



# The reduction of life hours of work since 1850: estimates for Dutch males

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## Summary

In this paper we deal with the development of the number of hours Dutch males work in their lifetime. Estimates of the life hours of work are made for ten-year birth cohorts between 1840 and 1950. The number of hours men work during their lives gradually diminished. Men born in 1840 worked on average 118 thousands hours, while it is only 67 thousands hours for the 1950 cohort. So, it almost halved. As a percentage of the total number of hours available to a person, the decline is even stronger: from 23 percent for the 1840 birth cohort to percent for the 1950 birth cohort. This is due to the increase in life expectancy since the mid-19<sup>th</sup> century.

Technological development is often seen as the major driving force behind the decrease in the life hours of work. However, there is quite some evidence that the extremely long working hours that were customary in the 19<sup>th</sup> century were not an economic necessity. When the working week exceeds 60 hours, an additional hour does not lead to more production. And in case of very long working hours the effect might even be negative. Perhaps the most important reason why employers were reluctant to reduce working time and the government hesitated to implement legislation forcing employers to do so, was fear for what people would do with more free time. Unbalanced power relations made it possible for employers to impose long extremely working hours on workers. The emergence of the labour movement changed that.

It is unlikely that in the future annual working time will be further reduced. Neither do we expect shorter work lives. At the moment the tendency is that people work longer as life expectancy continues to increase. It is more difficult to say what will happen with employment rates. Most economists think that in the long run technological development will have no negative effects on the macro employment rate. Other scientists believe that the new developments in technology are more universal than past developments and will therefore lead to more employment destruction than employment creation. If this scenario comes true it will not lead to a general reduction in the number of hours people work in their lifetime, but to higher unemployment among some groups.

Key words: working hours, labour market participation, working lives



## Introduction<sup>1</sup>

This paper presents estimates of the number of hours Dutch men spend on working in their lives. It does so for birth cohorts between 1840 and 1950 with ten-year time intervals. Measuring the development of the life hours of work is our main purpose, but we also deal with the question which factors affected this development. We take 1840 as our starting point mostly for a practical reason. The 1849 census was the first one containing labour force data broken down by age categories, which is necessary for a follow-up of cohorts. Only few people born in 1840 started their work life before 1849, making the 1849 census a good starting point for our analysis. As far as we know no previous attempt was made for the Netherlands to estimate the number of hours people work in their lives for a long historical period.

The number of hours people work in their lifetime is an important economic and social indicator. Together with the level of hourly wages it determines how much individuals earn on a life-time basis. But work also has opportunity costs. First, an early start of work life implies that less time is available for school education. School education produces several benefits like positive effects on productivity and social participation. There is overwhelming evidence that these benefits outweigh the costs of education.<sup>2</sup> A second opportunity cost of work is the loss of leisure time. Although work can be a positive thing in itself, people need a sufficient amount of free time to lead a pleasant life. In the 19<sup>th</sup> century the opportunity costs of work were largely neglected. Most people had to start their work life at very young age, worked long hours and had hardly time for joyful things. In many cases work lives lasted until death. Older people who were unable to work had to rely on their children (which were often poor themselves) and on poor relief. The support obtained was hardly enough to survive.

What are the main facts of the development of hours worked since the second half of the 19<sup>th</sup> century? In 1850 most people had a six-day working week with working days of 12 hours or more. Nowadays, the standard working week is usually five days of eight working hours. And many workers work part-time. Even among men this is the case. In 2014 25 per cent of Dutch male workers had a part-time job. The growth of part-time work is a relatively recent phenomenon. It coincides with the increase in labour market participation of women in the Netherlands since the 1970s. Most women (in 2014 75 per cent of the female workforce) work part-time. Later many men followed their example. The growth of part-time labour has also contributed to the diminishing average working week, which has more than halved since 1850.

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<sup>1</sup> Thank are due to Arie Gelderblom and José Gravesteijn for their comments on an earlier version of the paper.

<sup>2</sup> Most of literature concentrates on the effect on wages. The general conclusion is that the higher wages resulting from education outweigh the school costs and the foregone earnings that go along with education. For a review of studies in this field we refer to Psacharopoulos (1994).

We can also look at the number of hours worked during the year. Then we also have to take holidays into account. In the mid-19<sup>th</sup> century there were very few holidays and they were usually not paid. Nowadays, the number of paid holidays for a full-time worker is at least 25 (including official holidays like New Year's Day and Christmas Day). Taking the increase in the number of holidays into account, the annual number hours of worked by men has more than halved from 3500 in 1850 to slightly more than 1600 hours in 2010. We come back to the details later in this paper.

However, in this paper we go one step further by considering the number of hours people work in their lifetime. In addition to annual hours the length of a working life is an important factor determining life hours of work. For people reaching old age work lives have become shorter. In the mid-19<sup>th</sup> century the average age at which children left school was 10 to 11 years. In the absence of old-age pensions most people had to work as long as they could. Since the introduction of a general old-age pension in the 1950s most people retire at 65 or earlier. However, in the 19<sup>th</sup> century many people died before reaching 65. Although death rates were particularly high among infants and young children, mortality was also much higher than today among the working age population. Hence, not everybody born in 1940 had a shorter work life than the people born in 1840.

For birth cohorts from before 1840 there is not enough data to make reasonable estimates of the life hours of work. However, this does not mean that we can say nothing about the period before 1840. We know enough about this period to conclude that work lives and working hours have changed much more since 1840 than in the centuries before. For England Bienefeld (1972) presents information about daily working hours, the number of weekly working days and the number of yearly holidays since roughly 1300. Although the information is not available on a regular basis, it gives a good picture of the developments in working hours. Although Bienefeld deals with England the development of working time in the Netherlands will not be too different. We give a short summary of the conclusions drawn by Bienefeld. Between 1300 and 1850 daily working hours have been relatively stable at approximately 12 hours. During most of this period people worked six days a week, but during the late middle ages there has been a period during which people worked only half a day on Saturday and holidays were quite numerous. But in the 16<sup>th</sup> and 17<sup>th</sup> centuries the number of holidays was sharply reduced. At least partly Protestantism was responsible for this development. The number of hours worked may have increased somewhat during the early stage of the industrial revolution.

In this paper we concentrate on men. There are many uncertainties about the data, even for men. Still we think that our estimates for men give a fairly good picture of the development of the number of hours worked in their lifetime. Most uncertainty consists with respect to the estimates of the labour force, employment and unemployment for 1849 and 1859, because only four age categories were distinguished in these censuses. For the 1849 census there is no further breakdown of the age category 16 and older. The 1859 census is a bit

more detailed: 16-23 and 23 and older. However, for men it is reasonable to assume that the labour force participation rate increases at young age and then stays more or less the same for most of a person's work life. For women this is not the case. When a woman married it was customary and often even obligatory that she gave up her job. This led to a different age-pattern of labour force participation than for men. At young age the labour force participation rate of girls and young women increased, but relatively soon a decrease set in. While labour force participation of men stayed relatively constant until the age of 65 female participation rates already started to decrease considerably at the age of 55. This makes it more difficult to make estimates of the 1849 and 1859 participation rates for women in different age categories. Another problem is that particularly in the 19<sup>th</sup> century censuses are very unreliable with respect to female participation. Because paid work was considered to be undesirable for married women, the work they did was not always seen as 'real' work and not counted as such. Finally, estimates of hours worked by women should include hours spent on unpaid household work. How the number of life hours of work have developed for women will be subject of further research.

As far as we know no estimates have been made of the number of hours people work during their lives for the Netherlands. Mortelmans, Vanderweyden en Geldof (2005) have made such estimates for Belgium for cohorts starting from 1930. However, their methodology is different from ours, however (see the next section). Ausubel and Grübler (1995) have made estimates of the development of the life number of hours worked in the UK since the mid-19<sup>th</sup> century, but their estimates are not based on data about the number of years people actually worked. Hazan (2009) who gives estimates for the United States uses a methodology that is most similar to our approach. The most important difference is that he does not have historical data about employment rates broken down by age categories. He has to construct this data.

This paper is structured as follows. First, we discuss a number of options for the methodology to be used and present the method used in the paper. Then we present in more detail the method used to estimate labour force participation rates by age for the period 1850-2013. Next, we present estimates of unemployment rates by age for the same period. The following section contains our construction of employment rates for cohorts using the estimates of the employment rates as well as survival rates. Next, we discuss the development of the yearly number of working hours, followed by a section in which we present our estimates of the average life hours of work for ten-year cohorts starting from 1840 and compare the results with the available estimates for other countries. The last section contains the conclusions and some reflections about the future development of hours worked.

## Methodology

Our methodology is based on labour force data from censuses held between 1849 and 1971 and data published by Statistics Netherlands about employment broken down by age for the period since 1971. This data is far from complete. Particularly the first censuses held in the 19<sup>th</sup> century have several limitations. The censuses held in 1849 and 1859, for example, contain only a few age categories. Furthermore, the definitions used in the early censuses are not clear. Many assumptions must be made to construct a time series of employment by year of age, which can then be used to compute the life hours of work for age cohorts. Because this data is far from ideal, we first discuss alternative data sources.

Ideally, we would like to base the number of hours people work in their lifetime on panel data covering the life of every person who has lived since 1840. However, this type of longitudinal analysis is only available since 1999 when Statistics Netherlands introduced the Social Statistical Database (SSB). This system consists of individual data covering the whole population. For each person we have information about every job he has had. Furthermore, for each job we know when a person started in the job and when he quit the job. The information about jobs also covers the number of hours worked in the job. Furthermore, SSB contains a number of individual characteristics (age, gender and education). Individuals can even be followed on a monthly basis. However, most of our analyses deal with the period before 2000. And during this period no such information was available.<sup>3</sup>

An alternative approach would be to take representative samples of persons born in the 19<sup>th</sup> century or in the first part of the 20<sup>th</sup> century and follow these persons during their lives. If we knew enough about their lives we could compute how much hours they worked during their lives. With a sufficiently large sample size we could compute averages for the people born in each decade. This would provide a good indication of the development of life hours of work. There exists indeed a Historical Sample for the Netherlands (HSN). It consists of a representative sample of 78.000 persons born between 1812 and 1922 and forms an important instrument for socio-historical research (see Maas, Van Leeuwen en Mandemakers, 2008). However, this source does not contain the type of information about labour market participation we need for our purpose.

Still another approach is followed by Liefbroer and Dykstra (2000). They use information from surveys held in different parts of the 20<sup>th</sup> century that contain information about, for example, the age at which young people leave school and the age at which they had their first job. But the information is presented in a form that makes it unusable for our purpose.<sup>4</sup> The Dutch Labour Survey also contains a retrospective question about the year in which people started to work. With this information one could obtain information about the year

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<sup>3</sup> In principle SSB data could have been used for the years starting with 2000, but this data is quite expensive and no funding was available for acquiring it.

<sup>4</sup> It provides, for example, the median of the age at which people have their first job, while we would have needed the distribution of this age.

of entry in the labour market for people born as early as 1925.<sup>5</sup> However, by definition no information is obtained from persons in the cohort who had already died. This will probably cause biased results. One would expect that the latter group has experienced more health problems than the cohort as a whole causing a lower participation rate. Furthermore, the survey provides only limited information about how much time people have worked during their lives. So, still a lot of information would have to be added from other sources. This reduces the usability of the Labour Force Survey for our purpose.

The approach followed in this paper consists of the following steps:

### **Step 1: estimating the labour force between 1850 and 2013 broken down by 5 year age categories**

Based on data from the censuses between 1849 and 1971 and on statistical data covering the period 1971-2013, estimates are made of the labour force broken down by 5 year age categories (except for the oldest age category (65 to 80 years of age)).

