Netspar

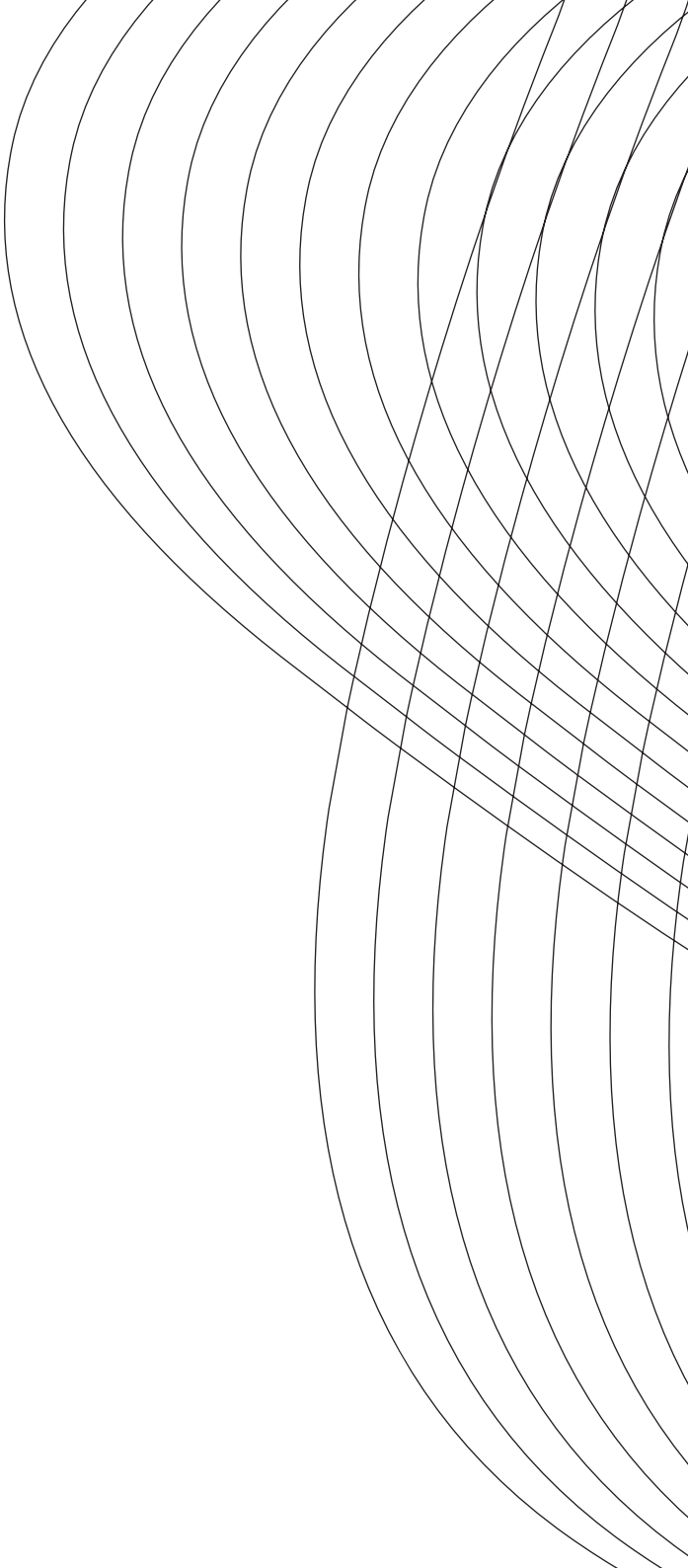
Network for Studies on Pensions, Aging and Retirement

Netspar PANEL PAPERS

Bastian Ravesteijn, Hans van Kippersluis and Eddy van Doorslaer

Long and healthy careers?

The relationship between occupation and health and its implications for the statutory retirement age



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PREFACE

Netspar stimulates debate and fundamental research in the field of pensions, aging and retirement. The aging of the population is front-page news, as many baby boomers are now moving into retirement. More generally, people live longer and in better health while at the same time families choose to have fewer children. Although the aging of the population often gets negative attention, with bleak pictures painted of the doubling of the ratio of the number of people aged 65 and older to the number of the working population during the next decades, it must, at the same time, be a boon to society that so many people are living longer and healthier lives. Can the falling number of working young afford to pay the pensions for a growing number of pensioners? Do people have to work a longer working week and postpone retirement? Or should the pensions be cut or the premiums paid by the working population be raised to afford social security for a growing group of pensioners? Should people be encouraged to take more responsibility for their own pension? What is the changing role of employers associations and trade unions in the organization of pensions? Can and are people prepared to undertake investment for their own pension, or are they happy to leave this to the pension funds? Who takes responsibility for the pension funds? How can a transparent and level playing field for pension funds and insurance companies be ensured? How should an acceptable trade-off be struck between social goals such as solidarity between young and old, or rich and poor, and individual freedom? But most important of all: how can the

benefits of living longer and healthier be harnessed for a happier and more prosperous society?

The Netspar Panel Papers aim to meet the demand for understanding the ever-expanding academic literature on the consequences of aging populations. They also aim to help give a better scientific underpinning of policy advice. They attempt to provide a survey of the latest and most relevant research, try to explain this in a non-technical manner and outline the implications for policy questions faced by Netspar's partners. Let there be no mistake. In many ways, formulating such a position paper is a tougher task than writing an academic paper or an op-ed piece. The authors have benefitted from the comments of the Editorial Board on various drafts and also from the discussions during the presentation of their paper at a Netspar Panel Meeting.

I hope the result helps reaching Netspar's aim to stimulate social innovation in addressing the challenges and opportunities raised by aging in an efficient and equitable manner and in an international setting.

Roel Beetsma
Chairman of the Netspar Editorial Board

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LONG AND HEALTHY CAREERS?

A preview of the policy implications

This paper summarizes the existing knowledge about whether occupation affects health and which workplace conditions are particularly harmful to health. Our reading of the literature is that at least half of the association between occupation and health is due to a selection effect, which reflects deeper disparities in health on the basis of socioeconomic background. Yet, recent evidence suggests that a causal effect of occupation on health does exist, and that this effect mainly derives from physical work conditions and from low job control at older ages. These main conclusions lead to the following policy implications.

Workers whose poor health was caused by occupational characteristics should be exempted from an increase in the statutory retirement age to the extent that their occupational health damage was not compensated through a wage premium. This is the case for individuals with meager endowments who face a severely constrained occupational choice set. Physical workplace conditions seem most detrimental to health, and workers in elementary and low occupations are most exposed to physically demanding occupational attributes. Furthermore, a low degree of control over daily activities at work is found to be harmful to health at older ages (Ravesteijn et al. 2013). Workers at older ages should receive assistance with respect to career development in order to maintain their productivity.

Ongoing work by Ravesteijn et al. (2013) could provide some guidance on the identification of occupations that are especially harmful to health. The POLS (Permanent Onderzoek Leefsituatie) data used in the present study provides information on the degree of physical and psychosocial demands for a large set of occupational titles in the Netherlands, and this could be used to construct a ranking of occupations. As yet, however, no administrative information on the occupational titles, work history or educational attainment at the individual level is available for the Netherlands – in contrast to Finland for example. We maintain that such information is essential to retrospectively identify work histories and we recommend that it be collected if a differentiated retirement age is considered.

To some extent, new longitudinal data collection efforts initiated by TNO could fill this gap. The large annual NEA (*Nationale Enquete Arbeidsomstandigheden*; n=25,000), which has been the most important source of cross-sectional information on health and work since 2003, was recently expanded with a panel data component (n=10,000) that started in 2007 and has had annual follow-ups since. If these could be linked to the registries, then a whole new set of research questions could be addressed. Moreover, the NEA panel was recently complemented by the international study STREAM (*Study on Transitions in Employment, Ability and Motivation*) which involves a longitudinal data collection effort among 12,000 workers in the age range of 45 to 65 from 2011 to 2013.

If these efforts prove insufficient, then individual history of income may be used as an imperfect proxy. In the meantime, a differentiated statutory retirement age may be obtained by making the retirement age conditional on the number of years

in employment, which would equally favor workers in physically demanding occupations.

Finally, even though not all health differences across occupational groups are due to occupation itself, occupation may be used as a marker for meager endowments or a series of adverse health shocks. Since life expectancy is worse for people who are lower on the occupational ladder, a uniform increase of the retirement age will harm the welfare of these people disproportionately because it will reduce their remaining lifetime in retirement by a larger proportion. Hence, to achieve distributional neutrality, workers in physically demanding occupations should not only be allowed to retire at a younger age to reflect their shorter life expectancies, but might also receive financial compensation because they disproportionately suffer from a uniform increase in the retirement. Occupational class is only one of many markers of meager endowments and persistent adverse health shocks. We propose using a wider array of indicators to determine the retirement age in order to prevent people from engaging in strategic behavior – which might include, for example, switching occupations at a certain age to be eligible for early retirement. The retirement age could be based on a weighted index of educational attainment, occupational class, and lifetime income and wealth.

