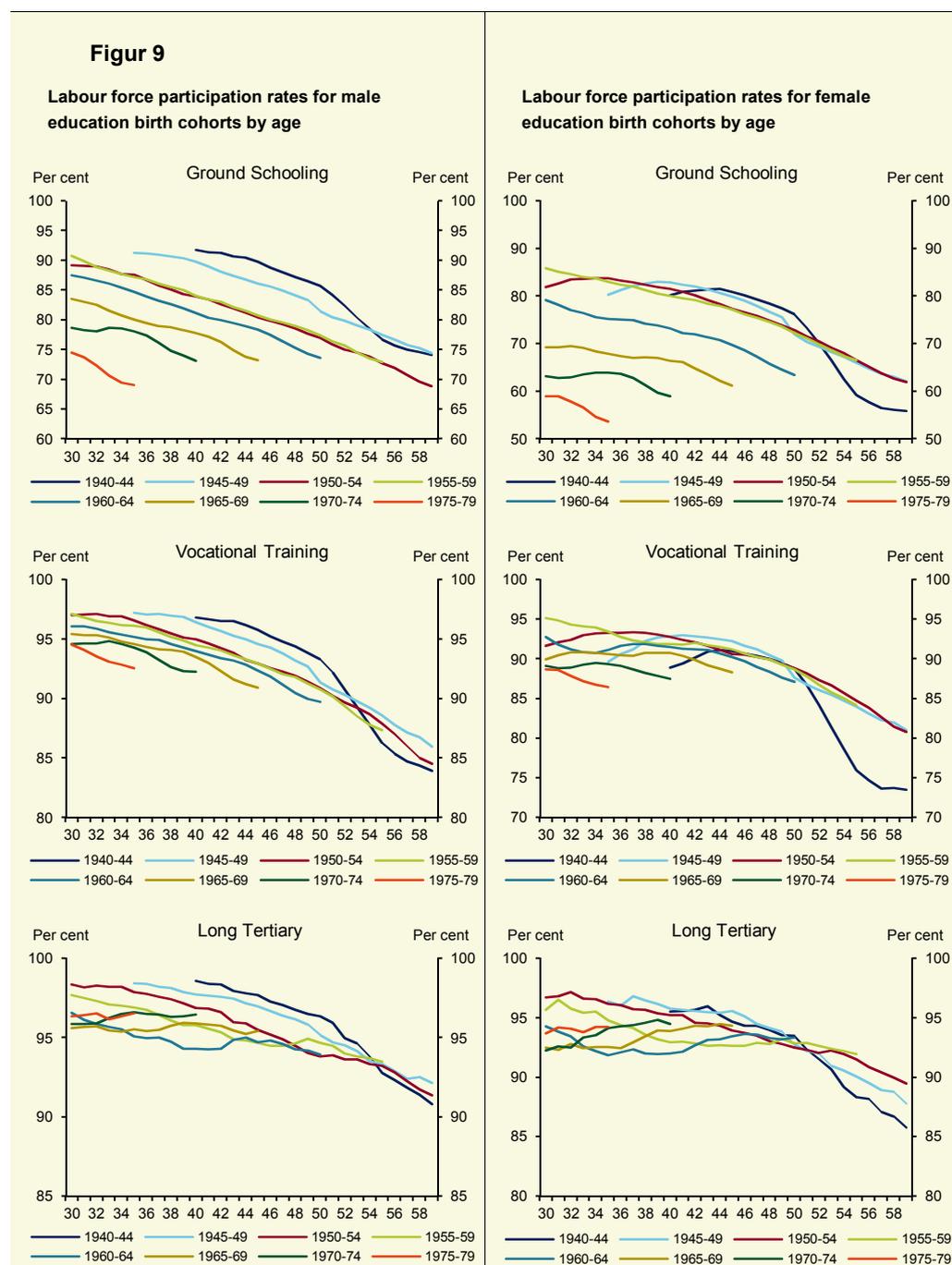
These differences suggest that the overall decline in labour force participation can partly be attributed to a number of policy developments and measurement issues that do not necessarily point to a continuing trend of declining participation going forward. In the next section, we will analyse these issues in more detail including how we account for them in the modelling of labour force participation. We will do so by exploring the cohort specific effects on labour force participation for cohorts of male and female education groups where policy and other relevant developments are taken explicitly into account.

4 Labour force participation of cohorts

In the remainder of the paper we will describe a model for the labour force participation of birth cohorts of males and females with different educations, and as a precursor to that, we will have a look at development in the unadjusted labour force participation rates of a selection of cohorts, *cf. figure 9*. The figures show that there are some noteworthy differences between the participation rates of these cohorts in terms of both their levels and developments during the previous three and a half decades. As it turns out, much of what is revealed by the modelling can be retrieved from the figures.

The participation rates for male cohorts with a ground school education all have similar age profiles with annual linear decline rates of around 2/3 percentage point. For female ground school educated, the age profiles are similar to those of males except that the older cohorts (1940-44 and 1945-49 in the figures) show clear signs of a convergence effect in the eighties, and that the younger cohorts (1960-64 to 1975-79) show stronger positive effects of the economic upturn leading up to the crash in 2008. Also, the drop in participation at age 50 for

the 1940-44 cohort, as a result of the introduction of the transition benefit, is larger for females.



Anm.: The age profiles are averages for five consecutive birth cohorts. The remaining education groups are shown in Appendix B.

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

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 vocational educations.

The age profiles for the cohorts with vocational educations also shift downwards across the cohorts, but the sizes of the shifts are much smaller than for ground schooling for all cohorts and across all ages.

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, the 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 their older counterparts. 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 does not appear to be a permanent effect. However, it is difficult on the basis of these charts to separate the scarring effect from the effect of current labour market situation. With the model presented in the next section, we endeavour to do just that.