### **Step 2: estimating unemployment between 1850 and 2013 broken down by 5 year age categories**

Data about unemployment by age category is only systematically available since 1971. So, for the major part of the period covered in this paper unemployment figures had to be estimated. These estimates are also made for 5 year categories.

### **Step 3: estimating employment between 1850 and 1950 for 5-year age categories**

Employment by year of age is computed by subtracting unemployment from the labour force.

### **Step 4: estimating yearly working hours on the basis of existing data sources**

On a yearly basis data about yearly hours worked are available from 1950 onwards. For earlier years researchers have made estimates for specific years in the first part of the 20<sup>th</sup> century and the second half of the 19<sup>th</sup> century. Both sources have been used to construct a time series for the yearly number of hours worked.

### **Step 5: estimating survival rates of cohorts on the basis of existing data**

Starting from 1850 death rates are available for each year of age. Statistics Netherlands publishes five-year averages. We assume that death rates between 1840 and 1850 are the same as the corresponding figures for 1850-1860. On the basis of the death rates we compute survival rates for each birth cohort.

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<sup>5</sup> Mortelmans, Vanderweyden en Geldof (2005) use this type of data for their paper.

## Step 6: using the results of the previous steps to compute the average life-time hours worked for a number of cohorts

The average number of life-time hours worked for a cohort  $i$  is computed by the following formula:

$$\sum_{j=5}^{79} np_{ij}(i+j)s_{ij}(i+j)h(i+j)$$

In this formula  $np_{ij}(i+j)$  is the net participation rate (or employment rate) in year  $i+j$  of the people born in year  $i$  that are still alive in year  $i+j$ . The survival rate of the people born in year  $i+j$  of cohort  $I$  is denoted by  $s_{ij}(i+j)$ . Finally,  $h(i+j)$  stands for the average yearly number of hours worked in year  $i+j$ . Net labour force participation is defined as the number of workers in a given group divided by the corresponding population. We assume that net labour force participation is zero for children below the age of 5 and for people older than 79 years of age. We also have to assume that hours worked are age-independent. This assumption is reasonable for men aged between 25 and 65. This is certainly true for the period before 1970 when almost all men worked full-time and working hours were highly standardised. Recent data from the Labour Force indicates that even nowadays the average working week hardly varies among 10 year age categories if we take people aged 25 – 65 into account. It is different for young men between 15 and 25 years of age and for people aged 65 or over. Their average workweek is only half of the workweek of the 25-65 years old. The 1960s marked the end of labour by children younger than 15 years of age. Labour by very young children (5-10) had disappeared by the end of the 19<sup>th</sup> century. Boys worked less hours than adult men, but on average the working week of boys was probably more than half the adult working week. In the older cohorts people older than 65 years of age probably worked the same number of hours than other adults. Our assumption implies that we probably somewhat overestimate the number of hours in the more recent cohorts. In computing the average life hours worked we assume that labour force participation rates and unemployment rates are constant within 5 year age categories.

In our calculations we use data about the participation rates of the various age categories. However, this data does not precisely correspond with the birth cohorts. People born in the Netherlands may emigrate and people from abroad may settle here. Particularly immigration may affect participation rates. Immigration of people from the former Dutch colonies and from Mediterranean countries started in the 1960s. Our assumption is that data about participation rates also apply to the birth cohorts. We make the same assumption with respect to death rates. This may lead to some underestimation of the hours worked by the 1940 and 1950 birth cohorts as participation rates of immigrants from non-western countries are lower than of the native population and death rates are higher.

Summarising, we can say that for the more recent years the method used leads to overestimation in some respect and to underestimation in other respects. At least to some extent, both types of errors will balance out. Furthermore, the underlying data for the more recent period is fairly reliable. However, for the older years and particularly for the period before 1900 there is much more uncertainty about the results.

## Data issues

There are several problems with the data. In this section we deal with the following problems:

- The age categories given in the various data sources are often different and not detailed enough;
- The definitions used in the older censuses are not always clear;
- Child labour is underestimated in the 19<sup>th</sup> century censuses.

We discuss the problems and point out how we deal with them.

### *Varying and rather broad age categories*

The 1849 census was the first one containing information about the labour force. Since then censuses were held in 1859, 1889, 1899, 1909, 1920, 1930, 1947, 1961 and 1971. In 2001 a virtual census was constructed on the basis of existing data sources. For the period 1971-2013 a lot of information about labour force participation is available from labour force surveys held during this period and from the Social Statistical Database of Statistics Netherlands (the Dutch statistical agency). The latter database was introduced in 1999.

For our purpose we need a breakdown of the labour force with respect to age categories. Table 1 shows which age categories are distinguished in the various censuses and in the data covering the period 1971-2013. It is clear that the age categories used in the censuses have changed over time. The 1909 census has a fairly detailed breakdown with respect to age categories. The 1920 and 1930 censuses have 10-year subcategories for people aged between 30 and 60. In the 1889 and 1899 censuses the breakdown by age categories is detailed for people below 25 (23 for 1899) and people older than 61, but the age categories are rather broad for people aged between 25 and 61 (23 - 61 for 1899). In the 1947 and 1960 censuses age categories are relatively broad for people aged between 25 and 65. In 1849 only two age categories were distinguished: younger than 16 years of age and 16 years of age or older. In 1859 the latter category is split into two: at least 16 years of age but younger than 23 years of age and 23 years of age and older.

Table 1 Age categories in the various censuses (between 1849 and 1960) and the statistical time series (1971-2013)

1849	1859	1889	1899	1909	1920	1930	1947	1960	1971-1995	1996-2013				
8 and 9	Up to 12	Up to 12	Up to 12	Up to 12	No labour market participation	No labour market participation	No labour market participation in this age group	No labour market participation in this age group	No labour market participation in this age group	No labour market participation in this age group				
10 and 11														
12 to 16	12 to 16	12 to 13	12 to 14	12 to 14	12 to 14	12 to 14	14 to 16	14 to 16	15 to 25	15 to 20				
		13 to 14												
		14 to 16	14 to 16	14	14 to 18	14 to 18	14 to 16	14 to 16						
				15					16	16				
16 and older	16 to 23	16 to 18	16 to 18	16 to 18	18 to 20	18 to 20	16	16	20 to 25	25 to 40	25 to 30			
		18 to 23	18 to 23	18 to 20			18 to 20	18 to 20				18	18	
				20			20	20				20	20	
				21 to 23										
		23 and older	23 to 25	23 to 36	23 to 25	21 to 25	21 to 25	21 to 25	25 to 40	25 to 40	25 to 30			
	25 to 36		25 to 31		25 to 30	25 to 30	30 to 40	30 to 40				25 to 40	25 to 40	30 to 35
			31 to 35		36 to 41	40 to 50	40 to 50	40 to 50				40 to 50	40 to 50	35 to 40
			35											
			36 to 51	36 to 51	36 to 41	40 to 50	40 to 50	40 to 50	40 to 50	40 to 55	40 to 45			
					41 to 45						45 to 50			
					45 to 51						50 to 55			
			51 to 61	51 to 61	51 to 55	50 to 60	50 to 60	50 to 65	50 to 65	55 to 65	55 to 60			
					55 to 61	60 to 65	60 to 65	65 to 70	65 to 70	No information about labour market participation of people aged ≥ 65	60 to 65			
			61 to 66	61 to 66	61 to 65									
	66 to 71	66 to 71	65	65 to 70	65 to 70	65 to 70	65 to 70		65 to 70					
	71 and older	71 and older	66 to 71	70 and older	70 and older	70 and older	70 and older		70 and older					
			71 and older	71 and older	71 and older									

Source: Statistics Netherlands

For the censuses between 1889 and 1960 labour force participation figures for five-year age categories have been constructed from the census data using linear interpolation. From the data it appears that there is not a lot of variation in participation rates within the 25-60 category. Therefore, the estimates for 5-year categories based on interpolation are fairly reliable. For the 1849 and 1859 censuses things are more difficult given the few age categories distinguished in these censuses. On the basis of the other censuses we assume for 1849 and 1859 that labour market participation rates are constant within the 25-60 age categories. Given this assumption labour force participation rates for 5-year categories have been constructed. For all censuses we assume that labour force participation is zero for children under 5 years of age and for people older than 79.

From 1971 onwards yearly data is available about labour force participation broken down by age group. However, until 1996 the age groups are relatively broad (15 to 25, 25 to 40, 40 to 55 and 55 to 65) and the group aged 65 years and over is not given. From 1996 onwards five-year groups are given. For the latter period there is also information about the participation of people aged 65 or older. In principle more detailed information exists for the period between 1971 and 1995. In this period the 1971 census was held. Furthermore during the 1970s and 1980s an earlier version of the current Labour Force Survey was held a number of times. The latter is held yearly starting from 1987. However, detailed information from surveys held between 1971 and 1995 is not published. Statistics Netherlands used this information to construct the earlier mentioned series with a breakdown of four age groups. We used the 1996-2013 data to construct a series with a breakdown of five-year age categories. However, it is clear that for the period 1971-2013 better estimates could have been made if we have had access to unpublished data about the period 1971 - 1999 and the micro data for the period since 2000. At the same time we think that the bias due to these problems is limited.

### *Definitional problems*

The main definitional problem is that we do not know which definition of the labour force was used in the older censuses. It is even possible that no clear definition was used at all. Most uncertainty exists with respect to the inclusion of people who were unemployed when a census was held. The definition of the labour force currently in use does not only include employed workers but also the unemployed. But were the latter counted as members of the labour force in the censuses held before the second world war?

Although reliable unemployment statistics are only available for the post-war period, there is enough information for the first half of the 20<sup>th</sup> century to conclude that unemployment existed. This is not only true for the Great Depression in the 1930s, when unemployment was extremely high, but also in the years before that period. There are no unemployment statistics for the 19<sup>th</sup> century. However, there is compelling evidence that also in the 19<sup>th</sup> century unemployment existed and was sometimes quite high (see also the section about estimating unemployment by age category). Estimates made by Statistics Netherlands suggest that between 1850 and 1900 the male unemployment rate varied between 3,7 and 8,7 per cent of the labour force.

From the available information we tend to conclude that in the 19 century censuses adult unemployment males were usually included in the figures. This can be inferred from the often very high participation rates resulting from these censuses. Let us look closer to the 1889 census, which has a relatively detailed breakdown with respect to age categories. For the age categories between 23 and 61 years of age, the participation rate was 97 to 98 per cent. It is likely that a few per cent of the population in this age category was unable to work due to disability or serious illness.<sup>6</sup> This would mean that unemployed people must have been counted as members of the labour force.

For people between 61 and 66 years of age the labour force participation rate according to the 1889 census was somewhat lower, but still high: 94 per cent. For people older than 65 years of age the participation rate was 83 per cent if we assume that nobody older than 79 years of age was working anymore. Most likely disability rates increase with age. Particularly among people older than 65 years of age many would have been unfit for work. We assume that for the age category 61-65 unemployed people are included in the labour force. For the people aged 65 or older we assume that nobody was unemployed.

For the younger age categories the situation is different. According to the 1889 census labour force participation rates for younger men below 23 years of age are rather low. Even for the group between 18 and 23 years of age it was only 88 per cent. For the 16 to 18 years old it was 75 per cent and for the 14 to 16 years old 48 per cent. At the same time school participation for these age groups was very low. Even at the very end of the 19<sup>th</sup> only a small percentage of the children continued to follow education after primary school. It is difficult to imagine that so many boys and young men who had left school were unwilling or unable to work.