Abstract

This paper investigates the relationship between occupation and health, and confirms that – also in the Netherlands in recent years – workers on a lower step of the occupational ladder on average report worse health, have a higher probability of disability and die earlier than workers in higher occupations. We sketch a theoretical framework to better understand the mechanisms underlying these disparities. Using the core insights derived from this model on selection and behavioral responses to changing workplace conditions, we review and assess the economic literature to date on occupation and health. After identifying the difficulties encountered in estimating causal effects of occupational characteristics on mental and physical health, we discuss how future research may try to overcome some of the crucial identification issues. We relate our findings to current policy issues with respect to occupational safety and the statutory retirement age, and discuss how future research could contribute to improved policy advice.

1. Introduction

In many Western countries the old-age dependency ratio – the ratio between the number of people over 65 years old and people in the productive age group of 15 to 65 years – has increased over the past decades. With ever-increasing life expectancy, and the baby-boom generation reaching retirement age, the dependency ratio is expected to double between 2000 and 2050 in the Netherlands (CBS 2012b). Unsurprisingly, this imposes an enormous financial burden on the public pension system. Increasing the economic activity of middle-aged and older individuals is considered essential to relieving these economic pressures. In response, governments are striving to discourage early retirement and to raise the legal retirement age. The conditions under which this higher legal retirement age should be implemented form a topic of heated debate. Conceivably, certain 'hard' occupations are harmful to health or are too demanding for older workers, and should be exempted from a rise in the statutory retirement age (e.g. Smulders et al. 2009).

The debate around 'hard' occupations is rooted in a striking and pervasive association between occupation and health, with very large differences in mortality across occupational groups. For example, Davey-Smith et al. (1998) show in a study covering 21 years that in the UK those in the highest occupational classes have a 70 percent lower risk of dying than those in the bottom occupational class. Kunst et al. (1998) confirm this finding for 11 European countries and report persistently higher mortality rates for manual workers than for non-manual workers. In France, manual workers have a 28 percent chance of dying between age 45 and 65, compared to only 16 percent for non-manual workers. Not only higher mortality rates confront manual workers; Case and

Deaton (2005) show that those employed in manual occupations have worse self-reported health than those who work in professional occupations, and that these differences increase with age.

This paper argues that a naïve interpretation of the empirically observed association between occupational characteristics and health may lead to misguided policy advice on (i) the identification of target groups that could benefit from policies relating to differentiated legal retirement ages and (ii) protection of the health of vulnerable groups. The aim of this paper is therefore to summarize the existing knowledge about whether occupation affects health and which workplace conditions are particularly harmful to health. In doing so, the review will be guided by descriptive evidence from the Netherlands as well as the use of a theoretical framework, which indicates that it is vital to thoroughly understand the association between occupation and health along two important dimensions.

First, it is unclear whether the strong and persistent association between occupation and health derives from the direct, causal effect of occupation on health, or whether this association stems from health-enabling and/or limiting factors compelling individuals to select into certain types of occupation. Another explanation is that underlying factors such as education or initial endowments affect both occupation and health, implying that health inequalities by occupation are simply a reflection of 'deeper' societal health inequalities across socioeconomic groups. If certain occupations were to *cause* workers to become disabled sooner and live shorter lives after retirement, then for equity reasons one could argue that the statutory retirement age should be dependent on occupation.

A second core insight from the theory is that individual choices are not made in isolation – an individual simultaneously chooses

(i) a basket of occupational attributes in terms of psychosocial and physical workplace conditions, and (ii) his level of health investment. Therefore, the observed health effect of a change in occupational characteristics is the sum of the direct effect of the occupational characteristics on health, and the indirect effect of the occupational characteristics on lifestyle choices with respect to health investment. This distinction is relevant, since improving working conditions may not be efficient or even reach its target and a differentiated statutory retirement age may not be as equitable, if the health differences mainly reflect a different lifestyle among workers in different occupations.

The paper is organized as follows. Section 2 documents patterns of occupation, health and longevity in the Netherlands. While this has been done before for self-reported health, this is the first such attempt to estimate differences in disability free survival and overall survival by occupation. Using ten years (1997-2006) of the annual cross-sectional survey with respect to health and work, the *Permanent Onderzoek Leefsituatie* (POLS), linked to a selection of nationwide registries by Statistics Netherlands, we demonstrate that a gradient by occupation in health and survival also exists for workers in the Netherlands. We find that, on average, and controlling for age, workers in higher-ranked occupations are more likely to report good or very good health and can expect to live longer and are less likely to become disabled.

In section 3 we propose an economic theory of health behavior across the life cycle to understand the stylized facts in section 2. From the model of a rational utility-maximizing consumer inspired by the Galama and van Kippersluis (2010) model, we derive two core insights with respect to health-related selection into occupation and behavioral response to occupational circumstance that we use to guide our review of the empirical

evidence. Subsequently, we use the same survey data to document the empirical relevance of these insights for the Netherlands.

Section 4 reviews the scientific evidence to date, guided by the same two core insights derived from the economic theory. We focus on the economic and social science literature rather than the medical or occupational epidemiology literature. We find that the evidence to date on the causal impact of occupational exposure to health – in contrast to the evidence on the association – is fairly thin, and that the available evidence is rather weak. The quest to estimate the causal effect of occupation on health is particularly hampered by the lack of suitable sources of exogenous variation, as generated by, for instance, natural experiments in occupational and working conditions, which could be exploited to estimate health effects. Studies with research designs and data that allow controlling for both selection and unobserved heterogeneity are very rare.

The first of our conclusions is that health differences across occupational groups largely reflect health-based selection into occupations. Nonetheless, since life expectancy is worse for people who are lower on the occupational ladder, a uniform increase of the retirement age will harm the welfare of these people disproportionately because it will reduce their remaining lifetime in retirement by a larger proportion. Our second conclusion is that at least part of the association between both physical working conditions and low job control at older ages is due to a causal effect on health. Hence, workers with a long history of working in physically demanding occupations or occupations with low job control could be allowed to retire at an earlier age if policymakers would opt to offset the inequality-enhancing consequences of raising the statutory retirement age.

2. Patterns of occupation and health in the Netherlands

While the association between occupation and health outcomes has been documented widely internationally, including occupational disparities for self-reported health and morbidity in the Netherlands (Kunst et al. 1990; Cavelaars et al. 1998; Mackenbach et al. 2008), such evidence has not yet been provided for disparities in mortality and the onset of disability the Netherlands. This is now made possible through the linking of surveys and administrative registers by Statistics Netherlands.

We use the Dutch *Permanent Survey of Living Conditions* (Dutch acronym POLS) which has been linked by Statistics Netherlands to the registers since 1997. POLS is a repeated cross-section survey that includes questions on measures of self-assessed health (SAH) and a detailed measure of type of occupation based on the Dutch Standard Classification of Occupations (SBC, 1992). For the years 1997 through 2006, we look at 115,888 individuals who report an occupational title. The earliest cross-sections are much larger, with 70 percent of observations in the first four years.

In line with the Dutch 1992 SBC occupational classification, we distinguish between five major occupational groups. These are elementary occupations, low-level occupations, mid-level occupations, high-level occupations and university-level occupations (CBS, 2012b). The 1992 SBC occupational classification is based on the skill level that is required for each occupation. Examples of elementary occupations (7,912 observations) include conveyer belt worker or cleaner. Low-level occupations include lumberjacks, miners and construction workers (24,037 observations). Mid-level occupations include foremen, building contractors or mechanics (38,980 observations). High-level occupations (19,743 observations) include primary school

teachers, mid-level managers, and head nurses. University-level occupations (7,319) include medical doctors, accountants, and architects[1]. In the remainder of this section we look at the association between occupational type and three measures of health. We find that this ordering is consistent with higher SAH, a lower probability of becoming disabled, and a lower probability of dying at any given moment. In other words, workers in a "higher" type of occupation on average report better health, are less likely to become disabled and live longer than workers in lower-ranked occupations.

2.1 Type of occupation and self-assessed health

In the survey years 1997 to 2001, respondents were asked to assess their health on a five-point scale from bad to very good. We limit our sample to working-age individuals between 20 and 65 years old, which is the current legal retirement age. Figure 1 shows patterns of occupation and health in the sample, not controlled for age, for the five occupational groups, for those on disability benefits, and for those who do not work. The figure shows that only a very small proportion of the people on disability benefits reports good health. Those who are not working report better health than those on disability benefits. The figure also shows that health status monotonically improves with higher levels of occupation. 81 percent of elementary workers report good or very good health as opposed to 90 percent of people in high-level or university-level occupations.

Figures 2 and 3 show the patterns of occupation and health for men and for women separately. The results are fairly similar with, two exceptions. Not-working men report worse health than

1 Due to changes in the coding procedure, 17,897 observations of occupational titles need to be recoded; they are currently excluded from the analysis

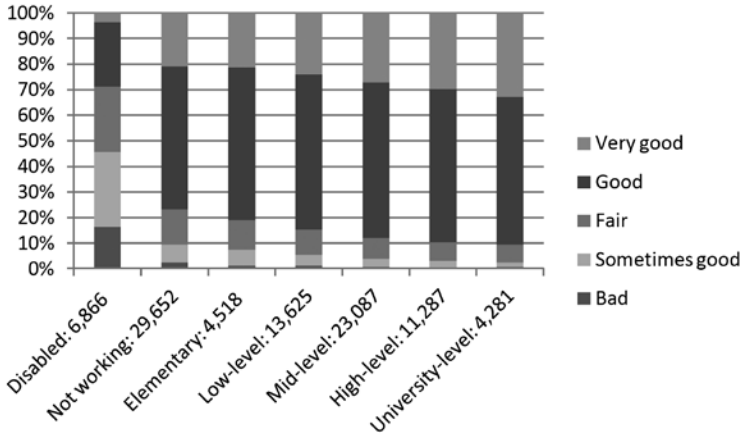

Figure 1. Self-assessed health and disability and employment status for men and women.