4.1 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. First, we estimate group-specific lifetime labour force participation rates for each gender, education and birth cohort group. The second component models the dependency of these group-specific participation rates on the cohorts' educational composition and the structural unemployment rate when the cohort entered the labour market, see section 4.2.

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 .⁸ Educational groups include ground schooling, secondary schooling, vocational training and short, medium and long tertiary qualification. A 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:^{9,10}

⁸ The observations are split 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, 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.

⁹ In a separate analysis (cit.) we specify and estimate a version of the model with a more flexible dynamic specification:

$$lfpr_{c,i,t} = \gamma lfpr_{c,i,t-1} + X_{c,i,t} \beta_{c,e,g} + \tau_{c,e,g} + \varepsilon_{c,i,t} \quad \varepsilon_{c,i,t} = \rho \varepsilon_{c,i,t-1} + e_{c,i,t}$$

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

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 :

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

$\tau_{c,e,g} \sim N(\hat{\tau}_{c,e,g}, \sigma_{e,g}^{\tau^2})$ 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 used in the modelling is described in Appendix C, which also contains a list with variable descriptions. The model is estimated separately for the 12 gender and education specific groups, and although this is not essential, it implies that all parameters are gender and education specific. The observations are weighted by the number of persons they represent. The number of years each cohort group is observed depends on their age range in the estimation period from 1980 to 2015. 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 the year.¹¹

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. Hence 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

This model specification is better equipped for making projections of labour force participations going forward. The specification used here is thus a special case with γ and ρ set to zero, which allows the random effect $\tau_{c,e,g}$ to be interpreted as a cohort effect that reflects the relative labour force participation of the cohort across their lifetimes.

¹⁰ The model has also been estimated as a probit model with random effects based on individuals observations of labour force participation. The results are qualitatively very similar to the results presented in this paper and can be obtained from the authors on request.

¹¹ This is to account for the lower participation for the (relatively few) persons who have not completed their highest education when they turn 30.

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^{2003}) and from 2008 (DB_t^{2008}) and both are interacted with age to capture that these changes had a different impact on registered participation for the younger and the older age groups.

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 described 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), Dagpengekommisionen (2015), Finansministeriet (2017), (Rosholm and Svarer (2008)). However, in most cases 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 to capture the effects of these changes.

The idea is to decompose unemployment into its structural and cyclical components that, as it turns out, have very different relationships with labour force participation.¹² 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.¹³ 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 the 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 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 a possible education specific displacement effect of the increasing education level of the consecutive cohorts in the panel.

¹² Cyclical unemployment is the difference between actual and structural unemployment.

¹³ 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.

The following table shows the estimation results as marginal effects of the estimated parameter values (the actual parameters 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 at all education levels have lower participation rates than natives.

Table 1

Marginal parameter effects in the LFPR model for males and female education levels

<i>Percentage point</i>	Males						Females					
	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
Desc. Non-west	-4,32	-3,72	-5,55	-2,72	-0,90	-3,95	-1,29	-8,82	-7,93	-6,68	-4,45	-8,18
Desc. West	-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 unempl.	-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 unempl.	-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	-	-	-	-	-	-	2,23	2,07	1,60	0,78	0,97	0,67

Note: A variable for the proportion of a cohort groups 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.

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 rate and, as expected, the adjustments in 2008 were the larger of the two breaks. In general, the impact was decreasing with education and age and it was larger for females than for males. This makes sense for at least two reasons. First of all, 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 reclassified 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.

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. 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.

The estimated direct effects of the labour market leave schemes and the transition benefits are all negative as 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 percentage point decrease in participation. The effect is higher for the younger and the older age groups, and lower for the age groups in the middle, which ostensibly reflects that unemployment generally fluctuates less with the business cycles for this group. The effect is stronger for females at 0.25 than for males at 0.14, and it is decreasing with education, particularly for males. 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 by 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 young group 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 followed the downward trajectory of structural unemployment.

Apart from being an interesting result in its own right, a strong connection between reduced structural unemployment 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 ‘moving’ people from unemployment benefits to other benefits such as disability pensions. In addition to that, the data breaks in 2002 and 2008 account for more than 2 percentage points. This points to a somewhat more optimistic expectation to the development in future participation rates than what could otherwise be extrapolated from the historical downward trends.

4.2 The estimated cohort effects

As shown by the age profiles for the cohorts in figure 9, 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 $\tau_{c,g,e}$. The estimated mean values $\hat{\tau}_{c,g,e}$ of the random effect thus represent adjusted *lifetime participation rates* for the cohorts of males and females with different education levels.¹⁴ These make the independent variables of the second model component:

$$\hat{\tau}_{c,e,g} = f(RI_{c,e,g}, SUE_{c,e,g}) = \sum_{j=1}^{J_i} [\alpha_{c_j,e,g} + RI_{c_j,e,g} \beta_{c_j,e,g}^{RI}] + SUE_{c,e,g} \beta_{c,e,g}^{SUE} + e_{c,e,g}$$

We consider 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 displacement effect of increasing educational attainment across cohorts (see below).

The components of the Ranking Index are defined as

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

For males, the piecewise linearity in the Ranking Index only applies to the unskilled groups, where a shift in the displacement effect can be identified. No shifts can be identified for males with vocational and tertiary educations. For females, the piecewise linearity also captures the shift from converging, and hence increasing, participation in the early years to a situation in the later years where the labour participation of cohorts of unskilled females are shifting downward as a result of the displacement 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 three 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.¹⁵

A key endeavour of the present study is to understand and explain 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 by less than the full impact of the shift toward higher educations with higher participation rates, i.e. a throughput of less than 100 per cent. If this presumption holds, we will observe a decline in the labour force participation rates of some or all education groups due to the presence of the so-called displacement 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 will be required. One such measure is the so-called *Ranking Index* that was originally proposed by Jensen et al. (2009). The idea is to

¹⁴ The interpretation of $\hat{\tau}_{c,g,e}$ as a measure lifetime participation reflects the fact that they represent relative participation rates across all the ages for each cohort and hence the cohort effects quantify the average lifetime participation relative to the other cohorts in the sample.