If unemployed boys and young men were not counted as members of the labour force, this would explain the unrealistically low participation rate of this group. However, there is also another explanation: the participation figures emerging from the censuses are low because youth employment was underestimated. In the next section we present evidence in favour of the this hypothesis for children below 16 years of age. Furthermore, we make a correction

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<sup>6</sup> According to SCP (2012) in 2012 approximately 3 per cent of the Dutch population in the 20-65 age category had a severe mental and/or physical handicap. We do not have data for the 19<sup>th</sup> century.

of the census figures for this group. For young men aged 16 or older there is no reason to assume that there was a major underestimation of employment. Therefore, it seems likely that for the latter age category the unemployed were not or only partly counted as labour market participants.<sup>7</sup> Probably, unemployment among young men was quite high. Only gradually, they would be able to find their place in the labour market. The population was relatively young and growing. Hence, the number of young people looking for their first job was large compared to the number of older people dying or retiring. Although the number of jobs grew, it was not enough for an immediate absorption of young men in employment. Hence, the number of job opportunities for young people was probably relatively small. It must have taken many of them quite some time to acquire a more or less stable employment position. This would mean that for young men the census data underestimate the true level of the labour force. However, in the absence of evidence from other data sources we did not make an attempt to correct this data. For the same reason we neither did this for people age 65 or older.

The *second* definitional question is whether people with small jobs were considered to be part of the labour force. Until recently employment statistics published by Statistics Netherlands did not include people who work less than 12 hours per week. Unemployed people looking for a job of less than 12 hours were not counted as unemployed. It is not clear what criterion was used in the older censuses. Before 1970 relatively few adult men worked less than 12 hours. However, people with their own shop or farm often let their children lend a hand. Probably, these children were not counted as part of the labour force in the censuses before 1960. We only know it for sure for the 1960 and 1971 censuses and for the data for the period 1971-2013.

### *Estimating the under-estimation of child labour in the early censuses*

In the 19<sup>th</sup> century child labour was a big social issue. Owing to the pressure of the labour movement legislation was gradually developed to make education compulsory for children and to forbid labour by young children. However, according to the censuses in the 19<sup>th</sup> century child labour was not as wide-spread as one would expect from the emotions it evoked at the time. On the basis of the 1859 census we estimate that only 0,6 per cent of the 5 to 10 years old and only 5,4 per cent of the 10 to 15 years old belonged to the labour force. It is quite probable that these figures underestimate the true level of child labour. This can be inferred from the fact that primary school participation of the 9 to 14 years old was considerably less than 100 per cent and from the fact that school attainment varied between the seasons. Particularly during summer and autumn it was considerably lower than in January. Table 2 provides figures for the 9 to 12 years old and for children aged 12 or over in 1862. The latter category consists almost exclusively of children aged 12 or 13. From the table we can conclude that on a yearly basis 73 per cent of the boys between 9 and 12 and 39 per cent of the boys aged 12 or 13 attended primary school. It would not be right,

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<sup>7</sup> It is unlikely that unemployment was present among young boys who usually attended school if they did not work.

however, to conclude that 27 per cent of the first age category and 61 per cent of the second age category worked. Another reason for keeping these children from school than work is to look after younger children if both husband and wife had to work (Knippenberg, 1986). In some families this situation occurred during the whole year, but in other families it was only the case in some parts of the year owing to the seasonal variation in employment. One should also bear in mind that even if children were supposed to work they might not be able to find a job.

Table 2. Primary school participation of boys in 1862: 9-12 years old and 12 years of age and older

Age	January	April	July	October	Yearly average
9-12	82	74	67	67	73
12 and older	54	38	31	32	39

Source: Knippenberg (1986).

For children younger than 9 years of age school participation figures are practically 100 per cent during the whole year, suggesting that only few children in this age category worked. However, we know from other sources that child labour by very young children was not exceptional (Brugmans (1958) and Vleggeert (1964)). We know turn to these other sources.

During the 19<sup>th</sup> century several employer surveys have been held. Some of them contain information about child labour. The surveys only deal with the manufacturing sector. Brugmans and Vleggeert cite a number of these studies. According to a survey held in 1819 14 per cent of industrial employment consisted of children. In a survey held in 1840 among firms with a total of 13 thousand workers the percentage share of children is 16. Neither survey mentions an age criterion for children, but Brugmans states that in the 19<sup>th</sup> century it was quite common to speak of child labour for working children below 16. According to a survey held in 1861 among almost 17 thousand workers 13,5 per cent of them were younger than 14 years of age. The share of the 14 to 19 years old was 22 per cent. Children up to 16 years of age will probably have made up 20 to 21 per cent of the workforce involved. A fourth survey held in 1873 covering slightly more than 30.000 workers concluded that 9,7 per cent were younger than 14 years of age. The share of the age category consisting of children younger than 16 years would then probably be 14 per cent. Only one survey cited by Brugmans, from 1871, explicitly uses 16 years of age as the borderline between child workers and other workers. The share of children younger than 16 years of age in this survey is 23 per cent. In Brugman's view this is the most reliable study. But is 23 per cent realistic?

According to the 1859 census the total labour force amounted to 1,3 million persons. The 1889 census gives a total of 1,7 million. In 1871 it may have been 1.4 million. The share of the manufacturing sector was approximately 30 per cent. Hence, approximately 420.000 persons belonged to this sector. On the basis of the censuses held in 1859 and 1889, we

estimate that 35.000 of these persons were younger than 16 years of age, which is only 8 per cent of total employment. Suppose, that  $x$  is the true number of children working in the manufacturing sector but not registered as such. If Brugman was right than  $x$  is equal to 80.000, implying that in reality 115.000 children were working in this sector. However, also in other sectors many children were working. Schenkeveld (2008) mentions that child labour was also widespread in agriculture. Then close to 200.000 children would have worked. As labour force participation of boys was much higher than of girls, about 150.000 boys would have worked. This seems to be unrealistic. It would mean that every boy who did not go to school was working during the whole year.

It should be noted that the two censuses apply to the situation at the 31d of December. We do not know to what extent people who were out of work on this date but did work in other parts of the year are counted as members of the labour force. During winter time many people were temporarily unemployed. Our guess is that young children were not counted as members of the labour force, because they were at school when the census was held. That would explain the low share of child workers in the censuses. We do not know in what time of the year the surveys mentioned earlier were held. Surveys held during summer or autumn would represent an overestimation of child labour.

If we take the yearly average of school participation of the 9 to 14 year old in 1862 and assume that half of non-participation consists of work we arrive at an estimate of 65.000 working boys younger than 16 years of age. Because of the seasonal variation in youth employment the total number of boys involved is larger. If we include girls total child employment could then be estimated at 100.000, half of whom was employed in the manufacturing sector. This is 15 per cent of total employment in this sector.

In this computation we assumed that child labour started with the age of 9. Labour by such young children is already dreadful. However, Brugmans and Vleggeert give examples where children as young as five years old were working in factories. Moreover, even very young children had to work long hours. It is difficult to estimate the number of children working at very young age. Vleggeert mentions a survey in 1873 among 490 factories with a total of slightly more than 32.000 workers. Factories with many child workers were included as well as factories with only few or no child workers at all. Almost 10 per cent of these workers were younger than 14 years of age. Only a small percentage (2,5 per cent) of the latter group were younger than 9 years of age. However, probably by 1873 labour by very young children had already declined. In the mid-19<sup>th</sup> century it was probably higher. On the basis of the available information we are inclined to think of a couple of thousands of very young children working.

Gradually child labour diminished. By the end of the 19<sup>th</sup> century more than 95 per cent of the boys between 6 to 12 years of age went to school in December. Furthermore, the seasonable component in school participation diminished. As is shown by table 3 between 1825 and 1875 it halved for children of 5 to 14 years of age (for these earlier years we only

have figures for this age category). The figure for 1825 is less reliable, although it fits well with the trend between 1851 and 1875. Although we do not have figures for more recent years it is likely that this trend went on. So, we can conclude that by the end of the 19<sup>th</sup> century school participation of boys aged between 6 and 12 was close to 100 per cent and that the seasonal component in school participation was close to 0. However, Schenkeveld mentions that it also occurred that children went to school, but had to work before and/or after school. In the second half of the 19<sup>th</sup> century, there might have been an initial increase in this substitution effect, We do not have figures about it.

Tabel 3 Seasonal component in school participation of the 5 to 14 years old: yearly averages 1825-1875

	Boys	Girls	Total
1825	Not available	Not available	12,5%
1851	11%	7,5%	9,5%
1855	10%	6,5%	8,5%
1860	7,5%	3,5%	6%
1865	9%	4,5%	7%
1870	7%	3%	5,5%
1875	6,5%	3%	5%

Source: Recalculations of data presented by Knippenberg

Our conclusion is that the census data underestimates child labour. According to the 1859 census slightly more than 48.000 boys were working in December of that year. However, owing to seasonal variation in employment, the yearly average figure is at least 65.000. This figure does not include child workers below the age of 9. At least a couple of thousands of boys in that age category worked. It is unclear how older boys who had left school and did not work in December were treated in the census. It is quite possible that they were not treated as part of the labour force, while they were in fact unemployed and should have been included in the labour force. Finally, it is possible that employment by young and particularly by very young children was not always reported by families, because people might have been aware of the social undesirability of child labour and may even be ashamed of the fact that they had to let their children work.

In view of the likely underestimation of child labour we have adjusted the labour force participation data presented earlier. We have made the following changes:

- In the age group 5 to 10 years of age we add 7.600 persons in 1859
- In the age group 10 to 15 years of age we add 13.600 persons in 1859
- We assume that in relative terms the underestimation in 1849 was the same as in 1859

- We assume that starting with 1859 the relative underestimation of child labour diminishes and becomes zero in 1900.

This leads to the following changes for the two youngest age categories.

Table 4 Labour force participation of males after and before correction for unobserved child labour: 1949-1900

	5-10 years old		10-15 years old	
	After correction	Before correction	After correction	Before correction
1849	0,05	0,006	0,27	0,18
1859	0,05	0,003	0,27	0,18
1889	0,01	0	0,18	0,16
1899	0,00	0	0,19	0,18
1900	0	0	0,18	0,18

## Labour force participation rates by age for the period 1850-2013

We have made yearly estimates of labour force participation rates for the period 1850-2013. Table 5 shows the results of the estimates of labour force participation rates for 5-year age categories for the census years and for every ten years in the period 1980-2010. For each age category between 5 and 25 we see a strong decrease if we compare 1849 with 2010. As we already pointed out in the previous section labour by children younger than 10 years of age had disappeared by the end of the 19<sup>th</sup> century. For the 10-15 years old this point was reached between 1960 and 1971.

For the 15-20 years old, labour force participation rates initially increased, but decreased after 1920. For the 15-20 years old it decreased from 0,79 in 1920 to 0,29 in 1980. For the 20-25 years old most of the decrease took place between 1960 and 1980. For both age groups we hardly see a structural change since 1980 anymore. The figures for 2010 are relatively low, but that is probably due to the recession. When the economy slows down we usually see that youth unemployment rises strongly, inducing young people to prolong their school participation.

Obviously, the structural decrease in labour force participation of young people has to do with increasing school participation. The latter development is usually attributed to economic development. In the second half of the 19<sup>th</sup> century the Netherlands industrialized and the period of economic stagnation in the first half of the century was followed by a period of economic growth with rising real wages (Van Zanden and Van Riel, 2000). Rising wages made it possible for parents to keep their children longer in school. But economic

development also led to a higher demand for skilled workers. The relationship between education and economic development is a two-way relationship.