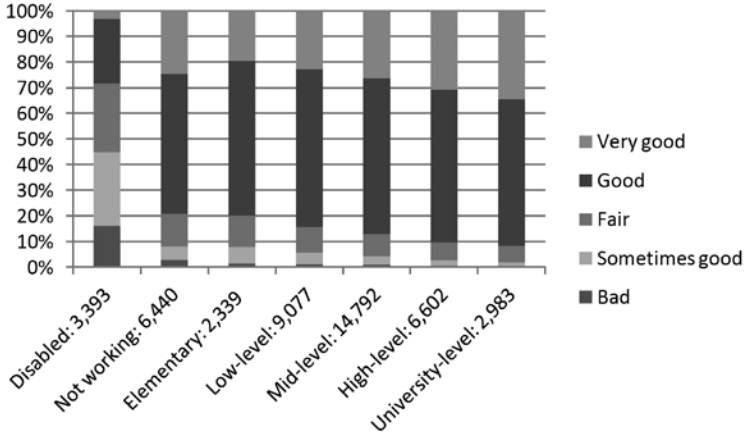

Figure 2. Self-assessed health by disability, not-working and occupation, males.

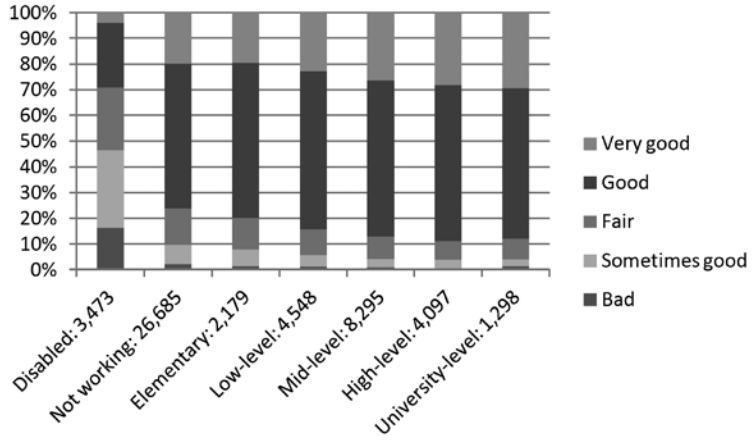

Figure 3. Self-assessed health by disability, not working and occupation, females.

not-working women. This may reflect that men are in general more likely to work than women, leaving a smaller, more selective group of men in the not-working category. The second notable difference between men and women is that for university-level occupations, women report worse health than men.

Figure 4 shows the proportion reporting good or very good health of individuals in the five occupational groups at different ages. It should be emphasized that these figures are drawn using different individuals at different ages, and hence cannot interpreted as the average life-cycle profile for the occupational groups due to selective attrition out of employment because of institutionalization and mortality (e.g. Baeten et al. 2012): these individuals are not observed in the working population. What is striking is that already at age 25 marked differences in health are observed across occupational groups. Since occupation is unlikely to have had much of an effect on health already at this age, this

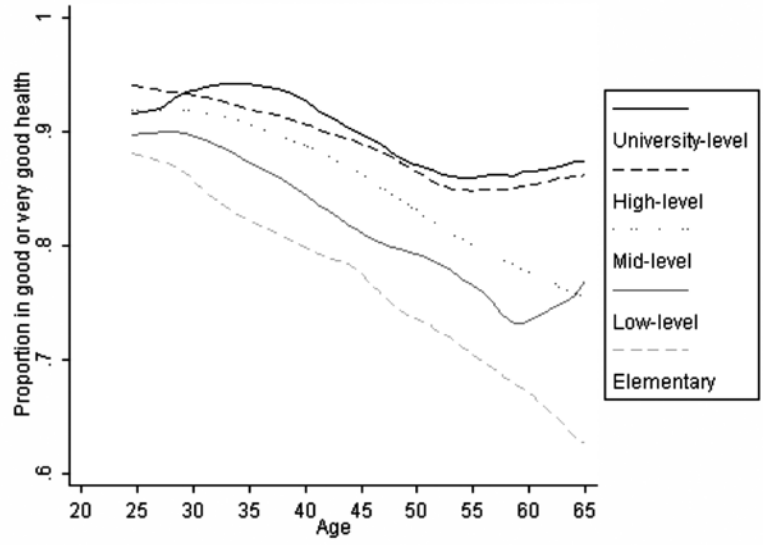

Figure 4. Proportion of workers reporting good or very good health by age, POLS 1997–2000

suggests that health-related selection into occupations may also play a role.

The proportion of workers in at least good health declines with age for all occupational groups and the decline is strongest for elementary, low-level and mid-level occupations. The health disparities between occupational groups increase with age, with around 87 percent of individuals in high-level and university-level occupations reporting good or very good health in their early sixties as opposed to 64 percent of elementary workers. This suggests more rapid health deterioration among workers in the lower occupational groups, yet it should be kept in mind that these are not lifecycle profiles and hence could reflect

	All	Men	Women
Disability	1.18** (.02)	1.21** (.02)	1.17** (.02)
Not-working	.02 (.02)	.03 (.03)	-.01 (.02)
Low-level occupation	-.13** (.02)	-.13** (.03)	-.13** (.03)
Mid-level occupation	-.25** (.02)	-.27** (.02)	-.23** (.03)
High-level occupation	-.36** (.02)	-.41** (.03)	-.32** (.03)
University-level occupation	-.45** (.02)	-.53** (.03)	-.32** (.03)

*Table 1. Ordered probit regression of SAH on working status. Coefficients of age, age squared and age to the third power not reported. * p-value<.05, ** p-value<.01*

cohort effects, selective promotion between occupational groups, selective mortality and other sources of confounding.
The initial rise in the proportion of individuals in university-level occupations reporting good or very good health may reflect the fact that the healthiest workers enter a university-level occupation in their late twenties or early thirties. The upward slope of the curves for university-level, high-level and low-level occupations at later ages could be the result of selection of healthy and unhealthy workers in and out of certain occupational types. For example, workers in good health may be promoted or workers in bad health may exit the labor force.

Another way of summarizing these health disparities, while controlling for age, is shown in Table 1. The table reports the results from an ordered probit regression of SAH on dummy variables indicating the occupational categories, not-working and disability while controlling for age, age squared, and age

to the third power. The reference category is elementary work, and a negative coefficient refers to better SAH. Unsurprisingly, individuals who receive disability benefits report worse health than elementary workers. Individuals in low-level, mid-level, high-level and university-level occupations report significantly better health. These findings are in line with e.g. Cavelaars et al. (1998). The SAH of individuals who do not work and who do not receive disability benefits is not significantly different from the SAH of elementary workers. The size of the coefficients cannot readily be interpreted because of the nature of the regression, which is ordered probit.

2.2 Type of occupation and disability

People who are unable to work for health reasons receive a disability benefit. We follow up workers aged 20 to 65 in the POLS survey data using longitudinal data in the Social Statistics File (Dutch acronym SSB). This allows us to analyze the duration until exit out of a disability-free spell into disability of individuals who reported that they were employed at the time of the POLS survey. We take into account the left-truncation as a result of the fact that we started to observe the individuals at the moment of the POLS survey, and we take into account right-censoring because of death, reaching the retirement age of 65 or the fact that we observe disability only until 2006.

Table 2 shows the estimated hazard ratios from a Cox proportional hazard model of the duration until exit into disability. The base category is elementary work. The likelihood of exiting into disability monotonically decreases with level of occupation. At a 5 percent significance level, individuals in low-level occupations are between 17 and 33 percent less likely into exit to disability than elementary workers at any age. Individuals

	All
Low-level occupation	.75** (.04)
Mid-level occupation	.55** (.03)
High-level occupation	.49** (.03)
University-level occupation	.37** (.03)

*Table 2. Cox proportional hazard model of exit into disability. * p-value<.05, ** p-value<.01*

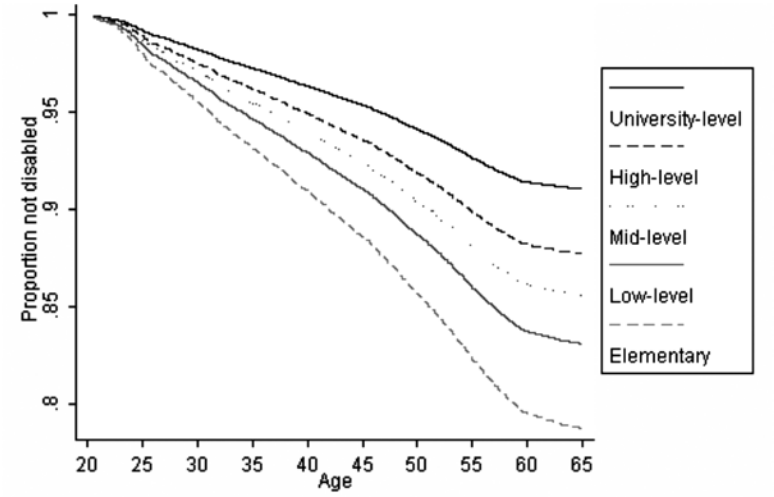

Figure 5. Survival until exit into disability, Cox proportional hazard model.

in mid-level occupations are between 38 and 51 percent less likely to exit into disability. For individuals in high-level occupations, this likelihood is between 45 and 57 percent, and for university-level occupations this is between 56 and 70 percent.