¹⁵ 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.

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. The position of the educations in the hierarchy is defined by the stacked shares for each cohort with bands that represent ability levels of each education. The Ranking Index for each education is defined as the midpoints of the educations range, cf. box 2.

Box 2

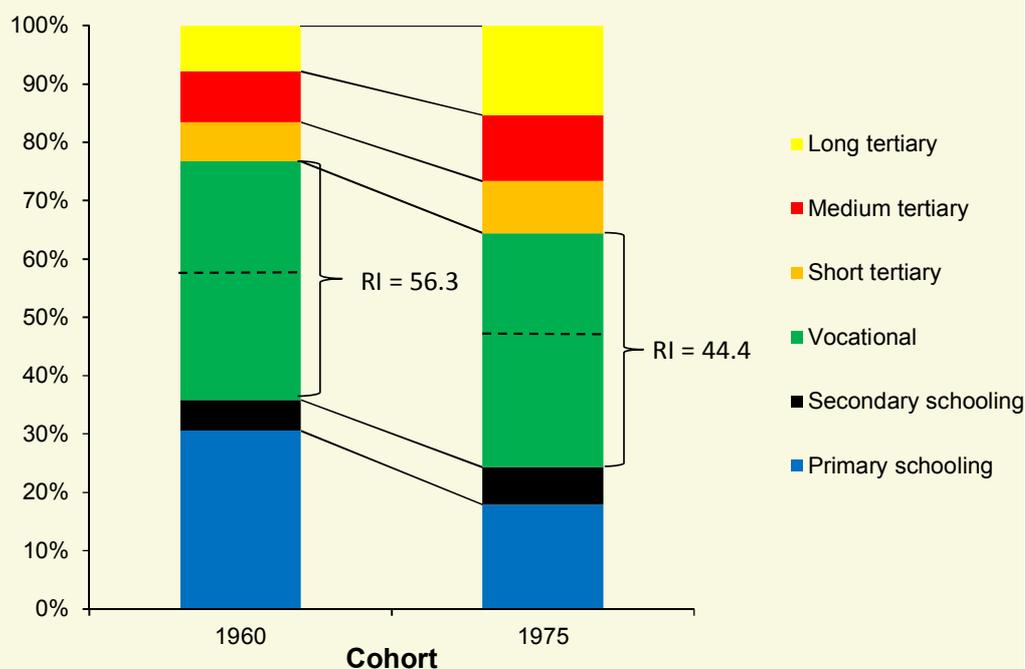
The Ranking Index – an education specific indicator for the marginal returns to education

The analysis covers more than 60 birth cohorts born in the years from 1922 to 1985. One of the most important developments that have occurred across this panel of birth cohorts is the increase in the 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 decreased 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 educational 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. The ranking index 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 ($RI = 24.3 + 40.1/2 = 44.4$). 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.

Figure b2 Ranking Index for male cohorts 1960 and 1975, vocational training



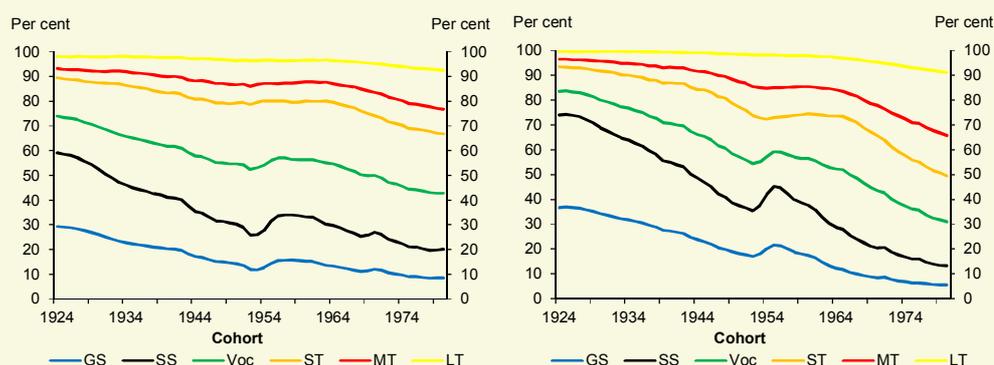
Source: Own calculations based on Danmarks Statistik's education register.

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 has declined as the general education levels increase 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 is temporarily reversed and fewer obtain an education beyond ground school, secondary school 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.

The intuition behind the mechanism 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 either receive individuals with less ability from below or deliver individuals with more ability to the groups above.