Table 5 Labour force participation rates of males by age group

	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65 and older
1849	0,05	0,27	0,62	0,84	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,90	0,70
1859	0,05	0,27	0,67	0,82	0,94	0,94	0,94	0,94	0,94	0,94	0,89	0,78	0,59
1889	0,01	0,18	0,75	0,93	0,98	0,98	0,97	0,97	0,97	0,97	0,98	0,94	0,83
1899	0	0,19	0,77	0,91	0,95	0,97	0,97	0,97	0,94	0,92	0,92	0,89	0,72
1909	0	0,16	0,79	0,93	0,96	0,97	0,97	0,97	0,95	0,94	0,91	0,84	0,65
1920	0	0,15	0,79	0,95	0,98	0,98	0,99	0,98	0,97	0,95	0,93	0,85	0,57
1930	0	0,09	0,78	0,94	0,98	0,98	0,98	0,98	0,96	0,94	0,90	0,79	0,48
1947	0	0,07	0,72	0,92	0,97	0,98	0,99	0,98	0,97	0,97	0,92	0,77	0,40
1960	0	0,03	0,63	0,91	0,98	0,98	0,98	0,98	0,98	0,96	0,90	0,85	0,23
1971	0	0	0,40	0,76	0,94	0,95	0,97	0,97	0,96	0,93	0,79	0,67	0,13
1980	0	0	0,29	0,68	0,95	0,96	0,97	0,92	0,90	0,86	0,74	0,34	0,06
1990	0	0	0,26	0,64	0,93	0,95	0,96	0,91	0,88	0,83	0,58	0,20	0,03
2000	0	0	0,28	0,70	0,91	0,95	0,96	0,94	0,92	0,87	0,65	0,23	0,04
2010	0	0	0,25	0,63	0,88	0,93	0,92	0,93	0,93	0,89	0,84	0,44	0,07

Sources:

- 1849-1961: estimates based on census data;

- 1971-2010: adaptations of yearly data published by Statistics Netherlands.

However, school participation is not completely determined by economic factors. Knippenberg (1986) points out that school participation already increased in the first half of the 19<sup>th</sup> century. In this period important steps were taken to modernise the Dutch economy, but productivity growth was still slow and real wages remained almost constant. Knippenberg attributes the increase in school participation during this period not to economic factors but to the building of a new nation state, the kingdom of the Netherlands, which came into existence in 1815. Political socialisation through education became an important goal of the new state. In his view the further increase in school participation in the second half of the 19<sup>th</sup> century is mostly due to economic factors. However, the need for more education was also due to the increasing complexity of society, which applies to all spheres of life, not only to the economy.

When education became compulsory for children between 6 and 12 years of age in 1900, school participation was already close to 100 per cent. In 1969 the government extended the number of compulsory school years to 9, followed by a further extension to 10 years in 1975. However, also when these extensions were introduced, it had virtually no effect on actual school participation. Perhaps compulsory education had an effect in the sense that there

was no way back anymore to the time that relatively young children had to work. If parents were tempted to pull their children out of school and send them to the labour market, it was not possible anymore.

For males aged between 25 and 55 participation rates did not change much between 1849 and 1960. It fluctuates between 0,94 and 0,98. But in the 1960s a decline in participation rates sets in. The precise pattern differs for the various 5-year age categories between 25 and 55. The decline is most clearly visible for the category 25-30. Also for this age category increasing participation in education plays a role. For the age categories 40-45, 45-50 and 50-55 we see a relatively strong decline between 1960 and 1990, but a partial recovery after 1990. In 2010 the participation rate for the age categories 30-35, 40-45 and 45-50 is 0,93; for the 35-40 category it is 0,92 and for 50-55 category 0,89. The introduction of the Disability Act in the 1960s may have played a role here. According to this act disabled workers could obtain a disability benefit. The act contained an article stating that the labour market situation could play a role in the decision to grant workers a disability benefit. In the 1970s this article was used (some would say abused) when the economy went through a restructuring phase. Many jobs in manufacturing were lost. Particularly, older workers were granted disability benefits. Because disability benefits, contrary to unemployment benefits, did not have a maximum duration, the former practically served as pre-retirement benefits. It explains the relatively strong decline of the participation rates for the 40-45, 45-50 and 50-55 groups during the 1970s. Later the Disability Act was reformed. Eligibility criteria became more strict and the number of people claiming a disability benefit decreased.

Labour force participation of people aged 55 to 65 diminished strongly during the 1960s (partly due to social security arrangements introduced at the time) and particularly during the 1980s (owing to early retirement schemes). But already in the mid-1990s labour force participation started to increase again. In 2010 it reached again the level prevalent in the 1960s. Gelderblom and De Koning (2016) list a large number of measures that have been taken to increase the participation of this age category. Reforms in disability arrangements and the gradual abolishment of early retirements are probably the most important ones. We see a particular large increase in labour force participation around 2007/2008, which clearly has to do with legislation introduced in 2005 that made early retirement financially totally unattractive. Also important is that pensions have become less favourable than they used to be, which stimulates people to work longer. The latter is also one of the factors explaining the strong increase in labour force participation of the group aged 65 and over after 2000. Since 1900 it had continuously diminished to almost 0 in the 1990s. But by 2010 it had already increased again to 0,07. However, less attractive pensions are not the only factor explaining higher participation rates for this age category. The strong increase in school participation after the war becomes now visible in a higher educational level of older workers. At the same time the share of older workers doing physically demanding and unattractive work is diminishing. Furthermore, the health condition of older people has

improved and is still improving. Education, health and working conditions all contribute to longer work lives.

By interpolation, the labour force participation by age category has also been computed for intermediary years in the period 1849-1971. This means that for this period we assume that factors like the business cycle that influence labour force participation do not influence the relative shares of the different age categories in the labour force. The influence of the business cycle is reflected in the total labour force, however.

## Estimating unemployment rates by age category

If a person offers his labour to employers, it does not automatically imply that he can actually find a job. Unemployment is a structural phenomenon in the labour market, although its incidence varies considerably. Economic activity fluctuates and, as a result, so does unemployment. Occasionally, economic crises occur that bring about mass unemployment that lasts for several years. We are still in the aftermath of such a crisis. In the past we have seen periods of mass unemployment in the 1980s and the 1930s. Although for the Netherlands no statistical information exists about unemployment in the 19<sup>th</sup> century we know that periods of mass unemployment have also occurred in this century. Particularly, in the mid-19<sup>th</sup> century the unemployment rate was probably close to 10 per cent. De Bosch Kemper, a 19<sup>th</sup> century academic who wrote about poverty and unemployment, mentions that in the mid-1800s 10 per cent of Dutch men aged between 23 and 65 were long-term unemployed (De Bosch Kemper, 1851). Van Loo (1981) mentions that during the years between 1807 and 1811 in Amsterdam 30 to 50 percent of the heads of families were unemployed. However, in the rural parts of the country unemployment was probably much lower. Statistics Netherlands has made estimates of the unemployment rate for the 19<sup>th</sup> century. For 1850 the estimate is slightly more than 8 per cent.<sup>8</sup>

In times of economic growth unemployment is low, but it still exists. This has to do with the dynamic nature of the labour market and the heterogeneity of workers and jobs. All the time workers quit their job, get fired or go on retirement. On the other hand, continuously new workers enter the labour market. Hence, all-the-time employers are looking for new workers and workers are looking for new jobs. Both types of actor have a lack of information. There is no register with perfect information about job seekers and vacancies that would lead to immediate matches. Both job seekers and employers have to spend time in the search process. It will usually take some time before an unemployed person finds a job and an employer can fill his vacancies.

The fact that employers are in need of specific skills and, may also lead to (or add to existing) unemployment, because acquiring skills is costly and may take considerable time. If, for

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<sup>8</sup> For England some unemployment data exist for the second half of the 19<sup>th</sup> century. This data also points to the conclusion (Burnett, 1994) that in the second half of 19<sup>th</sup> century unemployment rates were not too different from today.

example, a shortage of metal workers exists and an excess supply of clerks, the latter may stay unemployed because they lack the required skills for metal working. Retraining will take time and the returns to training are uncertain. It may well be that by the time a clerk has finished his training for metal working the labour market has changed and metal workers are no longer in demand. As a result employers and workers may be reluctant to invest in training.

Finally, unemployment may be influenced by labour market institutions like statutory minimum wages, social security and employment protection legislation. However, the literature about these institutions is far from conclusive about their impact on the labour market (see Howell et al (2007) for a critical review).

Data about unemployment broken down by age is available since 1971. This data is taken from the same dataset that provided the data about labour force participation for the period 1971-2013. As was mentioned earlier in this paper, this dataset distinguishes between four age categories (15-25, 25-40, 40-55 and 60-65). Only for the period 1996-2013 data for 5-year age categories is available. The latter data was used to construct figures for 5-year age categories for the whole period 1971 - 2013. Unemployment data is not available for the pre-war period. For the period between 1945 and 1971 unemployment data is available for some years, but this data does not seem to be comparable with the 1971-2013 data and is not used for that reason.

First, for each 5-year age category we compute the unemployment rate for this age category relative to the unemployment rate in the age category 30-35. Then, we regress these relative unemployment rates on indicators of the labour market situation (the macro unemployment rate and/or the mutation in this variable). In this way we take into account that for each age category the sensitivity of unemployment for the business cycle is different.

We assume that unemployment for people aged below 15 years of age or older than 65 years of age is zero. For people below 15 years of age it is likely that they were only counted as members of the labour force if they worked. For people older than 65 years of age our assumption is reasonable for recent years, but may not be right for the pre-war period when labour participation rates for this age category were still high. However, we do not have data about pre-war unemployment.

Given the estimates obtained for the parameters of the equations and the estimates of macro unemployment for the period 1800 - 1970 that were published by Statistics Netherlands, unemployment by age category has been computed for the period 1849 – 1970. Table 5 presents the results for the census years and the data for every ten year from 1980 onward. The results of the estimated equations are included in annex 2.

Since 1960 we can observe a rising trend in unemployment rates. However, from a longer term perspective unemployment rates in recent years are not exceptional. As we have already pointed out in this paper estimates for mid-19<sup>th</sup> century unemployment rates are

above 8 per cent. In the 1930s and 1980s we have also seen very high unemployment rates. What is really different in recent years is the strong increase in unemployment among the 60-65 years old. It probably reflects two developments: 1) a poorer image of older workers among employers compared to the past, 2) reforms of disability arrangements and early retirement schemes implying that workers who could previously use these arrangements are now becoming unemployed.

Table 5 Estimates of unemployment rates for men by age category: estimates for the census years and data for the period 1970-2010

	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65
1849	17,4%	13,9%	8,7%	6,9%	7,6%	6,4%	6,2%	6,0%	5,5%	0,7%
1859	14,5%	10,4%	6,2%	4,9%	4,9%	3,7%	3,8%	3,7%	4,0%	0,9%
1889	12,4%	8,3%	4,8%	3,8%	3,5%	2,5%	2,5%	2,5%	3,2%	1,0%
1899	12,3%	8,4%	4,8%	3,8%	3,5%	2,4%	2,5%	2,5%	3,1%	1,0%
1909	9,9%	6,5%	3,6%	2,8%	2,5%	1,6%	1,7%	1,7%	2,3%	1,0%
1920	8,8%	5,2%	3,0%	2,3%	2,0%	1,4%	1,5%	1,5%	2,1%	1,0%
1930	13,3%	9,3%	5,5%	4,3%	4,2%	3,1%	3,2%	3,1%	3,6%	0,9%
1947	5,4%	2,9%	1,7%	1,3%	1,0%	0,7%	0,7%	0,7%	1,2%	0,8%
1960	3,4%	1,9%	1,0%	0,8%	0,6%	0,3%	0,4%	0,4%	0,7%	0,6%
1971	6,3%	3,2%	1,6%	1,5%	1,4%	0,1%	0,1%	0,1%	0,4%	0,6%
1980	11,3%	7,2%	3,7%	3,1%	2,9%	1,7%	1,5%	1,4%	2,5%	0,6%
1990	13,7%	8,2%	5,0%	4,0%	3,7%	3,8%	3,3%	3,0%	3,2%	0,6%
2000	8,2%	4,6%	3,3%	2,1%	1,8%	2,0%	2,2%	2,2%	3,2%	1,4%
2010	15,2%	10,7%	6,6%	4,8%	3,9%	2,7%	3,5%	3,9%	5,2%	4,8%

## Estimating employment rates by age category

We used the data and estimates about the labour force and about unemployment (re-calculated as percentages of the population) to compute employment rates. These are graphically presented in the figures presented below. What is common to all age groups between 15 and 65 is the huge dip in the employment rate in the 1930s due the depression and a decrease in employment rates between 1960 and 1990.