Figure 5 shows the proportion of the population that survives disability-free until the age of 65, given that they worked before. At the age of 65, 21 percent of elementary workers have exited into disability, while only 9 percent of university-level workers have then exited into disability. What is also very striking is the monotonicity of the gradient: with every step down the ladder of the occupational ranking, the risk of disability increases substantially. The survivor function flattens after the age of sixty, possibly reflecting the increased likelihood of exiting the labor force into early retirement instead of disability.

2.3 Occupation and mortality

Occupational disparities in health are also reflected in differential survival. While these have been documented for many countries by Dutch researchers (e.g. Kunst, et al. 1990; Cavelaars et al. 1998), mortality differences by occupation in the Netherlands were always missing because of the absence of mortality data by occupation. Statistics Netherlands now allows the linking of the POLS survey to the Dutch Cause of Death registry (Dutch acronym DO), which registers all deaths. This enables analysis of the duration until death of individuals for whom we observe their occupational status in the POLS data. As before, we account for left-truncation and for right-censoring as well because we observe mortality only until 2010.

Table 3 shows the estimated hazard ratios from a Cox proportional hazard model of the duration until exit due to death. At any age, individuals receiving disability benefits are more than

	All
Disability	2.18 ** (.08)
Not-working	.81 ** (.07)
Low-level occupation	.85** (.08)
Mid-level occupation	.74** (.06)
High-level occupation	.62** (.06)
University-level occupation	.49** (.06)

Table 3. Cox proportional hazard model of exit into death.
** p-value<.05, ** p-value<.01*

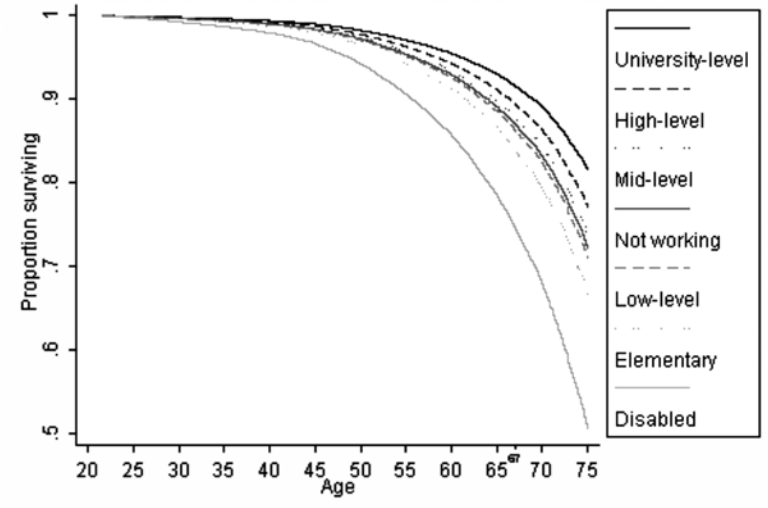

Figure 6. Survival until exit into death, Cox proportional hazard model.

twice as likely to die in the period of observation compared to individuals who were in an elementary occupations when they were observed in the POLS survey. Individuals in university-level occupations are between 38 and 61 percent *less* likely to die at any given age than elementary workers.

Figure 6 shows the estimated survival curves by occupation. It can be seen that, at the age of 65, already more than 20 percent of individuals who were on disability benefits have passed away, around 13 percent of elementary workers, and around 7 percent of university-level workers. In the coming years, the legal retirement age will be increased to 67 years old. At that age, and not taking into account any improvement in life expectancy in the coming years, 16 percent of elementary workers will have passed away, as opposed to 8 percent of individuals in university-level occupations.

All in all, the descriptive evidence presented here confirms that in the Netherlands – as in many other industrialized countries – patterns of morbidity, disability and mortality differ by occupation. Health and survival generally improve monotonically when moving up the occupational ladder. This begs the question to what extent these disparities reflect selection of healthier individuals into higher occupations versus the possibility that being in these occupations themselves exerts a negative influence on health. And in the latter case, it is still of crucial importance to know the extent to which this health effect of occupation derives directly from the physical or psychosocial working conditions or rather follows from different lifestyles outside work.

3. Theoretical framework

This section presents a theoretical framework based upon Grossman (1972), Case and Deaton (2005) and Galama and Van Kippersluis (2010), which represents choices of occupation, health and consumption levels. This should help us to better understand and interpret (a) the empirical patterns observed in the previous section and (b) the findings described in the international literature which are discussed in the next section.

The individual maximizes discounted lifetime utility, which depends on consumption *c* and health *h* in each period, by choosing the levels of consumption, health investment *m*, and occupational attributes *o*.

$$\max_{\{c_{t+j},m_{t+j},o_{t+j}\}_{j=0}^{T-t}} E\left[\sum_{j=0}^{T-t}\beta^j u(c_{t+j},h_{t+j})\,|\,I_t\right] \quad (1)$$

The individual faces a health and a budget constraint. In each period, health is determined by permanent health *p*, the biological aging rate *a*, the history of idiosyncratic health shocks η, and the history of health investments and occupational choices.

$$h_{t+j} = f(\mathrm{h}_p,\mathrm{a}_1,...,\mathrm{a}_{t+j},\eta_1,...,\eta_{t+j},\mathrm{m}_1,...,\mathrm{m}_{t+j-1},\mathrm{o}_1,...,\mathrm{o}_{t+j-1}), \quad (2)$$

where permanent, time-invariant health is a function of endowments $h_p=g(e)$. Permanent health reflects characteristics and circumstances that are stable over time, such as genetic predisposition for certain illnesses. Health deteriorates with age and because of harmful occupational characteristics, but can be improved by health investments. Initial health is viewed as the health level at the beginning of the working career, and is determined by permanent health, health depreciation due to age, and the effects of all past health shocks on current health.

As mentioned before, the effect of the history of health shocks is typically smaller than the sum of these health shocks.

Expenditures on consumption and health investment (at prices p_c and p_m) may not exceed total earnings. Wages *w* depend on endowments, current health, and on the level of harmful workplace conditions, the latter of which can be freely chosen in each period. Current health and endowments determine the maximum wage (the 'wage frontier') that individuals can attain. The wage can be increased by undertaking jobs with harmful workplace conditions that have a deleterious impact on health (i.e. health compensating wage differentials):

$$\sum_{k=1}^{T}(p_c c_k + p_m m_k) \leq \sum_{k=1}^{T}(1+r)^{k-1}\,\mathrm{w}(\mathrm{o}_k, h_k, e). \qquad (3)$$

In each period, the choice of consumption is determined by the marginal utility of consumption and the shadow price of consumption. The optimal level of health investment is determined by the marginal utility of health, future returns to health, the rate at which health investment "dies out", the shadow price of health investment, permanent health, foreseeable aging, and the history of health investment, occupational choice and health shocks, and the rates by which occupation-related health damage and health shocks die out.

Health investment and harmful occupation are each other's "mirror image". The former is costly but improves health, while the latter improves earnings but is harmful to health. The optimal level of health investment is determined by the marginal utility of health, future returns to health, the rate at which occupation-related health damage dies out, the shadow price of health investment, permanent health, foreseeable aging, and the history of health investment, occupational choice and health shocks, and the rates by which health investment and health shocks die out.

The role of endowments, effort, and institutions

The model emphasizes that the realization of lifetime utility depends on endowments, effort and institutions. First, endowments are characteristics of the individual that are not chosen (such as gender, race or genetic predisposition for learning, ability or disease). Individuals are also endowed with their family background. For example, later-life outcomes may be determined by the level of education and income of the parents or by their ability to raise children. Second, lifetime utility is determined by individual effort: e.g. investment in health is costly, but this type of effort is rewarded in terms of earnings potential and future health. Similarly, working may be harmful to health, but work is rewarded with earnings. Third, institutions determine how initial endowments and effort are rewarded in terms of utility, and they determine the parameters of the constraints. For example, remedial teaching programs may reduce the importance of endowments, while payroll taxes reduce the rewards of endowments and effort in terms of earnings.

Initial endowments, which are given in the model, cannot be chosen either by the individual or by the government. Effort can be freely chosen by the individual but not by the government. Institutions are under the control of the government but not of the individual. They determine the parameters of the constraints that the individual faces and shape his set of possibilities.