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



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

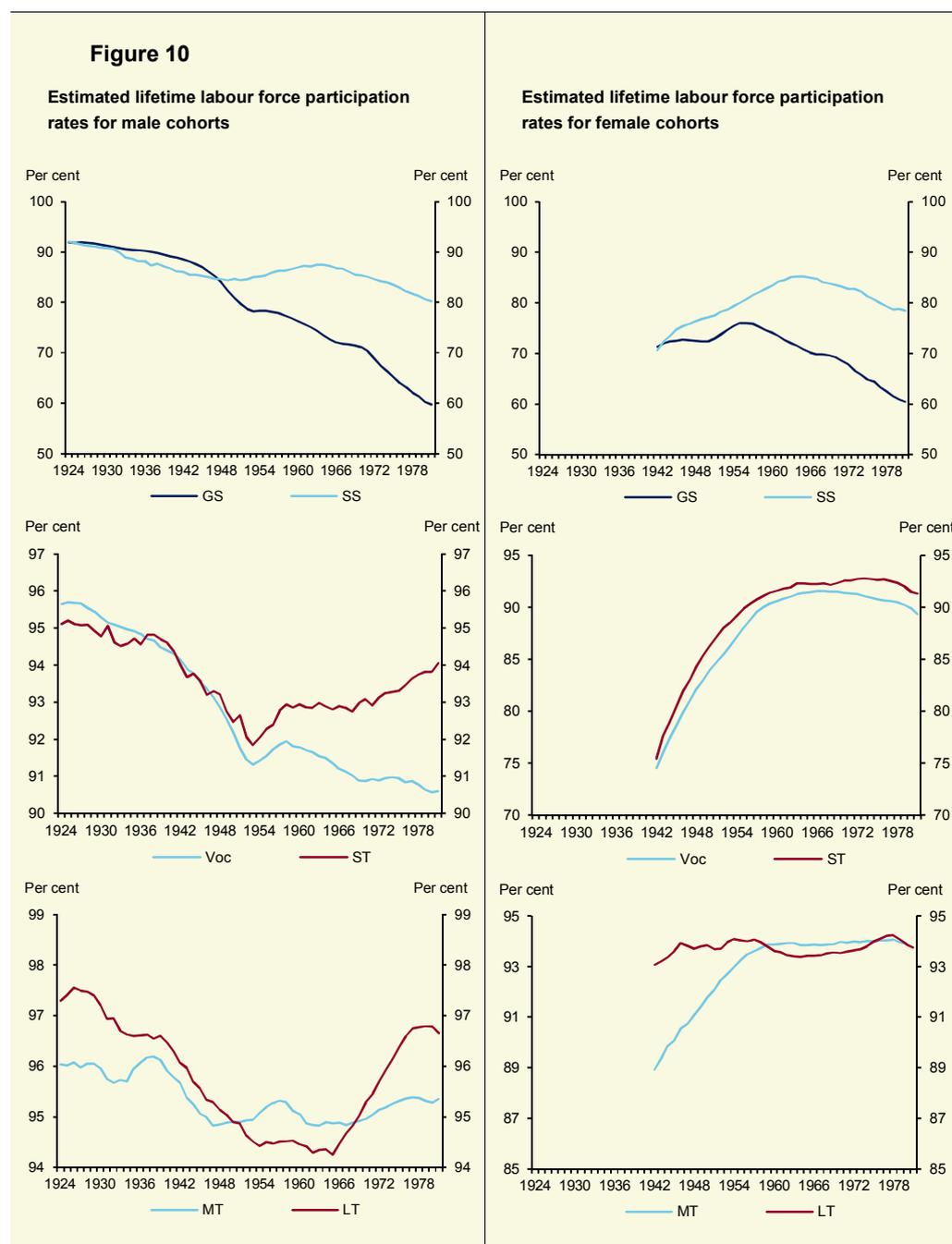
The construction and use of the Ranking Index is based on several important assumptions. First of all, it is assumed that the relationship between ability and education is hierarchical by nature. Second, we assume that individuals achieve an education according to their position in the ability distribution 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.¹⁶

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.

Returning now to the estimated lifetime participation rates for cohorts, the following figures show marginal effects of the estimated $\hat{\tau}_{c,g,e}$, cf. figure 10. The marginal cohort effects quantify relativities across cohorts where other factors are held constant.¹⁷ The figures show that the development in lifetime participation across cohorts of males and females with different education levels follow very different trajectories. A number of interesting insights are revealed.

¹⁶ Sogaard (2011) applies a normal distribution as an alternative to the uniform distribution.

¹⁷ Due to the non-linearity of the log-ratio transformation, the figure shows 'pseudo' marginal values – instead of estimated $\hat{\tau}_{c,g,e}$ – that illustrate the impact of the cohort effect on the participation rates of each cohort group. The profiles show the relative rates for the cohorts when evaluated at the average participation rate across the estimation sample for each group.



Note: The average labour force participation rates of the cohorts are five year averages of cohort averages across the estimation sample for each education group from 1980 to 2015 and for all 30-59 year olds. The marginal cohort effects are made comparable across cohorts by setting other variables to the same 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).

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. This represents the cohort specific aspect of the convergence in female participation rates. The convergence is present for almost all female education groups but strongest for secondary schooling, vocational training and short tertiary. The convergence is also present 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

displacement effect is in operation, which tends to reduce participation – a phenomenon we will return to shortly. 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, it is less than 1 percentage point that 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 is complete for the cohorts born between the mid-1950s and the mid-1960s and for subsequent cohorts, the lifetime participation rates tend to level out, or decline as it is the case for the unskilled with ground and secondary schooling and to a lesser extent for vocational training.

The 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. This makes the development in labour force participation of unskilled females increasingly look similar to their male counterparts.