Figure 1 displays the results for four age categories: 5-10, 10-15, 15-20 and 20-25. Labour by children younger than 10 years of age had disappeared by the end of the 19<sup>th</sup> century. The employment rate for the 10-15 years old became zero in the 1960s. It shows an almost linear downward trend since the mid-19<sup>th</sup> century. Obviously for both age categories the fall in the employment rate is due to increasing participation in education.

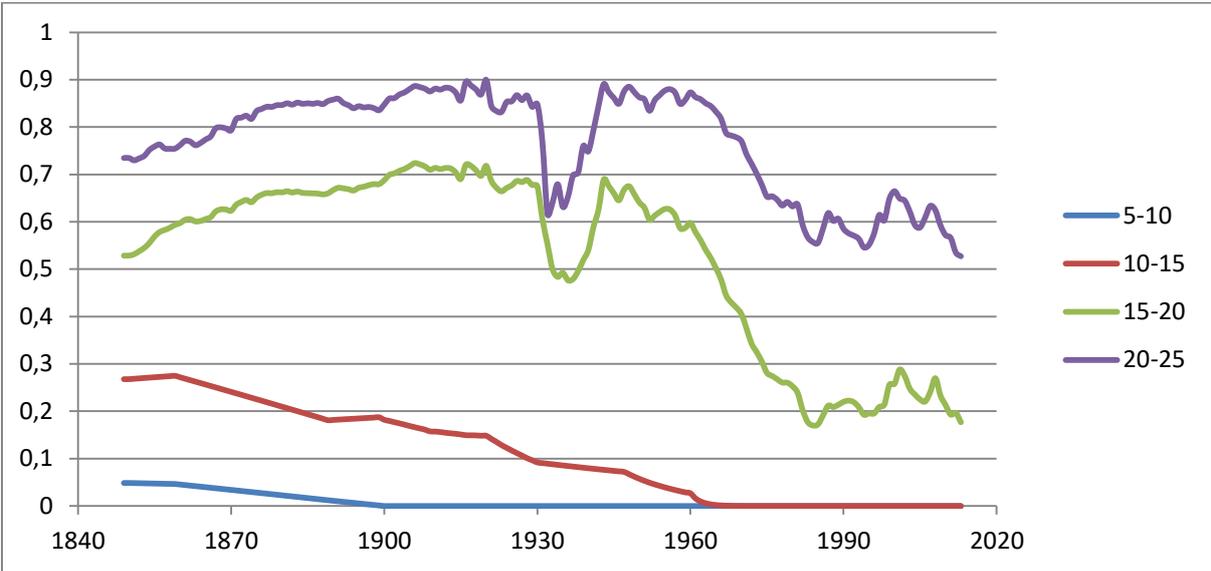
For the 15-20 years old we see an initial increase in employment rates in the second half of the 19<sup>th</sup> century. This is probably due to the improving economic situation in this period.

Shortly after 1900 a structural decrease in the employment rate of this age category sets in that lasts until 1980. The decline in the employment rate is particularly sharp during the 1960s. Since 1980 it seems to stabilise at a level of 20 to 25 per cent.

For the 20-25 years old the structural decrease in the employment rate is more recent: it starts roughly in 1960. This coincides with the strong increase in the number of students in higher education in the 1960s. Here too we can observe a certain stabilisation after 1980: there is still a decrease, but it is much smaller than before.

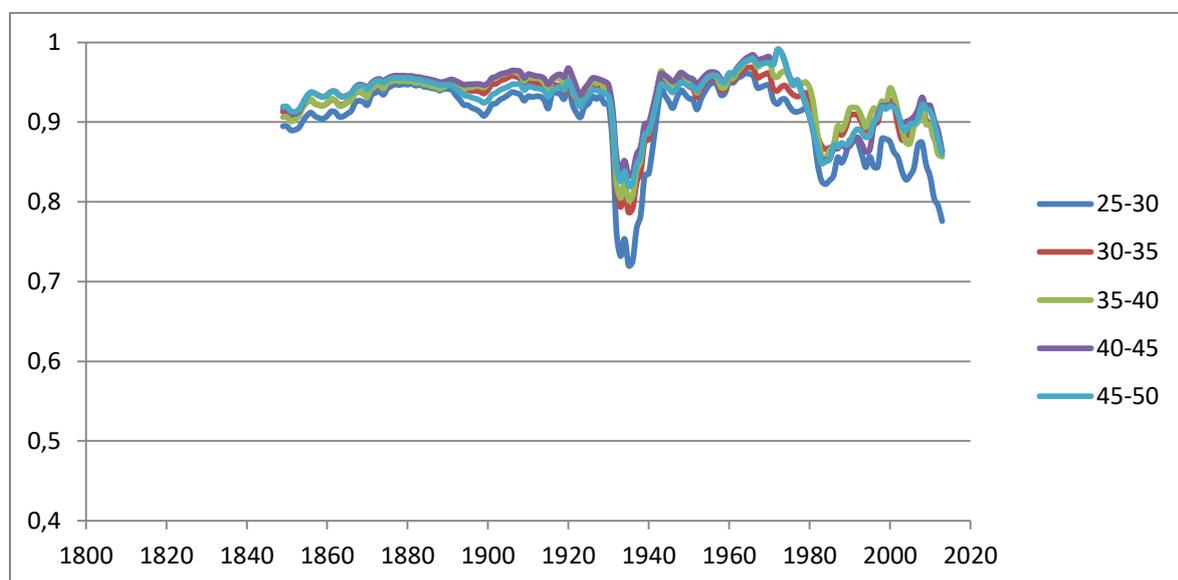
Increasing participation in education also explains the decrease in employment rates in the 15-20 and 20-25 categories. Initially this decrease went on after 1980. The stabilisation of employment rates for these age categories after 1980 had to do with the increasing share of students combining their study with a job. According to Lucassen (2003) the share of the students between 15 and 24 years of age combining their study with a part-time job has doubled between 1992 and 2001. In 2001 slightly more than 50 per cent had a job. However, since then this percentage has not changed much anymore. School participation, on the other hand, has gradually stabilised.

Figure 1 Male employment rates for age categories below 25: 1849-2010



As figure 2 shows the employment rate is developing very similarly for the age categories between 25 and 50. Employment rates are still quite high for these categories. Initially, the influence of the institutional changes in the 1960s and 1970s (a considerable growth in employment and income protection) was small. However, after the crisis in the early 1980s employment rates remained at a lower level than before. With the exception of the 45-50 years old we see a recovery of employment rates after the crisis in the early 1980s. But employment rates do not completely retain the values of the period before that crisis. For the 45-50 years old we can even observe a further (but small) decline. This may be a delayed effect of the institutional changes mentioned.

Figure 2 Male employment rates for age categories between 25 and 50: 1849-2010



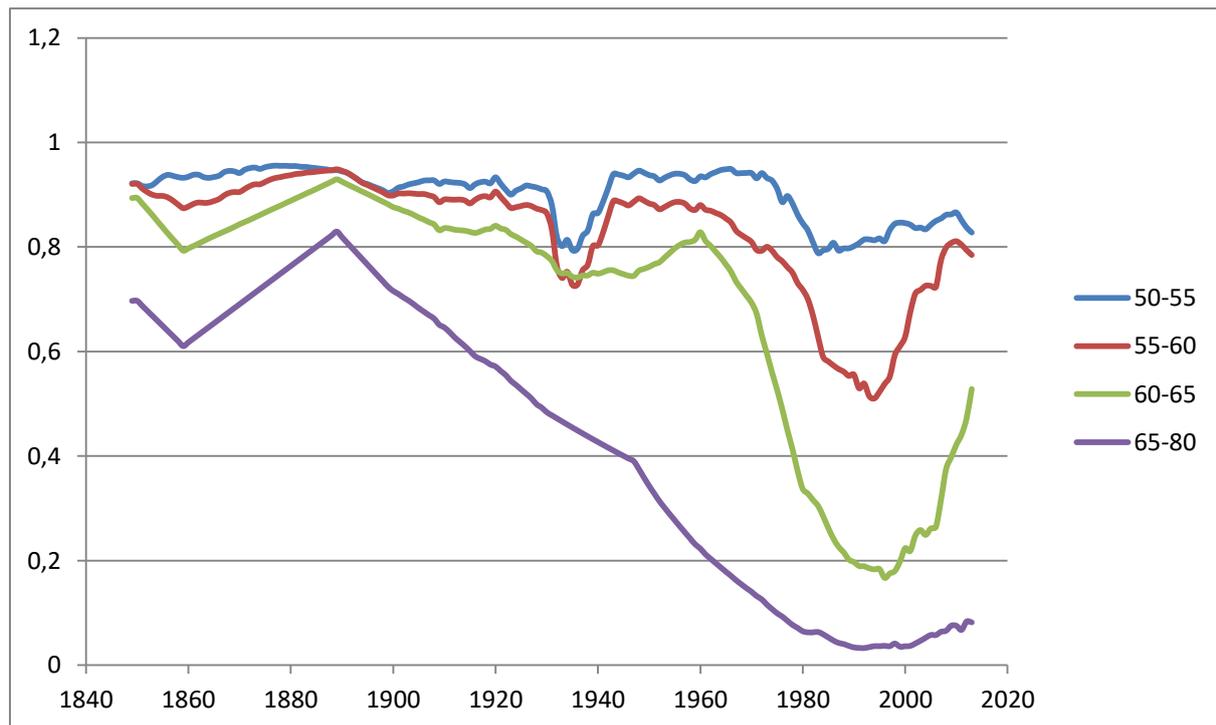
The development of the employment rate of the older age categories is remarkable (figure 3).<sup>9</sup> This is particularly true for the age categories 55-60, 60-65 and 65-plus. During the 20<sup>th</sup> century employment rates of older workers have decreased. For people aged 65 years and above it is almost a downward sloping straight line. The effect of the introduction of old-age pensions after the war is relatively small. However, for the categories 55-60 and 60-65 the decline accelerates after 1960. In the 1980s the decline becomes gradually smaller and during the 1990s there is a turning point after which a strong recovery takes place.

The decline in employment rates coincides with the extension of social security and welfare. The 1960s saw the introduction of the disability act and the general social assistance act. Furthermore, entitlement criteria for unemployment benefits were loosened and the maximum duration of unemployment benefits extended. Early retirement schemes became

<sup>9</sup> For a more detailed analysis of the labour market situation of older workers we refer to Gelderblom and De Koning (2016).

popular in the 1970s and (particularly) the 1980s. However, relatively soon reforms took place making the schemes less attractive again. Benefits were cut and entitlement became much stricter. This process was completed in 2005 when fiscal arrangements favourable to retirement schemes were completely abandoned.