The individual may choose one of many combinations of consumption, health investment, and harmful workplace conditions, but only a limited set of combinations of choices yields the highest lifetime utility. If individuals optimize their utility, then any resulting differences in utility are the result of initial endowments and institutions and are therefore not under the control of the individual, but possibly under the control of

policymakers. Inequality in lifetime utility is multi-dimensional. Disparities in health outcomes are not necessarily a sign of disparities in total lifetime utility, since they could be the result of a personal trade-off. Only when inequalities are persistent throughout leisure, consumption and health, can we conclude that they reflect inequality of lifetime utility.

Core insights from the theoretical framework

The economic framework yields several insights that are relevant to the interpretation of empirical evidence on occupation and health. Two of these deserve special attention.

1) *Individuals select into types of occupation on the basis of endowments, education, and health*

Many factors may simultaneously influence occupational choice and health outcomes. For example, initial endowments influence an individual's health and wage prospects. Empirically, it is therefore important to account for all factors that simultaneously influence both occupational choice and health outcomes if we want to obtain estimates of the causal effects of occupation on health. Additionally, not only do occupational characteristics affect health, but health may also influence occupational choices. Health, which is subject to shocks, co-determines the wage rate and the rewards of engaging in harmful occupational characteristics. In simple terms, health determines the type of occupation one is able to perform. For example, a back injury may force a construction worker to switch to another occupation, and some physically demanding occupations such as firefighting require healthy workers (Kemna, 1987). Both unobserved heterogeneity and reverse causality prevent us from making

statements about a possible causal effect of occupation on health on the basis of the simple association.

To illustrate these insights, we use the same POLS data to show some descriptives for the Netherlands. While age differences by occupation are not large, workers in lower-ranked occupations tend to be younger, with an average of 38 years of age for elementary occupations and 42 years of age for university-level occupations, possibly reflecting how careers develop over the life course. The variation of age within each occupational group is slightly larger for the lower occupational types, reflecting the fact that some workers are not promoted to higher occupations, while younger people start their career in a lower occupation but may end their careers in a higher occupation Unsurprisingly, given the way that type of occupation is defined, there is a strong association between educational attainment and type of occupation (as demonstrated in figure 5). The lower educated are mostly employed in elementary and low-level occupations, while those that finished higher education are almost exclusively found in high-level and university-level occupations. Lower education refers to the general education until age twelve. LBO refers to lower vocational training until the age of 16. MAVO refers to mid-level secondary education until the age of 16. HAVO is higher secondary education until the age of 17. VWO is preparatory academic education until the age of 18. MBO is middle vocational education, which requires at least an LBO or MAVO degree. HBO is a four-year college degree that requires at least a HAVO degree. University requires at least a VWO degree or the first year of HBO.

Several ethnic groups comprise a sizeable part of the Dutch population, most notably individuals whose ancestors were born in the former colonies of Surinam and the Netherlands Antilles, or in Morocco or Turkey, where many workers were recruited

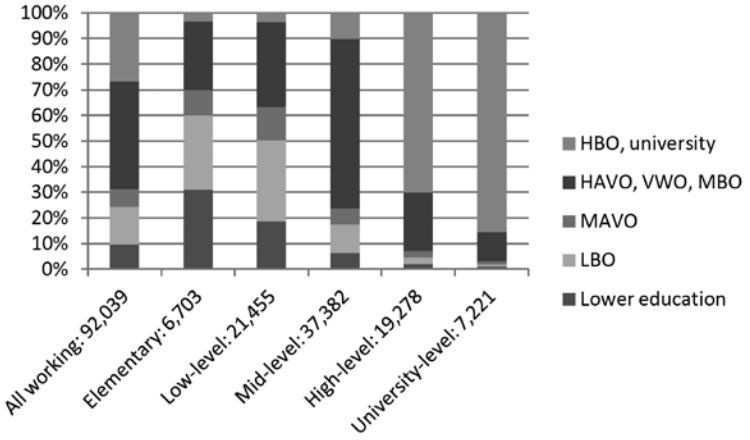

Figure 7. Occupation by educational attainment

since the 1960s. We have linked the POLS survey data to the Dutch Municipal registration (Dutch acronym GBA), which has information on the country of birth of the parents. The four groups together comprise 7.3 percent of the Dutch population, or close to 1.25 million individuals. These individuals have lower educational attainment, lower earnings and worse health than those of Dutch descent. There may be selective sampling in the POLS, since the respondents had to answer in Dutch. This would lead to an underrepresentation of members of ethnic minorities who lacked Dutch language skills. This would be less of a problem for the Netherlands Antilles and Surinam, where Dutch is spoken, than for Turkey and Morocco.

Figure 8 shows the occupational distributions for each of these groups. Individuals from ethnic minorities are on average on a lower step of the occupational ladder. This is especially true for the two Mediterranean countries, where low-skilled labor was recruited in the second half of the twentieth century, than for

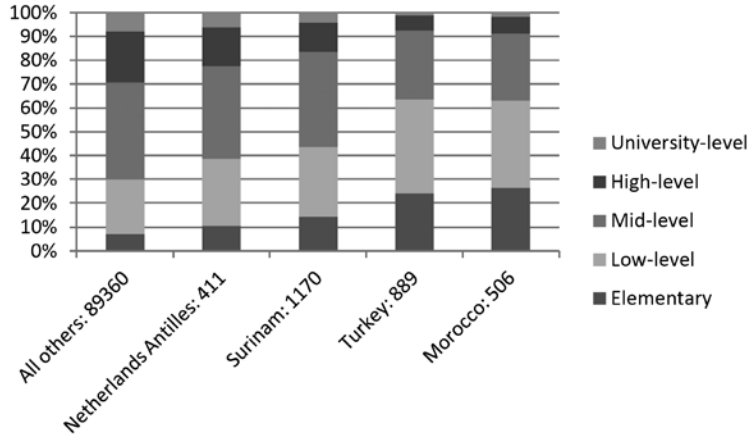

Figure 8. First- and second-generation migrants and type of occupation

the former colonies. We did not control for age, nor did we look at the proportion that did not work at the time of the survey. It is important to note that only the first and second generation migrants are included. The third generation is included in the first column.

In sum, there is strong selection into occupation on the basis of socioeconomic indicators such as endowments and level of educational attainment. The model shows that agents with low endowments have lower permanent health and lower earnings for each choice of occupational characteristics. Depending on preferences, agents may choose to sell off more health capital by choosing harmful occupational attributes in order to increase earnings. If the utility function is concave in consumption, the marginal utility of consumption is high for low levels of consumption. Selling off health capital by choosing harmful occupational attributes is therefore more attractive for agents with

low endowments. If they don't fully offset these negative effects by investing in health, then workplace conditions contribute directly to health inequalities across socioeconomic groups.

2) Compensating behaviors and the difference between structural parameters and observed effects

A second core insight from the theory is that individual choices are not made in isolation. With respect to occupation and health, an optimizing individual adjusts his behavior in response to his realized occupational choice. The individual may choose a job with workplace conditions that are harmful to his health, yet are associated with a higher wage. Although this compensating wage premium has historically been associated with a potentially dangerous occupation requiring hard physical labor (Adam Smith, 1776; see also Viscusi, 1978; 1979), a modern-era variant may perhaps be found in an investment banker who depletes his health capital through high levels of job stress and long working hours in exchange for a relatively high wage. Depending on which choice yields the highest utility, the individual receiving the wage premium may use these additional earnings to invest in his health to partially offset the detrimental effects of his occupation or may spend it on unhealthy consumption.[2] Therefore, the total health effect of a change in occupational characteristics is the sum of the direct effect of the occupational characteristics on health, and the

2 We expand on Smith's notion of the compensating wage differential by noting that, given the parameters of the model, disparities in earnings not only represent sacrifices in terms of effort, but are also determined by initial endowments. Hence, while Smith essentially does not worry about adverse occupational characteristics (as he believes all workers are compensated financially), we argue that part of these differences in working conditions may not reflect free choice, but are the consequence of differences in initial endowments.

indirect effect of the occupational characteristics on behavioral choices with respect to health investment.

Note that the behavioral adjustment is different from the selection issue mentioned under core insight 1, in terms of timing. If smoking differences in adolescence reflect different preferences across individuals, which in turn lead to different occupational choices, this is considered selection. In contrast, if workers in certain occupations initiate smoking to cope with stress on the job or due to peer effects among colleagues, then these are considered behavioral adjustments. In the absence of a full-fledged structural model – which inevitably requires strong functional form assumptions and very detailed empirical data – or an experimental setting, it is extremely difficult to obtain an unbiased estimate of the direct effect, since we only observe the total effect after the behavioral response.

We look at the patterns of smoking and exercise for each occupational category. In the POLS basic survey, respondents were asked about physical exercise until 2001 and about smoking until 2004. Individuals in lower occupations are more likely to smoke, with close to 50 percent of elementary workers smoking. The proportion of smoking individuals gradually decreases, with 45 percent in low-level, 38 percent in mid-level, 28 percent in high-level, and less than 24 percent in university-level occupations smoking. We also see that individuals in lower occupations are less likely to engage in physical exercise after work. 59 percent of elementary workers do not engage in any physical exercise, and this percentage gradually decreases: 52 percent of low-level, 43 percent of mid-level, 31 percent of high-level, and 27 percent of university-level occupation workers do not engage in any physical exercise.