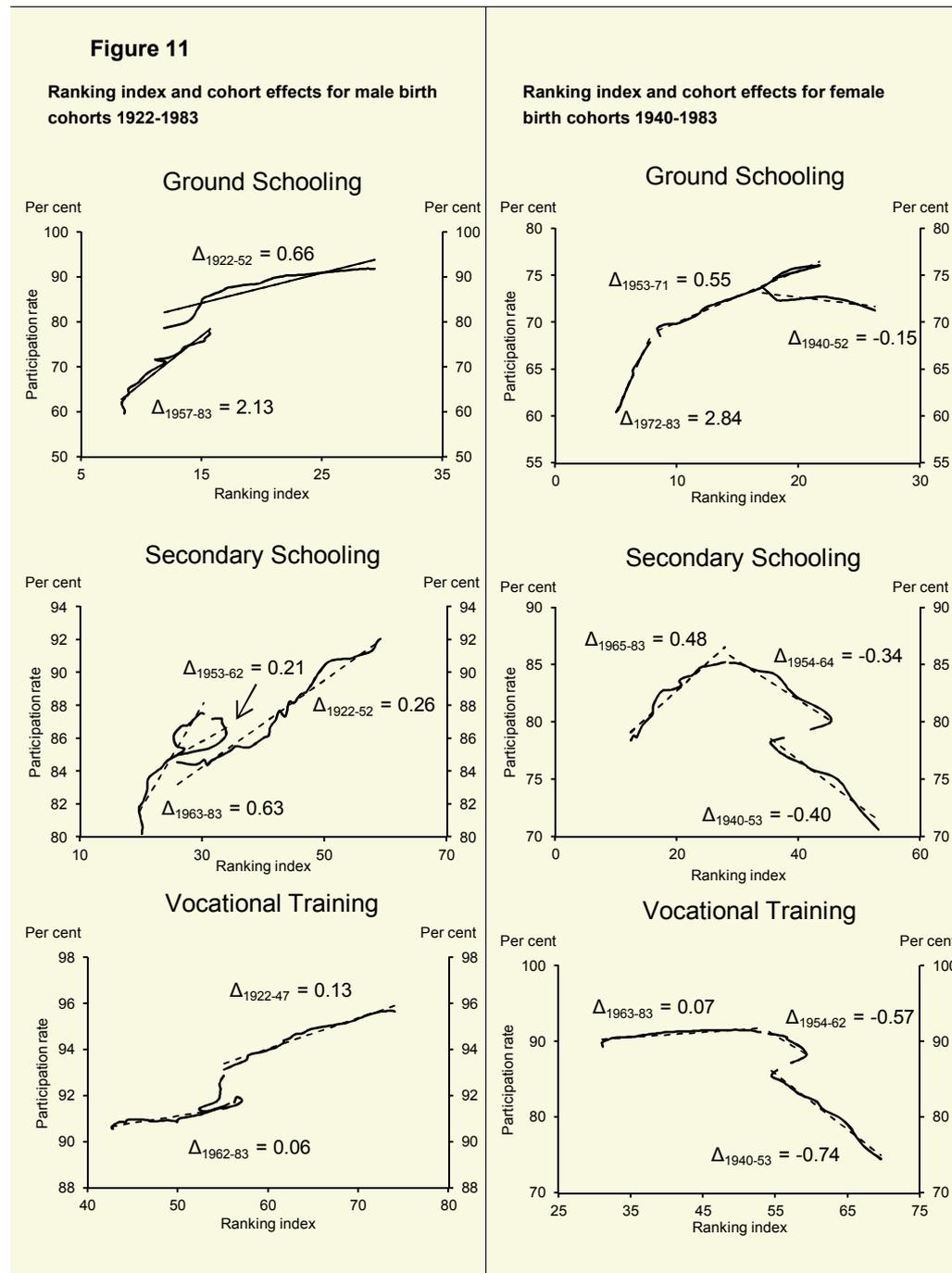
Indeed, for males with ground schooling, there has been an even more dramatic downward shift in participation rates across all the cohorts spanned by the panel. The decline started at a slow pace of around one quarter percentage point per cohort up until the cohorts born in the mid-forties where after the decline rate accelerated to around half percentage point for the cohorts born up until the early 1950s. The downward path then took a small breather before heading south again at an increased 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.

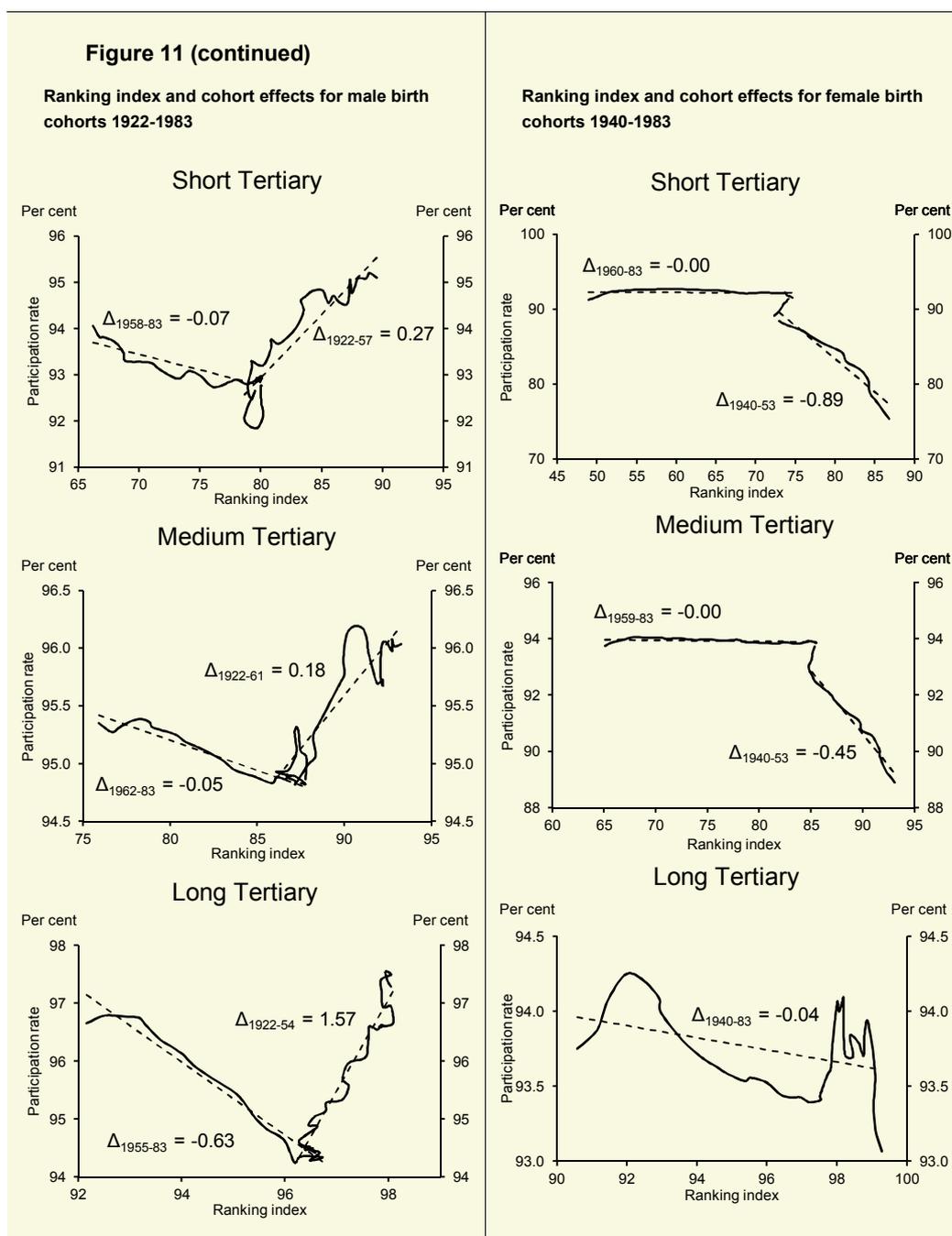
Initially, the participation rates for male cohorts with secondary schooling are shifting downward at the same rate as ground schooling, but only up until the cohorts born in the mid-forties, where after they level out and actually increases for the cohorts born from the early fifties to the early sixties. The participation rates then commence a decline parallel to that of females with secondary schooling, and like their female counterparts, the males cohorts with secondary schooling decline by around 7 percentage points from the early 1960s toward the youngest cohort in the panel.