Figure 3 Male employment rates for the older age categories: 1849-2010



It is too simple, however, to conclude that only institutional changes have caused the structural decline in the employment rates of the 55-60 and 60-65 age categories. At least partly these measures were taken in response to labour market developments. Early retirement schemes, for example, were introduced during a period of high unemployment to offer more job opportunities for young people. Furthermore, this period was characterised by large-scale job destruction. In the 1960s and 1970s a considerable part of traditional manufacturing industry disappeared from the Netherlands. Many older workers who lost their job were allowed to make use of a disability benefit, which practically served as early retirement. In the 1980s early retirement schemes took over this role. One cannot be certain that these people would have found another job if the early retirement schemes would not have existed. The fact that unemployment among older workers has increased in recent years is partly due to the fact that access to disability benefits has become much more difficult and early retirement schemes have been abolished. But it is also likely that the latter

has contributed to the rather spectacular increase in employment rates since the end of the previous century. However, the following factors also play an important role: a) the increasing educational level of older workers, b) the decreasing share of physical demanding work and c) the improving health of older workers.

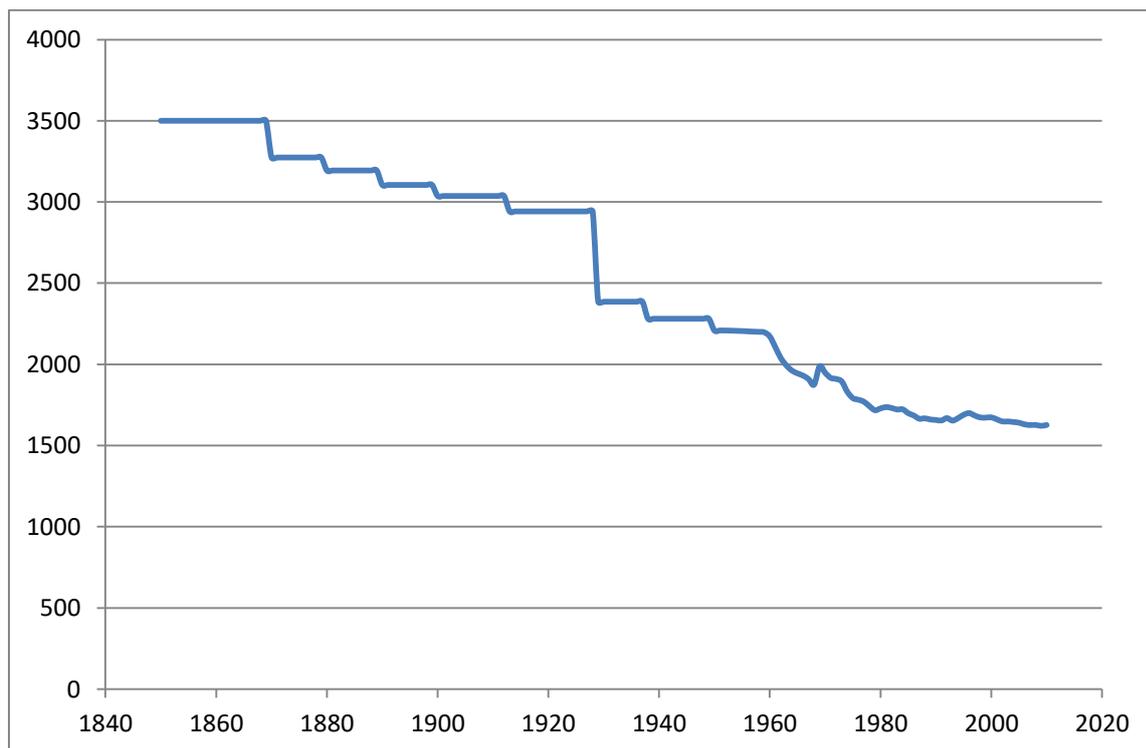
## Yearly working hours

Since 1950 yearly information about working hours is available from Statistics Netherlands. Since 1969 more detailed information is available on the subject. For the period before 1950 Huberman and Minns (2005) present estimates of the annual number of working hours for several countries including the Netherlands. This data goes back to 1870. According to these estimates the annual number of working hours in the Netherlands was 3274 in 1870. Working hours per week amounted to 65 hours and people had only a few holidays. Huberman and Minns do not present estimates for male and female workers separately.

Brugmans presents information about the length of the workweek in the Dutch manufacturing industry around the middle of the 19th century. Sometimes the examples given by him apply to a specific industry in a particular town. Other cases refer to manufacturing industry as a whole in a province. This information suggests that in manufacturing industry working weeks for men were usually longer than 65 hours. In one case, in a brick factory in the north of the Netherlands, adults males had to work 120 hours per week! Perhaps, this was an exception, but working weeks of 84 hours or more for adult male workers seem to have been quite common. Working weeks shorter than 72 hours, on the other hand, seem to have been the exception in manufacturing industry. Also in agriculture long working hours were common. Taken together agriculture and manufacturing industry constituted almost two-thirds of total employment in 1849 and 1859. For construction workers, who held a seven per cent share in employment, Brugmans mentions a somewhat shorter work week: 66 hours. Household servants, 9 per cent of total employment, usually worked from 8 to 8 during the week. But they also had to work part of the Sundays. For the remaining industries we do not have information.

On the basis of the available evidence we assume that in the middle of the 19<sup>th</sup> century the average working week for adult men was about 72 hours. This includes time for breaks, but according to Brugmans breaks were not taking more than a few hours. The annual number of hours effectively worked would then have been close to 3500. We assume that this figure applies to the 1850s and the 1860s. Brugmans suggests that working hours may have increased somewhat between 1840 and 1860 as a result of the introduction of gas light in factories. But the information is too scanty to quantify this increase. Figure 2 shows the resulting time series of the annual number of hours worked. This number more than halved from approximately 3500 hours in 1850 to almost 1630 hours in 2010.

Figure 2 Annual hours worked per male worker: 1850-2010



Source: Huberman and Minns, Statistics Netherlands, adapted by De Koning.

Until 1970 the reduction in annual hours worked was completely due to a shorter work week and an increasing number of holidays. The rather minor decrease since 1970 is due to the fact that more men became engaged in part-time work.

According to Brugmans, child workers worked somewhat shorter hours than adults. However, their working week was still unconceivably long. In the brick factory mentioned earlier, for example, children worked 90 hours per week. Brugmans and Vleggeert give more examples of factories where children, even children as young as five years old, worked long hours. In our computations we assume that the working week of boys up to 15 years of age was 70 per cent of the working week of adult male workers.

The 19<sup>th</sup> century was not a party to workers. Pay was hardly enough to survive, working conditions were very bad, the number of hours worked was extremely long and housing conditions were very poor. People worked and lived in the dirt.<sup>10</sup> Why was the number of hours worked by adults and children that long?

An obvious explanation is that shorter working hours would have led to lower output and lower wages. And because wages were already very low, workers could not afford wage

<sup>10</sup> Vander Woud (2010) gives a description of the housing conditions of the working class in the 19th century. The title of his book is telling: 'A kingdom full of slums: back streets and filth in the 19<sup>th</sup> century.'

cuts. However plausible this argument seems to be, it is probably not true. Let us take a closer look at the relationship between the number of hours worked per day and daily production per hour. One would expect that long working hours lead to fatigue and that fatigue leads to decreasing marginal productivity. At some point people may become so tired that they start making mistakes and more hours may no longer lead to more production. If accidents take place, total daily production may even become less and employers may be faced with additional costs. Also the risk of injury will increase, which is in fact another reason why health can be affected. With work days of 12 hours or more this seems to be quite possible.

There is considerable evidence that long working hours lead to a decrease in production per hour. Pencavel (2014) mentions a number of case studies of firms that point to this conclusion. Some of these cases go back to the second half of the 19<sup>th</sup> century. Pencavel also re-examines observations on munition workers during World War I. Using econometric methods he finds that if weekly working time is less than 48 hours, production per worker is proportional with hours worked. Beyond 48 hours the marginal effect of an increase in working hours on production per worker diminishes. If workers work longer than 60 hours per week more hours do not lead to more production anymore. Pencavel's dataset does not contain observations of work weeks longer than 70 hours. But on the basis of his results it is quite likely that when working time becomes extremely long, production per worker will diminish due to mistakes and the damage caused by the mistakes.

Also studies using aggregate data point to the conclusion that long working hours have a negative effect on marginal productivity. Golden (2011) provides a literature review in this field. An interesting recent study was carried out by Cette et al (2011) who analyse the relationship between working time and productivity per man hour on the basis of data about 18 OECD countries covering the period since 1950. Their results point to a non-linear relationship between productivity and working time. According to the results per hour productivity always decreases if working time increases. For longer working times the decrease becomes stronger. When annual working time becomes higher than 1.925 hours, a one per cent increase in hours leads to an increase in the production per worker of only 0,1 per cent. Above the threshold of 2025 hours worked per year an increase in working hours has no effect on production per worker anymore. If we take into account that people have a number of holidays per year, 2025 working hours per year imply a workweek of approximately 45 hours. This is much shorter than the 60 hours threshold found by Pencavel. However, Pencavel states that his data refer to a specific type of industry and that the hours-productivity relationship is probably different for other industries. We add to this that it is also likely that employers react on a reduction in working hours by taking measures to improve production efficiency.

Pencavel also presents some evidence indicating that extremely long working hours increase the chance of injuries and illness. We add to this that prolonged exposure to extremely long

working hours can have negative long-term effects on health, employability and productivity. Life-time production per worker will be lower because on average workers live shorter and are less productive during their lives. Child labour makes things even worse. A child who starts to work at ten or even younger and has to work long hours under poor working conditions will not even develop properly, neither physically nor intellectually. This was not only true for manufacturing industry but also for agriculture. One might associate agriculture with healthy work in the open air, but according to Schenkeveld (2008) at least in some parts of agriculture working conditions for children were such that the children involved were already worn out before they reached adulthood.

On the basis of the available evidence we conclude that in the 19<sup>th</sup> century extremely long working hours were not a necessity. Moreover, labour by young children was probably not necessary. If working hours would have been reduced to 60 hours per week and labour below the age of 12 or 13 would have been forbidden, macro-economic production would probably not have been lower. Furthermore, in view of the negative side effects of extremely long working hours it is even likely that work-time reduction would have led to a higher macro output.<sup>11</sup>

As Pencavel points out already in the 19<sup>th</sup> century there was evidence that shorter working hours were not harmful to the economy. But employers who were willing to reduce working hours to more normal proportions were the exception rather than the rule. Furthermore, government and parliament long resisted the call for a law prohibiting extremely long working hours. In the Netherlands it lasted until the 1870s before a law against child labour was adopted, which however did not apply to the agricultural sector. Not before 1919 the first law was introduced that limited working time for adults.

The question is then: why did most employers refuse to reduce work time even if it would not harm production? There are at least three possible explanations. The first explanation is that it was more profitable for employers to have a relatively small number of workers working long hours than more workers working shorter hours. Labour costs are partly quasi-fixed costs that vary with the number of workers, but not with the number of hours worked by workers.<sup>12</sup> More workers means higher expenses on tools and housing, for example. If hourly wages are low compared to these quasi-fixed costs, long working hours will be optimal for the employer. However, we have shown that the elasticity of the number of hours in the production function is low. This means that if hours are reduced, it hardly affects the number of workers needed. Quasi-fixed costs must then be very high compared

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<sup>11</sup> There are also other cases where shorter hours do not lead to lower production and even reduce the costs for employers. Retail firms, for example, have peaks in the number of customers on specific hours of the day and on specific days of the week. Hence, the use of part-time labour on peak hours will be cost-reducing in such cases. Part-time labour took off in the 1970s when paid work for married women became gradually accepted and more and more women became interested in a part-time job.

<sup>12</sup> The distinction between variable and quasi-fixed costs goes at least back to Oi (1962).

to hourly wages to arrive at extremely high working hours, which is not realistic. In annex 2 this is shown with the help of a formal model.