In sum, health behaviors not only differ greatly across occupational groups; there is also a clear gradient with increasingly healthier behavior with every step on the occupational ladder. Therefore, any observed health differences across occupational groups may also reflect differences arising from health behaviors, and not only from the work situation itself. These differences in health behaviors may arise in response to occupational characteristics, but they may also reflect selection effects.

A related issue is that the individual makes a discrete choice from his occupational choice set and opts for a basket of occupational attributes. Each occupation is characterized by psychosocial and physical workplace conditions. Occupations with heavy manual work duties may simultaneously be characterized by low job control – the degree of control that an employee has over his daily activities. Researchers should be careful in attributing certain health effects of an occupation to a specific attribute if this characteristic is simultaneously associated with other characteristics within occupational types.

In the POLS survey, individuals are asked to describe the characteristics of their job. The survey includes information on physical demands (from 1997 to 2004), inconvenient work postures and repetitive work movements (from 1997 to 2002). Information on psychosocial aspects of the job including time pressure and control over daily activities at work (from 1997 to 1998) was collected in the POLS health module, which is based on a subsample of POLS respondents. Table 3 shows clear gradients in both physical and psychosocial job characteristics favoring the higher occupations. The only exception is working under time pressure, which we find to be reported more often among the higher-ranked occupations.

Occupation level	Physically demanding	Inconve-nient work postures	Repetitive work movements	Control over execution of duties	Under time pressure
Elementary	58%	39%	70%	63%	49%
Low	51%	40%	63%	68%	54%
Mid	39%	39%	57%	81%	70%
High	16%	19%	39%	81%	72%
University	9%	18%	41%	94%	86%

Table 3. Occupational class and occupational attributes. Percentage of respondents sometimes or regularly exposed to respective occupational attribute versus no exposure.

4. Does occupation affect health? A review of the literature

The theoretical framework outlined in the previous section provides some important implications for the empirical literature. This section translates the theoretical insights into empirical challenges, and assesses the contributions of the empirical literature, exploring the extent to which empirical studies to date have succeeded in overcoming these challenges. We focus on the general health effects of occupational characteristics, and hence do not discuss specific occupations. We leave the assessment of the effects of non-ergonomic physical workplace conditions (such as exposure to radiation and biochemical agents) to specialized researchers, since these issues affect only a limited number of workers and therefore are beyond the scope of the present paper. Finally, we will not discuss the health effects of job losses, contractual conditions, or the differential probability of job loss by occupation.[3]

4.1 Descriptive evidence of association

'(...) even among middle-class office workers, lower ranking staff suffer much more disease and earlier death than higher ranking staff' (Wilkinson and Marmot 2003). Abundant literature documents strong associations between type of occupation and health (see Marmot et al. 1999, Goodman 1999, and Mackenbach et al. 2008) for excellent reviews. Yet, most of the epidemiological literature often focuses on very specific occupations (e.g. Niedhammer et al. 1998 for the French Gazel cohort study), or specific health conditions. Regarding the latter, a lot is known on the association between occupational characteristics and (i)

3 As in recent contributions by Eliason (2009), Robone et al. (2011), and Sullivan (2009).

the risk of heart diseases (e.g. Marmot et al. 1997; Hemingway and Marmot 1999), (ii) asthma (e.g. Kogevinas et al. 1999), (iii) musculoskeletal disorders (Bernard 1997; Burdorf and Sorock 1997), and (iv) depression (Rugulies et al. 2006). For an overview, see Erikson and Torssander (2008). Here we restrict ourselves to the literature that focuses on the broader picture of the relationship between occupation and health outcomes.

Although the economic literature has devoted relatively little attention to the relationship between occupation and health, interest has grown in recent years. Case and Deaton (2005) describe patterns in the US *National Health Interview Survey* (NHIS) data that suggest that manual work may cause health to decline more rapidly with age than non-manual work. They aggregate type of work and make a dichotomous distinction between manual and non-manual occupations. They show that, on average, SAH of manual workers is significantly worse – and declines more rapidly – than SAH of non-manual workers, and even more so for workers at older ages. Cutler et al. (2011) show relatively large differences in the five-year mortality rate across occupational groups using the same US NHIS data, linked to the cause of death register. While managerial and professional occupations have a five-year age-sex adjusted mortality rate of 0.015, the manual workers' rate is 0.023. They interpret these differences as mostly due to differences in rank. Morefield et al. (2011) take the analysis one step further by exploiting the longitudinal *Panel Study of Income Dynamics* (PSID) to explore the cumulative effects of blue- versus white-collar work on dichotomized self-reported health while controlling for average health over the last five years and other control variables. They report that five years of blue-collar employment is associated with

a 4 to 5 percent increase in the probability of moving from good to poor health.

While clearly informative, and suggestive of an effect of occupation on health, the theoretical framework of the previous section indicates that these studies have limited ability to (i) establish a causal effect of occupational demands on health (cf. core insight 1 of the theory), and (ii) distinguish the direct effect of occupation from other indirect lifestyle effects (cf. core insight 2 of the theory). In the following subsections we follow the same structure as in the theory by discussing empirical contributions divided into these two core insights of the theory.

4.2 Empirical evidence on selection and the estimation of causal effects

Several recent papers attempt to go beyond the description of the occupation–health association and to estimate the health *effects* of occupation. One strand in this literature has focused on *first occupation*, on the grounds that the first occupational choice is predetermined with respect to current health and constitutes one type of many choices made in early adulthood which may have long-lasting effects on health later in life. Sindelar et al. (2007), examining this long term association using the PSID data, find that people whose first occupation was as a professional or a manager are less likely to report fair or poor health and to suffer from a heart attack. In later work, Fletcher and Sindelar (2009) acknowledge the endogeneity of first occupational choice and use father's occupation during childhood and the proportion of blue-collar workers in the state as instrumental variables for first occupation. They confirm that first occupation in a blue-collar occupation has a negative effect on SAH.

Fletcher (2012) uses the *Wisconsin Longitudinal Study* to describe the association between first occupation and health outcomes up to 50 years later for a cohort of high-school graduates in Wisconsin. First occupation is measured both as a binary indicator of blue-collar work, but additionally as a vector of adverse job conditions using the link with Dictionary of Occupational Titles (DOT). Fletcher is able to control for a battery of pre-determined control variables such as intelligence and family background, and additionally runs sibling fixed-effects models to reduce endogeneity concerns. Fletcher presents evidence that a large part of the association between initial occupation and health evaporates as soon as one controls for intelligence, family background and sibling fixed effects, suggesting that selection into occupation on basis of individual characteristics is very important. The association between initial occupation – whether measured by blue-collar work or adverse job conditions – differs substantially across gender and by health outcome, and only a few of the associations are statistically significant in the sibling fixed-effects model.

Using the US PSID, Kelly et al. (2011) also estimate the impact of first occupation, but focus on health behaviors rather than health. The authors use (i) a method of internal instruments developed by Lewbel (2007), and (ii) a method proposed by Altonji et al. (2005) to deal with selection into occupation on the basis of unobserved factors. The latter technique imposes a correlation between unobservable factors and assumes that the degree of sorting on the basis of observables is equal to the degree of sorting on the basis of unobservables. Their results indicate that the effect of occupation on health may be (partly) transmitted through lifestyle factors.

A second strand in this literature has focused on the (cumulative) impact of *current occupation*. Datta Gupta and

Kristensen (2008) compare the effect of a subjective assessment of the work environment on self-reported health and the presence of a limitation in activities of daily living (ADL) across Denmark, France and Spain using the *European Community Household Panel* (ECHP). The authors estimate a random-effects ordered probit model where the random effect is modeled as a function of the mean of the explanatory variables and initial health following Mundlak (1978). The results indicate that having a satisfactory job environment improves self-reported health and reduced ADL limitations in all three countries, where the effect is larger in France and Denmark compared to Spain.

Cottini and Lucifora (2010) take a similar approach by comparing the effects of workplace attributes on mental health across 15 European countries using the *European Working Conditions Survey* (EWCS). They estimate an ordered probit model for mental health distress and include country fixed effects alongside a set of demographic and socioeconomic control variables. Their results indicate that adverse working conditions negatively affect mental health, with the largest effect due to working at very high speed and under tight deadlines, with low job autonomy, and being involved in complex tasks. As robustness checks they investigate heterogeneous response styles across job satisfaction and acknowledge that job satisfaction could affect reporting of mental health problems, such that the impact of job conditions on mental health will be a composite effect of reporting and a true health effect. They also seek to address the potential problem of endogeneity of job conditions by instrumenting an index measure of working conditions by (i) an index of regulation of occupational health and safety by country, and (ii) an index of job control defined by industry and occupation. Both instruments are based upon the idea that institutions or competition at an aggregate

level are plausibly exogenous to the working conditions in a particular firm. Estimates exploiting these instruments show even larger effects of working conditions on mental health.