The obvious explanations for this striking development is that a displacement effect has been thinning out the proportion of the unskilled who are able to work as the more capable were lifted out of the group cohort by cohort. The displacement effect for male and female education groups can be illustrated by plotting the lifetime participation rates against ranking indexes as shown in figure 11. The slopes of the trajectories represent education specific displacement effects. In general, a positive slope indicates that an increasing education level is associated with declining participation across cohorts. Specifically, a slope of 1 means that a 1 percentage point decline in the ranking index of a group across cohorts is associated with a 0.5 percentage point decline in the group's participation rate. The line segments in figure 11 indicate how the displacement effect may have increased across the cohorts in leaps and bounds, although for some groups it appears that the slope – and hence the displacement effect – increases more gradually for certain sequences of cohorts. The division of time periods for the different groups was done manually so as to best capture the data.

The slope is negative for the oldest female cohorts for most education groups. This is of course a result of the increasing participation rates for the converging cohorts of females and

not a reverse displacement effect. A negative slope is thus observed for the cohorts of females with ground schooling, short tertiary and medium tertiary up to cohorts 1952 to 53 and for secondary schooling and vocational training up to cohorts 1962 to 64. For the cohorts that follow, the slopes are either flat or positive, which suggests that displacement may have replaced convergence as a main driver of the development in female labour force participation.





Note: The charts plot the Ranking Index (1. axis) versus the cohort profiles for the labour market participation rates (2. axis) for the six education groups of males and females. The timeline generally move from left to right as the Ranking Index decline with increasing education levels. A positive slope indicates a negative relationship between education levels across cohorts and their labour force participation rates, ie. an indication of a displacement effect. The time period were divided from eyesight judgement.

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

For the cohorts with ground and secondary schooling, the displacement effects for males and females are quite similar and generally increasing across the cohorts. For males with ground schooling, the displacement effect has been increasing dramatically across the cohorts from 0.66 for the cohorts born up until the early 1950s to 2.13 for the youngest cohorts in the sample who were born in the 1970s and the early 1980s. The females with ground schooling

follow a similar trend, which is somewhat delayed due to the convergence of female labour force participation that had the opposite effect for the older cohorts in the sample. The displacement effects for the youngest cohorts – 2.13 for males and 2.84 for females – are the best estimates for the effect on labour force participation of reducing the proportion of future cohorts with ground schooling. The implication of these results is that a reduction in the proportion of a cohort with ground schooling will tend to reduce the participation rate by around 1 and 1.5 percentage points for males and females respectively. However, the increasing displacement effect across the cohorts in the sample suggests that the displacement effect is likely to increase even further if the proportion of future cohorts with ground schooling continue to decline.

The displacement effect for secondary schooling is also increasing across the cohorts, but at around 0.5 to 0.6 for the youngest cohorts for both males and females, the effect is much weaker than for ground schooling.