A second explanation is that employers had not much to gain by shorter working time. Suppose that a reduction in working hours from 72 to 60 does not affect output. The employer would only gain from the reduction if he could limit the increase in hourly wages to such extent that productivity per hour would increase more than hourly wages. Shorter hours would then go hand in hand with lower weekly pay. However, weekly wages were already hardly enough to survive. Under 19-century conditions many employers had a certain power to control wages. Workers were often depending on a single employer in their home town for employment. They had to accept the employer's offer or would otherwise become unemployed with no income at all. Marx's theory of exploitation rests on the assumption that employers could keep wages at the survival level. However, if wages are on survival level, there is no room for further reductions.

Gradually the monopsony power of employers, as we call it today, was counterbalanced by unions. Furthermore, as the labour movement became stronger it also gained more political influence resulting in laws that improved the situation of working people. In the Netherlands the industrialisation process started later than in most other industrialised countries. And the same was true for the labour movement. The first modern union with strong ties with the labour movement, the diamond cutters union, was founded in 1894.<sup>13</sup>

A third explanation is that government and employers, or more general the ruling classes, felt uncomfortable with the idea that workers would have more leisure time. It was believed that free time would not be used well and would undermine social discipline (Cross, 1989).

Our conclusion is that technological progress only played a limited role in the reduction of working hours, at least in the initial phase of it. The effect of shorter hours on the production per worker was relatively small and probably zero or even negative in the phase when working time was extremely long. Unions played a decisive role in the process of work time reduction.

This also means that at least during the early phase most of working time reduction had little to do with the increase in real wages. It is often believed that the increase in real wages led to shorter work time and more leisure. The neoclassical model dealing with the worker's choice between leisure and income predicts that higher wages lead to more leisure if the income effect of the wage increase ( which increases income) dominates the substitution effect (due to the fact that higher wages make leisure more expensive). However, the majority of the workers earned a wage hardly high enough to survive. For them there was not much to choose.

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<sup>13</sup> For a history of Dutch unionism see Van der Velden (2005).

Scientific studies measuring the wage elasticity of working time are relatively recent. For men, these studies typically find that the income effect and the substitution effect almost cancel each other out, implying that there is hardly any effect of real wages on hours.<sup>14</sup> It is of course possible that workers' preferences have changed. One could argue that in the 19<sup>th</sup> century there was not a broad spectrum of consumption goods available to workers. When basic needs were filled, more leisure would then become the highest priority. Bienefeld give some indications of an inverse relationship between wages and hours for some occupations in the 19<sup>th</sup> century. In the 20<sup>th</sup> century a variety of new consumer goods were developed that gradually became affordable for workers. This may have led to a higher priority for goods (income) compared to leisure.

It is only recently that individual workers have obtained more opportunities in choosing the number of hours they work. In the Netherlands there is even a law given workers the right to work part-time, although it is only partly reinforced in practice.<sup>15</sup> For most men, working time is still highly standardised, which does not leave much room for choice apart from the possibility in some industries to work overtime. In defence of the neoclassical model one could argue that although individual workers could not choose to work fewer hours, unions could do this on behalf of them by adopting the preferences of the average worker. However, it also possible that instead of representing workers' preferences, unions (also) formed these preferences. The relatively small part of the workers active in unions may have acted as a kind of peers for the majority of workers.<sup>16</sup>

## Expected life duration

How many hours people from a given birth cohort work on average in their lifetime is also influenced by death rates. In the 19<sup>th</sup> century life expectancy was much shorter than nowadays. Death rates were higher among people of all ages and many people already died before the age of 50. This affected the average life hours of work negatively.

Statistics Netherlands publishes data about death rates by year of age for birth cohorts starting with 1850. This data has been used to compute survival rates by year of age for these cohorts. We assume that death rates for the 1840 birth cohort is the same as for the 1850 birth cohort.<sup>17</sup> We also assume that death rates are not affected by immigration and

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<sup>14</sup> For a review of the literature see Borjas (2007).

<sup>15</sup> The rise in agency work made it easier for workers to work only some days per week or only some months per year. Furthermore, more opportunities for part-time work within the framework of a permanent job have developed. Originally, however, most part-time work arose in sectors where employers were seeking flexibility. In the retail industry, for example, employers have to deal with peak hours and peak days. Hence, part-time labour was in their interest. At the same time an increasing number of women wanted to work part-time. Part-time labour by men has also increased, but employers in the industries where most men work are often still reluctant to accept working part-time.

<sup>16</sup> Collewet, De Grip and De Koning (2015) provide evidence that if a person's peers work longer (shorter) hours, he is also inclined to work longer (shorter).

<sup>17</sup> Van Poppel et al (2005) have made estimates of life expectancy for people born in the period 1841-1850, but as far as we know detailed data about death rates corresponding with these estimates are not published.

emigration. For birth cohorts of 1920 and later life duration is only partly observed. Death rates and life expectancy figures for these cohorts are partly based on projections made by Statistics Netherlands.

In mid-19<sup>th</sup> century death rates among infants and young children were extremely high. Almost 30 per cent of the 1850 birth cohort died before the age of five. For the 1950 birth cohort this was less than 4 per cent. For that reason we decided to make the comparison between birth cohorts on the basis of people who reached the age of five, the age at which labour force participation started in the 19<sup>th</sup> century for some children. So, we make the comparison on the basis of the people in each cohort that could have participated in the labour market.<sup>18</sup>

Also for people older than 5 years of age mortality was much higher in the mid - 19<sup>th</sup> century than for more recent cohorts. People of the 1850 birth cohort that reached the age of 5 had 40 per cent chance to reach the age of 70. For the 1950 birth cohort this is expected to be more than 80 per cent. In the recent cohorts chances of survival have particularly increased among older people.

Table 8 Survival rates and average life expectancy for men at birth per cohort conditional on reaching 5 years of age: 1840 - 1950

Age	Birth cohort										
	1850	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950
5	1	1	1	1	1	1	1	1	1	1	1
10	0,94	0,94	0,96	0,96	0,98	0,98	0,98	0,99	0,99	0,99	1,00
20	0,89	0,89	0,93	0,93	0,95	0,96	0,97	0,98	0,98	0,99	0,99
30	0,81	0,83	0,87	0,89	0,91	0,93	0,95	0,94	0,97	0,98	0,98
40	0,74	0,77	0,83	0,85	0,88	0,90	0,91	0,93	0,96	0,96	0,97
50	0,67	0,71	0,77	0,80	0,84	0,85	0,88	0,90	0,93	0,94	0,95
60	0,57	0,61	0,68	0,73	0,76	0,78	0,80	0,82	0,85	0,88	0,90
70	0,40	0,46	0,52	0,56	0,61	0,60	0,62	0,64	0,70	0,77	0,81
80	0,18	0,22	0,25	0,30	0,33	0,32	0,33	0,37	0,45	0,57	0,63
90	0,03	0,03	0,05	0,06	0,07	0,07	0,07	0,10	0,16	0,24	0,30
100	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,01	0,01	0,02
Average life expectancy	61,0	63,5	66,2	68,5	70,2	70,5	71,8	72,8	75,9	79,4	81,2

Van Poppel et al (2005) discuss the factors that caused the decrease in death rates. Water and sanitation programmes, better housing and supervision on food and milk preparation played an important role in the 19<sup>th</sup> century. But also behavioural aspects like birth control and personal hygiene reduced death caused by infection. Furthermore, shorter working

<sup>18</sup> This does not affect our estimates of the number of hours people work in their life time, but it does affect the percentage of the total number of hours spent on work.

time and improved labour conditions have contributed to the decline in death rates. The reduction in malnutrition made possible by higher wages should be added to these factors. By the end of the century the most appalling situations in factories had disappeared. In the 20th century gradually health care became a more important factor causing a further decline in death rates. And relatively recently a healthier life style has become an important factor causing longer lives.

## Life-time hours worked

The estimates of employment rates by age category, survival rates by year of age and annual hours worked have been combined to compute the average life-time hours worked for each cohort.<sup>19</sup>

For the 1940 cohort and particularly for the 1950 cohort people may still remain active after 2013, the end of our data period. For the 1940 cohort this concerns people that stay at work when they are older than 73 years of age. However, at this age a considerable part of the cohort has already died. Furthermore, labour force participation is very low at this age. Hence, the results are not that sensitive to the assumptions made. For the 1950 cohort this is a bit different. Labour force participation among the category between 60 and 65 has increased considerably. Furthermore, the survival rate of this cohort is higher than that of the 1940 cohort. We have assumed that net participation rates of older workers belonging to the 1950 cohort will double compared to the 1940 cohort for each year of age. We think that this assumption is justified in view of the gradual increase in official retirement age that is taking place.

Table 9 summarises the results for each cohort. People born in 1840 who reached the age of five worked on average 118 thousands of hours during their life. For the cohort born in 1950 this is only 67 thousands of hours, despite the fact that life expectancy for the latter cohort is much longer (81,2 versus 61 years). The 1840 cohort spent 23 per cent of the time available in their life on work. For the 1950 cohort this is only 9 per cent.

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<sup>19</sup> The data since 1950 refer to hours actually worked. For earlier years no information about sickness of workers is available. It should be noted that a general insurance against sickness for workers only exists since 1930. In case of sickness workers received 80 per cent of their wage. Before that time only a small percentage of the workers had some insurance against sickness (Rommelse, 2011). Sick workers could call upon poor relief, but only if they were unable to work for a longer time. And benefits paid within the framework of poor relief were very low. Hence, in case of sickness most workers would continue to work as long as possible.

Table 9 Life-time hours worked by males in absolute numbers and as a share in total hours available: birth cohorts 1840 – 1950, only people that reached the age of five

Birth cohort	Number of hours worked during life (*1000)	Total number of hours during life (*1000)	Hours worked as a share of total hours
1840	118,3	520,0	0,23
1850	114,0	534,1	0,21
1860	114,8	556,2	0,21
1870	115,4	579,6	0,20
1880	109,6	600,2	0,18
1890	102,6	614,9	0,17
1900	97,4	617,3	0,16
1910	88,8	628,6	0,14
1920	81,5	637,9	0,13
1930	76,1	665,0	0,11
1940	69,9	695,7	0,10
1950	66,9	711,3	0,09

Slightly more than 60 per cent of the decrease in the share of hours worked in total hours is due to a decrease in annual hours worked. The remaining part of the decrease has to do with the fact that the average labour force participation rate during a person's life has become lower.

Roughly one third of total time is spent on sleep. Probably, that has not changed much. What did change is the time spent on education and training. In mid-19<sup>th</sup> century on average children spent less than six years in school. The average age at which children left school may be estimated at 10 to 11 years. There was hardly no formal education and training in later life. For the 1950 birth cohort the average age of leaving school is approximately 19 years.<sup>20</sup> Furthermore, many people in this cohort engaged in adult education and training in their free time. A rough estimate is that the 1950 cohort has spent 10.000 hours more in education than the 1840 cohort. Although this is a substantial number it is still relatively small compared to the change in the number of hours worked during life. Hence, most of the time that became available as a result of working time reduction could be spent on consumption activities.

In table 10 we compare our estimates for the Netherlands with estimates made by other authors for Belgium, the United States and the United Kingdom. The table contains averages of two sequent birth cohort (1840 and 1850, 1850 and 1860, etc.) for the Dutch and US estimates to make these estimates more comparable with the ones for Belgium and the UK.

<sup>20</sup> We base this estimate on Liefbroer en Dykstra (2000) who provide figures for birth generations about the average age at which 25%, 50% and 75% of males have left the educational system.