Cottini and Ghinetti (2011) use the *Danish Work Environment Cohort Study* (DWECS), a panel survey with detailed information on self-reported physical and psychosocial workplace conditions and physical and mental health matched to administrative data on labor market histories. They estimate three equations jointly – one for the health outcome, one for lifestyles, and one for work conditions using a recursive multivariate probit model with arbitrary correlation between the error terms of the three equations to account for the endogeneity of job conditions and lifestyles. Results show that adverse working conditions reduce especially mental health. Given that the authors use no more than two waves of the panel, inclusion of lagged dependent variables or fixed effects is considered to be too demanding, and no exclusion restrictions are used to improve the statistical inference. While statistically the model is still identified on the basis of the non-linear functional form, serious doubts can be casted on the robustness of the results of multivariate models without exclusion restrictions (Keane 1992; Altonji et al. 2005).

Fletcher et al. (2011) combine information on physical requirements of work and environmental conditions in the *Dictionary of Occupational Titles* (DOT) with the US PSID, linking both sources using three-digit occupational classifications. Occupational exposure to adverse conditions is measured as the aggregated score across the last five years. They use a random effects ordered probit model to regress SAH on the five-year average scores of physical requirements of work and harsh environmental conditions. They include initial health and a five-period lagged health variable in their model to control for time-

invariant and time-varying factors that may affect both health and type of occupation. The results of Fletcher et al. suggest that physical demands have a strong negative effect for white women but not for men and non-white women, and that environmental conditions have a strong negative effect for young men but not for young women.

Robone et al. (2011) use twelve waves of the *British Household Panel Survey* (BHPS) to estimate the impact of contractual and working conditions on self-reported health. In their paper, working conditions here do not refer to the direct physical or psychosocial demands, but reflect overtime hours, managerial supervision, promotion opportunities, preferences for work hours, and the location of the workplace. The authors estimate a random effects ordered probit model controlling for a lagged dependent variable, to reduce endogeneity concerns. To allow for possible correlation between the random effect and other regressors, the random effect is modeled in a Mundlak-specification as a function of the mean of the time-varying covariates and the initial value of health. Results differ a lot by gender, but overall there seems to be a positive health effect of working from home, and negative health effects of working more hours than preferred and having fewer promotion opportunities.

Ravesteijn et al. (2013) employ dynamic panel data methods to account for health-related selection into occupation. They find that (for Germany, and looking at self-rated health) a one-year exposure to a one-standard-deviation increase in physical workplace conditions leads to an immediate effect on health that is comparable to the average health deterioration of aging six months. This accounts for approximately 50 percent of the association between physical workplace conditions and health and the estimates indicate that the effect is stronger at older ages.

A low degree of control over daily activities at work is harmful to health, but only at older ages.

Summary and assessment – There is a strong association between *first* occupation being blue collar and later life health outcomes. Yet, a large part of the association disappears as soon as one controls for intelligence, family background and sibling fixed effects, suggesting that selection into occupation on the basis of individual characteristics is very important (Fletcher 2012). In order to overcome these selection issues, instrumental variables such as father's occupation and the proportion of blue-collar workers in the state at labor force entry have been proposed (Fletcher and Sindelar 2009; Fletcher 2012). These sources of exogenous variation are, however, not completely satisfying. First, Kelly et al. (2011) question the statistical strength ("relevance") of the two instrumental variables; second, exogeneity of these instrumental variables seems questionable, since father's occupation and state level macroeconomic variables are likely to affect health through other channels than occupation alone. Father's occupation will be correlated with household income throughout childhood, which may affect health through an unhealthy diet or other channels. High state employment levels may be associated with low per capita statewide healthcare spending, which could indicate a lower level of preventive and curative care. The approach suggested by Altonji et al. (2005) and adopted by Kelly et al. (2011) to estimate the impact of first occupation on health behaviors is gaining popularity and seems promising to also estimate the effect of occupation on health outcomes.

In the literature on the effects of *current* occupation on health, most scholars have used panel data, which allows them to include lagged values of health to alleviate reverse-causality concerns.

Often, this is accompanied by a random effects specification to account for unobserved heterogeneity. The assumption of this method is that random effects are not associated with the covariates. Yet, since lagged health is one of the covariates in the regression, this assumption does not hold and the estimation procedure yields inconsistent results. Datta-Gupta and Kristensen (2008) and Robone et al. (2011) attempt to mitigate these concerns by modeling the random effect as a function of time-invariant observed characteristics, which seems methodologically a promising attempt. Ravesteijn et al. (2013) focus on linear fixed effects and lagged dependent variable estimators, and provide a solid theoretical justification for their empirical strategy. Another potentially fruitful avenue is Cottini and Lucifora's (2010) attempt to exploit exogenous variation in a regulation index of occupational health and safety by country, and an index of high performance work organization defined by industry and occupation. The aforementioned studies all show relatively strong effects of current occupation on (mental) health.

It is particularly difficult to measure c*umulative* effects of occupation on health. Especially in the case of occupation, the health effects of exposure to adverse job conditions may only become apparent after several years. Apart from the usual data limitations that work histories are not fully observed, there are also methodological challenges to estimate these cumulative effects. For example, Fletcher et al. (2011) estimate the effect of five-year averages of job characteristics on current health while controlling for health five years earlier in order to reduce reverse-causality concerns. Clearly this effort is to be applauded, as it tries to estimate the effect of a five-year exposure to adverse working conditions. Yet, it may result in biased estimates if events during the past five years, such as a car accident, have affected both

occupation and health. A serious car accident is likely to impact on health, but may additionally lead a person to switch jobs, such that the health effects of the accident might be attributed to the occupational switch if the accident is not observed. These time-varying unobserved factors may be less of an issue when focusing on the effects of current occupation on health, since in this case one can include health lagged one period. Lagged health is likely to pick up potential time-varying confounding events over the past years, such that the direct occupational effect can be estimated cleanly. In sum, it is a very serious challenge to estimate cumulative effects of job conditions on health with non-experimental data.

4.3 Empirical evidence on compensating mechanisms and which occupational attributes matter

The most influential idea on compensation is without any doubt the compensating wage differential, which dates back to the early work of Adam Smith (1776). Smith's idea is that the total package of benefits and costs of all occupations must be perfectly equal; otherwise, employees would switch to the occupation with the greatest relative advantages up to the point where these advantages would return to the level of other occupations. The work by Adam Smith has led to a massive volume of empirical tests, where studies find a clear wage premium associated with increased mortality risk (Smith 1979). The evidence is more mixed, but growing, for non-fatal morbidity risks (e.g. Duncan and Holmlund 1983; Rosen 1986; Viscusi 2004). The theoretical appeal and empirical confirmation of wage premiums associated with increased health and mortality risks additionally has proven to be one of the most fruitful avenues for obtaining reliable estimates

of the value of a statistical life (see Viscusi and Aldi 2003, for an excellent review).

While the compensating wage differential mainly refers to *ex ante* compensation – individuals receive financial compensation for engaging in health-depleting or risky work – the overall compensation effect can be much broader than this. We argue that the overall compensation effect consists of the whole set of behaviors associated with a certain type of occupation. For example, the additional income earned by engaging in health-depleting work may be spent on health care to offset (part of) the health decline; yet, it may also be spent on unhealthy consumption, which would reinforce the health-depleting effect of certain occupations. Moreover, if workers in some occupations are simply engaging in more health-depleting consumption (such as smoking), or health enhancing activities (such as sports), due to e.g. peer effects or encouragement of the employer, then this constitutes an important *indirect* effect of occupation on health.

It is imperative to distinguish between the direct health effects of harmful occupational characteristics (the structural, direct effect of occupational characteristics such as heavy lifting or monotonous work) and the indirect effects through adjustment of consumption patterns and the amount of time spent working. In simple terms, if only manual workers are smoking, one may erroneously attribute the health differential across manual and non-manual workers to the manual aspect of the job, whereas in fact it is smoking that causes the disparities in health.

While very few studies have directly investigated the effects of occupation on compensating health behaviors[4], the association

4 See Landsbergis et al. (1998) and Moon and Kim (2001) for the effect of occupation on smoking, and Theorell (2000) for a general review of the epidemiological literature on occupation and health behaviors.

between education and health behaviors is well known (e.g. Kenkel 1991; Cutler and Lleras-Muney 2010). Our own descriptive analysis illustrates the non-surprising finding that health behaviors differ considerably across occupational groups. Choo and Denny (2006) use the *Canadian Community Health Survey* (CCHS) to show how manual work is associated with self-reported health over the life cycle. They control for an extensive set of lifestyle factors, and conclude that even though the effect of manual work is reduced by around 10 percent after including health behaviors, there seems to be an independent effect on health over and above any differences in lifestyle across occupations. Cutler et al. (2011) observe that, after controlling for health behaviors, the differences in health across occupational groups diminish, suggesting that differential health behaviors across occupational groups play an important role in the observed health disparities by occupation, but do not explain all occupational differences in health.

Lakdawalla and Philipson (2007) use the *National Longitudinal Study of Youth* 1979 (NLSY) and link this with the Dictionary of Occupational Titles (DOT). The authors investigate the relationship between cumulative exposure to physical demands of jobs and weight. Their results indicate that men in the most fitness-demanding occupations are 14 percent lighter than men employed in the least fitness-demanding occupations. Additionally, men in the most strength-demanding occupations are 15 percent heavier than men in the least strength-demanding occupations.