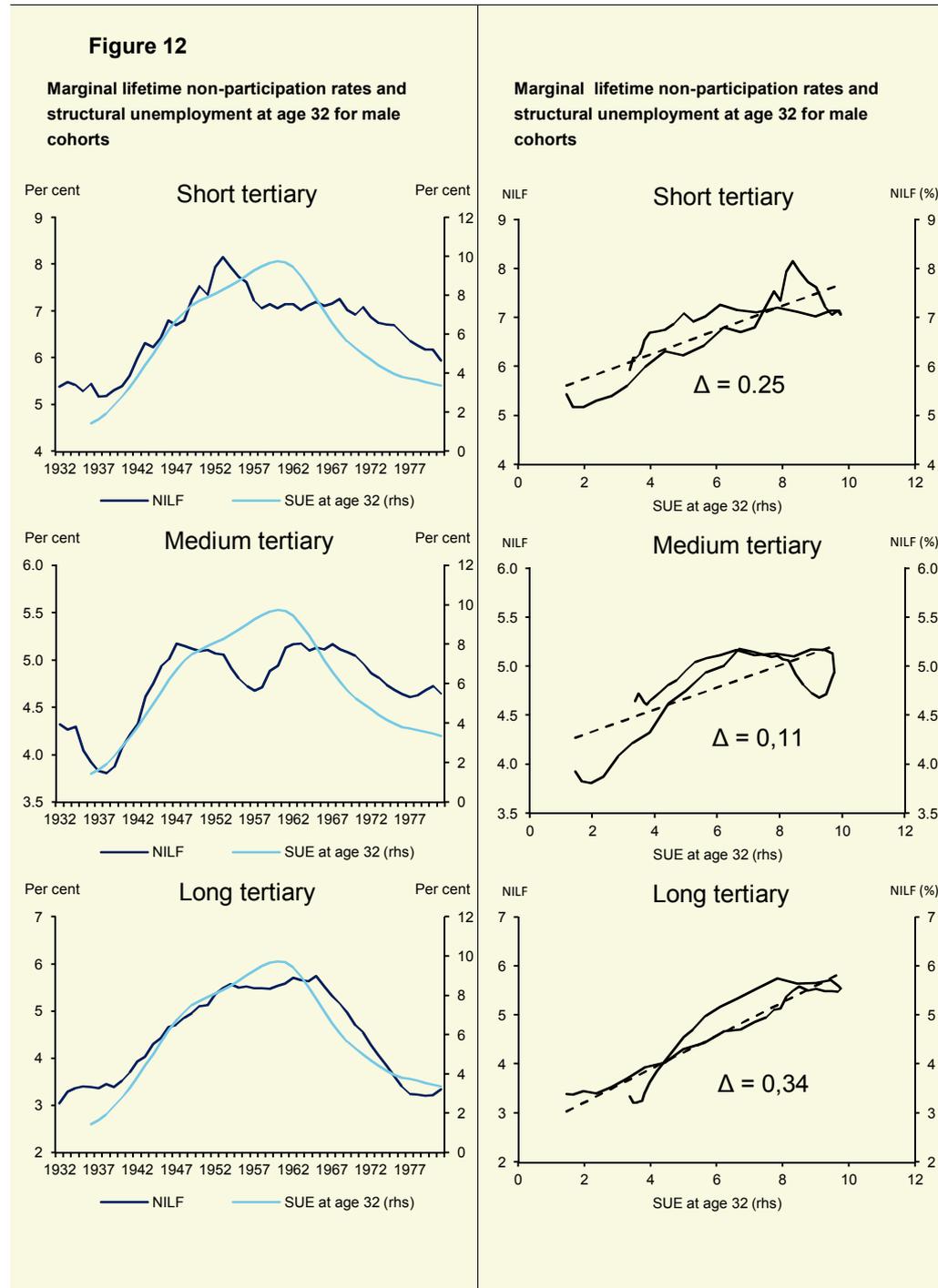
The lifetime participation for the vocationally trained and tertiary educated females tends to level out although the youngest cohorts do show signs of marginally reduced participation rates. Nevertheless, the displacement effect is only small for vocationally trained females and there are no real signs of displacement for tertiary educated females.

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, 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 displacement 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 displacement 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 and 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 displacement 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 more plausible explanation for the underperformance of these cohorts is that they entered the labour market during a period with persistently high unemployment rates that would have increased the risk that 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 after completing their educations. This is evident from the following figures that illustrate this relationship by plotting the lifetime non-participation rates that is, $100 - \text{participation}$, for males with tertiary educations against

structural unemployment in the year when the cohorts were 32 years old. These simple plots are clearly indicative of a strong relationship between the lifetime labour market performance of cohorts of males with tertiary educations and the labour market structures in the years when the cohorts enter the labour market – a scarring effect that has had a negative impact on the affected generations.



Note: The charts to the left show the marginal non-participation rates for cohorts vs. structural unemployment in the year the cohorts turn 32 years. The charts to the right are plots of these series.

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

To summarise the above discussion, we have two well-founded presumptions about what might have affected the estimated cohort effects. The first presumption is that 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 displacement effect, the increase is smaller than the direct effect of the cross-sectional differences in participation rates for education groups. We quantify the displacement effect, and how it may have impacted on the participation of each educational group as well as the population as a whole, by using the education specific Ranking Index to represent the level of educational attainment of individual cohorts of males and females, cf. box 2.

The second presumption is that the lifetime participation of individual cohorts could be affected by the general strength of the labour market situation at the time the cohorts enter the labour market. We test this by relating the estimated cohort effect to the level of structural unemployment at the time that a cohort-education group leaves the education system to enter the labour market. The presence of such an effect is equivalent to a *scarring effect* of entering a labour market during a period when it suffers from structural problems. The negative 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.¹⁸

It turns out that the scarring effect is also measurable for male cohorts with vocational educations, but not at all for females. The absence of a scarring effect for unskilled males with ground and secondary schooling is presumably because of the lower skill levels required for the job tasks typically performed by these groups, and hence unemployment is not detrimental for future job prospects. For females, the failure to identify a scarring effect is likely because the reverse convergence effect is dominant for the cohorts born up to around 1960 and – as discussed earlier – it was a likely contributing factor to the increasing structural unemployment towards the mid-1980s.

The results are summarized by the following table that shows the estimation results for the embedded model of the lifetime labour force participation of cohorts, and how it is related to the displacement effect and, for relevant groups, the scarring effect of early career labour market structures as represented by structural unemployment, at the time when they left the education system to enter the labour market.

The parameter estimates of 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 – medium tertiary at the low end and long tertiary at the high end. Since structural unemployment has moved from 1 $\frac{2}{3}$ per cent in the late 1960s to 9 $\frac{3}{4}$ per cent in the early 1990s and back again to current levels at just above 3 per cent, the implications of this result is that the labour market situation facing cohorts when they leave the education system is associated with a difference in lifetime participation rates of between $\frac{3}{4}$ and 2 $\frac{1}{2}$ percentage points.