Table 10 Life hours of work (\*1000) by males for Belgium, the Netherlands, the United States and the United Kingdom

	Belgium <sup>a)</sup>	Netherlands <sup>b)</sup>	United States	United Kingdom
Method	Retrospective questions in survey	Cohort approach based on statistical information	Cohort approach partly based on statistical information and partly on estimates of participation rates for age groups	Statistical information about annual working hours combined with assumptions about the theoretical length of work lives, but method does not take changes in the pattern of labour force participation during work lives into account
1840-1850		116,2	113,8	
1850/1860		114,4	110,0	149,7
1860/1870		115,1	104,6	
1870/1880		112,5	98,8	
1880/1890		106,1	95,9	
1890/1900		100,0	93,8	
1900/1910		93,1	89,9	
1910/1920		85,2	86,4	
1920/1930		78,8	83,2	
1930/1940	81,2	73,0		122,9
1940/1950	73,0	68,4		

a) Estimates by Mortelmans, Vanderweyden and Geldof (2005): averages for men born between 1930 and 1940 and between 1940 and 1950 respectively ;

b) Estimates in this paper: averages of two sequent birth cohorts {1840 and 1850, 1850 and 1860, etc.};

c) Estimates by Hazany (2009): averages of two sequent birth cohorts {1840 and 1850, 1850 and 1860, etc.};

d) Estimates by Ausube and Grübler (1995): 1856 and 1931.

The estimates made by Hazany for the United States, which cover the period 1840 – 1930, are very similar to our estimates. He uses a similar method as we do. The main difference is that he lacks data about labour participation broken down by age categories, which had to be estimated. Our results are also similar to the estimates made by Mortelmans, Vanderweyden and Geldof (2005) for Belgium concerning males born between 1930 and 1940 and males born between 1940 and 1950, which are based on retrospective questions in surveys. It should be noted that the sample size on which their estimates are based are relatively small. The estimates Ausube and Grübler (1995) give for the UK are much higher. If we look at their figure for people born in the 1930s it appears to be much higher than the estimates for Belgium, the Netherlands and the US. However, Ausube and Grübler do not measure the actual length of work lives, but take the number of years a workers could theoretically work. They do not take unemployment, disability and early retirement into account. Their estimates may give a reasonable indication of the percentage decrease of life hours of work, but probably do not accurately reflect how many hours British men actually worked in their lifetime.

## Conclusions and final remarks

The main conclusion is that males who were born in 1840 and reached at least the age of 5 worked on average 118 thousand hours during their lives, which comes down to 23 per cent of the total number of hours available during their lives. For the 1950 birth cohort the average number of hours had become much smaller: 67 thousand hours or 9 per cent of total hours. Most of the decreasing ratio of hours worked can be attributed to the reduction in the annual number of hours worked. However, also a substantial part of the decrease (approximately 40 per cent) is accounted for by the increase in life expectancy and by a decrease in employment rates for most age categories, particularly for the youngest and the oldest age categories. People live longer but work lives have become shorter.

What has caused the reduction in weekly hours? Technological progress and the resulting increase in productivity and real wages are often seen as the main cause, but we do not think that this was the case, particularly not in the early phase of working time reduction. There is considerable evidence that the extremely long working weeks in the 19<sup>th</sup> century were not efficient. They may even have been counter-productive. Long working hours do not only lead to fatigue, but also to accidents and damage. Furthermore, constant exposure to extremely long working hours and poor labour conditions will harm a worker's health in the long run and thus also his productivity. The initial reduction in working hours to a 60 hours working week did therefore not affect production per worker and may even have had a positive effect on it. There is also evidence that the further reduction of the working week to 45 or even 40 hours has had little effect on production per worker, although this may partly be attributed to measures taken by employers to improve efficiency in response of it.

Employers and government were very reluctant to do anything against the extremely long working hours. One important reason was that for many workers weekly wages were hardly above survival level and could not be reduced further. Hence, employers would not gain much from a reduction in working hours. The second reason is that employers and government were uncomfortable with the idea that workers would have more leisure time. It was both seen as a moral and a political danger. Unawareness about the fact that extremely long working hours are not productive may have played a role too, although evidence of this was already available in the 19<sup>th</sup> century. Unions and, to a lesser degree, the political branch of the labour movement were the decisive factor in the process of working time reduction.

There was a broader opposition against labour by children, particularly by children younger than 12 years of age. Even many conservatives were of the opinion that each child needed some education to become a good Christian or a good civilian. In the Netherlands the first law limiting working time, introduced in 1873, applied to children. It abolished labour for children in all sectors except agriculture, but the latter sector made up more than one third of total employment. The further decline in child labour was closely intertwined with economic development. Higher real wages made it possible for parents to keep their children longer at school, but new technologies also required more educated workers. This mechanism gradually also applied to the 15-20 years old and the 20-25 year old. However, in recent years participation in school education seems to have reached its ceiling.

The annual number of hours worked is also stabilising. Working time has reached the level at which further reductions lead to production loss. Since the 1990s we can observe a considerable increase in the net participation of people older than 55 years of age. Early retirement schemes were abolished and there is uncertainty about pensions. The rising trend in the participation of older people is likely to continue in the next decade. Therefore, we can expect that men born in 1960 will work more hours in their lifetime than men born in 1950. However, the increase in life expectancy will also continue. So, people from the former cohort will work more hours but also have more hours available in their lives compared to the latter cohort. Perhaps, the share of hours worked in total hours available will not differ too much between the two cohorts. Current government policy is aimed at stabilising this share by adjusting retirement age. The latter is already changing to 67 age of years in 2021, but further changes are already envisaged.

It is difficult to predict what will happen in the future. Robot and information technology are developing rapidly and will probably lead to a considerable increase in productivity. If the new technologies also lead to the creation of a sufficient number of new jobs a new period of economic growth like we have previously experienced in the 1960s might be possible. What is different from the past, however, is the weak position of labour. Union power is eroding. Labour protection legislation has been weakened and so far attempts to reverse this trend have not been successful. Wages are under pressure. As a result labour's share in

national income has decreased. What we also observe is a polarisation of work: the share of higher level jobs increases, but this goes at the expense of secondary level jobs. There is a growing group of workers experiencing job uncertainty and lower wages. This is not a good recipe for balanced growth. In this situation it is unlikely that the past trend of working time reduction will continue.

But even if we would have a new situation of balanced growth with rising wages it is questionable whether the reduction in life hours of work we have experienced since the 19<sup>th</sup> century will continue in the future. Male worker's preferences with respect to leisure and income are such that hourly wages hardly affect the supply of hours. More likely is that some reduction in working hours will take place, because workers will experience a growing need for training during their work lives. It is also possible that the distribution of paid work and household work between men and women will become more equal, which would imply shorter working time for men.

It is unclear how the further development of robot and computer technology will affect employment. According to Frey and Osborne (2013) almost half of US employment is at high risk of being automated relatively soon, that is within the next two decades. But Arntz, Gregory and Zierahn (2016) think that the effect will be much smaller: on average 9 percent for the OECD countries. In the past technology destroyed many jobs, but also created new jobs. Therefore, many economists (see for example Ter Weel, 2015) think that the new technologies will not lead to a lower macro employment rate in the long run.

However, there is an important difference between the new technological developments and the technologies of the previous centuries. In the past only specific industries were affected. Productivity in agriculture and manufacturing increased to such an extent that the shares of these industries in total employment declined. In the end employment in these sectors even declined in an absolute sense. Productivity in service industries on the other hand, did not change or only to a very limited extent. Both in commercial and public service industries employment grew considerably. But the new technological developments affect all industries including service industries. Automation has already led to employment losses in the financial sector, retail trade, travel agencies and some parts of the public sector. It is likely that in the future the increasing use of online education will lead to job loss in the educational sector. The health care sector was responsible for a large share in employment creation during the last decades, but robot technology is likely to have a negative effect on its employment in the future. Employment in the IT sector may initially grow further, but even in this sector computers will increasingly substitute labour. There is not a single industry that will not be affected. Another new feature of the new technologies is that not only low-skilled work is affected. In the past it was mainly low-skilled work that was substituted by capital. Currently, particularly jobs at the intermediary level are disappearing, but in the future higher educated professionals may also become equally vulnerable for technological change. In fact, this is already happening (Carr (2014)).

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## **Annex 1: equations used to estimate unemployment rates by age category**

The equations estimated are of the following form:

$$\ln\{ur_i(t)/ur_{30-35}(t)\} = \beta_0 + \beta_1 ur_{macro}(t) + \beta_2 ur_{macro}(t - 1) + \varepsilon(t)$$

This means that the explanatory variable is the unemployment rate in age category I ( $ur_i$ ) relative to the unemployment rate in the age category 30-35 ( $ur_{30-35}$ ). In this way we can ensure that the implied estimates of unemployment add up to the estimates of macro unemployment as provided by Statistics Netherlands. Index I stands for the age categories 15-20, 20-25, 25-30, 35-40, 40-45, 45-50, 50-55, 55-60 and 60-65. The other variables and symbols have the following meaning:

$ur_{macro}$  = macro unemployment rate;

$t$  = time;

$\beta_j$  = unknown parameters that must be estimated ( $j=0,1,2$ );

$\varepsilon$  = error term.

The estimation results are given in the table below.

Table A1.1 OLS estimation results

	Constant	U	U(-1)	$\Delta U$	Adj. Rsquared
15-20	1,534339 **	-0,11171 **	0,040294		0,476
20-25	0,944149 **		-0,0297 **		0,096
25-30	0,242356 **			-0,02163	0,009
35-40	-0,28195 **	0,063133 **	-0,01938		0,497
40-45	-0,98791 **		0,111983 **		0,198
45-50	-0,86594 **		0,093639 **		0,164
50-55	-0,80092 **		0,080795 **		0,123
55-60	-0,18454 **			-0,09461 *	0,046
60-65	0,022721	-0,26613 **			0,194

### Annex 3: a model with quasi-fixed labour costs

Suppose the long-term production function is given by:

$$y = g(h)h(k, l)$$

Where the symbols used have the following meaning:

y = production volume

h = working time

k = capital stock

l = number of workers

If we assume that firms minimise costs given the volume of their output and that f is linear homogenous in k and l, then:

$$\frac{w}{r} = \frac{\frac{\partial y}{\partial l}}{\frac{\partial y}{\partial k}} = f\left(\frac{k}{l}\right) \quad \text{or} \quad \frac{k}{l} = f^{-1}\left(\frac{w}{r}\right)$$

Where w denotes wages and r the price of capital.

Hence:

$$y = g(h) l h\left(\frac{k}{l}\right) = g(h) l f^{-1}\left(\frac{w}{r}\right)$$

If w and r are given for firms we arrive at the following model:

$$y = g^*(h)l$$

Where:

$$g^*(h) = g(h) f^{-1}\left(\frac{w}{r}\right)$$

Labour costs are as follows:

$$c = (wh + f)l$$

Where  $c$  denotes total labour costs for the employer,  $w$  hourly wage and  $f$  quasi-fixed costs.

When we combine the two equations we obtain:

$$c = y(wh + f)/g^*(h)$$

If hours are equally productive as workers, costs are a decreasing function of hours and employers will be tempted to require very long working hours. If, however, at some point hours become less productive, the optimal number of hours  $h^o$  is finite. We have:

$$h^o = \left\{ \frac{\varepsilon}{(1-\varepsilon)} \right\} \frac{f}{w}$$

In this formule  $\varepsilon$  denotes the elasticity of hours in the production function. The optimal number of hours is longer, the lower hourly wage is compared to the quasi-fixed labour cost component.

However, the empirical evidence suggests that  $\varepsilon$  is low even in case of workweeks of 60 hours. Suppose that  $\varepsilon$  equals 0,1. Then  $wh^o/f$  would be equal to 1/9, implying that quasi-fixed costs per orker are much higher than the costs of labour hours. This does not seem to be plausible.