The estimated parameters for the Ranking Index quantify education specific displacement effects for both males and females. The results suggest that while the unskilled and those with vocational educations have been severely affected by displacement, the tertiary

¹⁸ A structural scarring effect is 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 a measure for the business cycle.

educations have been entirely unaffected. The results imply that the effect of reducing 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 for males and 2.83 for females). For secondary schooling and vocational training, the displacement effect is significant but much weaker. The estimated effect of reducing the proportion of a birth cohort with secondary education is to reduce 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.

Table 2

Lifetime labour force participation – the effects of the Ranking Index (RI) and structural unemployment (SUE)

	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)		
	1953-56	-0.01 (0.56)	-	0.99	1953-71	0.55 (0.02)	-	0.997
	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 are identical to the ones in figure 11 and have been identified as those that gives the best fit.

The results for ground and secondary schooling show that the displacement 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 displacement 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 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 displacement 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. The following table 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 displacement effect), the estimated effect after discounting for the displacement 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 immediate effect is larger for changes in the education level that 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). Secondly, the effect and in particular the throughput is higher for females than for males. Thirdly, the throughput is lower for changes that shift from educations with high displacement (e.g. ground schooling) and especially when the receiving education group also has high displacement (e.g. secondary schooling and to a lesser extent vocational training).

Table 3
Estimated effect on lifetime labour force participation of cohorts of an increase in education levels

Change from -> to	Full effect		Estimated effect		Throughput (%)	
	Males	Females	Males	Females	Males	Females
	----- 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 displacement effects in table 2 (for the youngest cohorts where the effect changes across cohorts). The displacement effect is 100 minus the estimated throughput.

If, for example, the education of a cohort is lifted by elevating 1 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 in the absence of displacement of 0.24 and 0.27 percentage points. If instead a 1 percentage point is elevated from ground school 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 show that the displacement effect is generally stronger for males than for females, and it is relatively strong for lifting people from ground schooling to secondary schooling. Displacement, however, is much weaker when the share of secondary school leavers that also complete tertiary educations is increased. Previous research estimated the *average* displacement 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 *displacement effect*, and that overall labour force participation rates are lower compared to the predictions assuming a full effect of increasing educational attainment. However, the displacement effect depends on the compositional nature of the change and it predominantly affects the participation rates of the unskilled, while tertiary educations are unaffected.

6 Concluding remarks

The analysis presented in the paper has two important contributions to our understanding of the development in the labour force participation of cohorts. First of all, we demonstrate that 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 displacement 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, displacement has only reduced participation for the diminishing group of unskilled and to a lesser extent the vocationally trained – and at an increasing rate. In contrast, the tertiary educated have been largely unaffected in spite of having increased their share of the birth cohorts over time. A profound implication of these results is that educating an increasing proportion of the cohorts has reduced participation of the unskilled, but not the tertiary educated. As a result, the education level of the labour force has been elevated by more than the increase in the education of the population. The result also names displacement as the main reason for the plummeting labour force participation rates for the unskilled. Indeed, the effect of displacement among the unskilled suggests that across cohorts, the average resources of the diminishing group of unskilled has been decreasing as the education system has lifted the more resourceful people out of the group.¹⁹

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. Unskilled males who also entered the labour market during a recession, however, did not suffer from the scarring effect. It has not been possible to identify an equivalent scarring effect for females, presumably because these cohorts of females had increasing participation rates across cohorts as part of the general convergence of female labour force participation.

¹⁹ A tell-tale sign of the displacement effect is an equivalent dramatic increase in the incidence of disability pensioners among the unskilled.

The study provides some answers but also leaves many questions unanswered about the past and the expected future labour force developments. Firstly, while the displacement effect is ostensibly behind the decreasing labour force participation of the unskilled, we have a very limited understanding of the interaction between supply and demand factors as expressed, for example, by the notion of a race between education and technology (see Acemoglu 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 displacement 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.

Finally, we need a better understanding of how the educational composition of new cohorts is likely to affect future labour supply and productivity. While the modelling approach presented in this paper reveals interesting insight into the cohort dimension of labour force participation, it is inadequate for forecasting purposes due to the specification's lack of dynamics. A common approach to projecting the size and structure of the labour force is based on simple cross-sectional frequency tables (CSFT) and the non-dynamic assumption, that the current relationship between labour force participation and key demographic variables such as gender, age, ethnicity and educational attainment will continue in future years (e.g. DREAM, 2015, Hansen, 2016, Finansministeriet, 2014). Amending the cohort modelling approach with a dynamic specification to address this shortcoming is an avenue of future endeavours that has the potential to improve the labour force forecasting used to make long-term government budget forecasts.

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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
Innerecept	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 C 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 1980-2015. The data cover 100 per cent of Danish residents aged 30 to 59 during the years from 1980 to 2015, hence covering male cohorts born between 1922 and 1985. We discard 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, maintained by Statistics Denmark, is used to identify individuals' socioeconomic status each year, where the definition of labour force participation approximates the ILO definition (see box 1 for further detail). The socioeconomic status of an individual during the last week of November is used as the labour force status in the calendar year. Register-based information on transfers and earnings are used to group individuals into the three main categories namely employed, unemployed and outside the labour force. We group the individual specific data by gender, education, birth cohort and ethnicity, counting Danish, non-western and western descendants. For each year, we compute the group-specific labour force 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 proportions accordingly. Also, 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 reference week of the labour force status from RAS (the last week of November). We use annual structural and actual unemployment rate estimates computed by the Danish Economic Councils.

Table C1 – Variable definitions

Variable	Definition
$lfpr_{c,i,t}$	Log-odds-ratio of labour force 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
$LLS_{c,i,t}$	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 box 2.
$SUE_{c,e,g}$	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