Kelly et al. (2011) claim to be the first to estimate the causal impact of first occupation on health behaviors such as obesity, smoking and physical activity. As mentioned before, apart from instrumental variables estimation, the authors use a method proposed by Altonji et al. (2005) to deal with selection into

occupation on the basis of unobserved factors. They find that entering the labor market as a blue-collar worker raises the probabilities of obesity by 4 percent and of smoking by 3 percent.

Summary and assessment – While the specific literature on the effects of occupation on health behaviors is surprisingly thin, it has been established that health behaviors differ substantially across occupational groups. As shown by Kelly et al. (2011), these differences are, at least partly, causally related to one's first occupation. This indicates that the effect of occupation on health will be – at least in part – transmitted through lifestyle factors. Yet studies controlling for health behaviors still find health differences across occupational groups, suggesting that not all of the health differentials across occupations can be attributed to health behaviors alone.

Which occupational aspects matter?

There is a large body of evidence – mostly from the epidemiological literature – indicating that physiological and psychological workplace conditions can harm health. It does not require an elaborate theory to argue that harsh physical conditions at work could harm health, and indeed several empirical studies have indeed linked manual work and physiological workplace conditions to poor health outcomes. The general picture is that physically demanding work is harmful to health, especially at older ages (e.g. Bernard 1997; Case and Deaton 2005). The main complication is that occupational characteristics (such as harsh physical conditions) tend to be accompanied by adverse psychosocial characteristics of the job, which makes it hard to disentangle the effects of physical work *per se*.

In contrast to the literature on physical job demands, there is a wealth of theoretical contributions in the field of psychosocial job demands. One of the most influential contributions is Karasek's stress-management model of job strain (1979). Karasek was the first to explicitly distinguish between decision latitude and job demands. Decision latitude refers to worker decision autonomy (job control) – that is, the degree to which a worker can influence his workplace situation. Job demands are simply stressors on the job. In Karasek's model, increased decision latitude reduces mental strain while increased job demands lead to higher mental strain. He defines job strain as the interaction effect between decision latitude and job demands. According to Karasek, pooling these two job characteristics in a single index would mean that the positive and negative effects of job strain would cancel out. A potential implication of the model is that job strain can be reduced by giving workers more control over their job, without lowering job demands and thereby productivity.

Karasek uses US and Swedish data to test the implications of his stress-management model. He constructs a variable to indicate "decision latitude" on the basis of the skill level, whether the job is monotonous, and the extent to which the worker can make his own decisions, among others[5]. A variable that indicates "job demands" is constructed by combining information on whether the job requires working fast and working

5 For the US data, this variable is based on eight variables describing a job: requires a high skill level, requires employees to learn new things, involves non-repetitious work, requires creativity, allows an employee to make his own decisions, whether one can make one's own decisions and affords an employee some say over what happens. For the Swedish data, the variable that indicates the level of decision latitude is based on variables indicating the following: the skill level that is required for the job, whether the job is repetitious or monotonous and the expert rating of the required skill level.

hard[6]. Karasek constructs several measures of mental strain (including exhaustion, depression, job and life dissatisfaction, pill consumption and sick days). Karasek reports associations between job strain and mental strain and claims evidence of a causal relationship on the basis of Swedish longitudinal data. He concludes that the mental health of workers would benefit from the increased influence of organizational decisions, while job demands and productivity would remain unchanged.

A competing theoretical framework is the effort-reward imbalance model (Siegrist 1992; *Siegrist 1996*)[7]. This model compares job demands in terms of physical and psychosocial effort on the one hand, and recognition/reward in terms of wages, esteem, job stability, and available career opportunities on the other hand. Only in the case of an imbalance between effort and reward does the model predict a negative health impact. Bosma et al. (1998) compare the job demand-control model of Karasek and the effort-reward imbalance model of Siegrist (1996) using data from the Whitehall II study. They confirm that the imbalance between personal efforts and rewards predicts higher risk of coronary heart disease – in line with the model by Siegrist. They also confirm that low job control in itself is strongly related to heart disease, while job strain or more generally high job demands are not.

The findings of the *Whitehall I and II studies* by Marmot et al. (1984; 1991; 1997) brought the concepts of "rank" and "social status" into the theory on psychosocial job demands. The first

6 In the US data, this variable is based on variables such as whether the job requires working fast or working hard, whether there is a great deal to be done, not enough time, excessive work or no time to finish, and whether there are conflicting demands. In the Swedish data, job demand is constructed from variables indicating a hectic job and a psychologically demanding job.

7 See Bakker and Demerouti (2007) for a complete overview and review of the two models and proposed alternatives.

Whitehall study, which began in 1967, showed that male British civil servants in low employment grades suffered from higher mortality rates than their colleagues in high employment grades, despite a great deal of homogeneity across the six employment grades. After ten years, mortality for the highest employment grade was about one-third of the mortality rate of the lowest from a wide range of causes of death. For example, administrators showed only half the death rate of clerical personnel. In the Whitehall II study, a new cohort of civil servants, both men and women, was established in the mid-eighties to investigate the causes of these disparities in mortality rates. Whitehall II shows that differences in morbidity between highest-status and lowest-status civil servant jobs were still high in the eighties, and only a quarter of these differences in coronary and other diseases between employment grades could be explained by established coronary risk factors. Marmot and his colleagues argue that differences in health outcomes between civil servants of higher and lower rank are due primarily to seniority in the employment hierarchy – rank. They show that low job control seems important, yet they reject the hypothesis of Karasek that high demand at work plays an important role.

The earlier mentioned study by Fletcher et al. (2011) is the first study in the field of economics to investigate the effect of physical requirements of work and environmental conditions on worker's self-reported health using the US *Panel Study of Income Dynamics* (PSID) linked with the DOT. The authors use one assessment of physical demands needed and combine several assessments of the environmental conditions into a scale using principal component analysis. The physical demands category they focus on is strength, which is expressed by one of five terms: Sedentary, Light, Medium, Heavy, and Very Heavy. They add the Strength and Environmental

Exposure scales over the last five years to obtain a cumulative scale of physical and environmental conditions. The results show that both physical demands and harsh environmental conditions harm self-reported health.

Fletcher (2012) uses the *Wisconsin Longitudinal Study* linked to the DOT to construct a 'bad job' factor that includes ten job conditions: (1) working for the presumed good of people, (2) activities resulting in the prestige or esteem of others, (3) general educational development, (4) adaptability to performing under stress when confronted with emergency, critical, unusual or dangerous situations, (5) job involves hazards, (6) job involves extreme heat with or without temperature changes, (7) job involves noise or vibrations, (8) physical demands scale, (9) activities of a concrete, routine or organized nature, and (10) demands climbing or balancing. Although Fletcher shows that starting your career in a 'bad job' is detrimental for later life self-reported health, he is unable to disentangle the individual contributions of the ten job conditions.

Cottini and Lucifora (2010) use the European Working Conditions Survey and show that adverse working conditions negatively affect mental health, with the largest effect being due to working at very high speed and under tight deadlines, with low job autonomy, and being involved in complex tasks.

Summary and assessment – There is no disputing the fact that physical demands at the workplace matter for health. Both from the epidemiological literature and the recent studies by Fletcher et al. (2011) and Ravesteijn et al. (2013) it becomes clear that harsh physical conditions could lead to musculoskeletal conditions and worse health in general.

There is more controversy surrounding the question whether and how psychosocial aspects of the job matter for health. Very interesting theoretical contributions have been offered by the work of Karasek, Siegrist, and Marmot, to name a few. Yet, empirical tests of these models have not always succeeded in resolving the issues with regard to (i) selection into occupation, as mentioned in section 3.3, and (ii) the clustering of physical and psychosocial job conditions, as mentioned in the previous section. For example, the weak point of the empirical analysis by Karasek is the use of composite measures. Decision latitude combines information on the required skill level of the worker with information on the level of decision authority of the job. It is unclear whether the association with mental strain stems from the characteristics of the job or those of the worker himself. If highly educated people are generally less likely to suffer from mental strain, then education could act as an omitted variable, affecting both decision latitude and mental strain. Even the analysis of the longitudinal data does not present conclusive evidence of a causal relationship, since it does not take into account that unobserved events may have influenced both type of work and mental strain. Nevertheless, the association between decision latitude and mental strain merits further investigation.

A similar problem holds for the work of Marmot and his colleagues, whose use of an index of decision latitude potentially suffers from the same omitted variable bias as in the analysis of Karasek. The effect that is attributed to decision latitude may in fact be caused by elements of socioeconomic status that were not controlled for. Case and Paxson (2011) point to another form of selection bias in their re-examination of the Whitehall II data. The authors confirm that entry grade and current occupational grade at Whitehall are significantly related to SAH in later years

of the study, yet show that their significance is eliminated by the addition of controls for members' *future* occupational grades. This suggests that occupational grade may be more of a marker of poorer health than a cause of poorer health. Using first-difference models of SAH and occupational grade, they find *no* association between current civil service grade and future SAH. In contrast, they *do* find a significant association between current SAH and future civil service grade. These findings support the health selection hypothesis and do not support the hypothesis that social position in adulthood influences changes in health status[8].

The work by Fletcher et al. (2011) is a major contribution towards opening up the black box containing the occupational characteristics that matter to health – in sharp contrast to the common binary classifications economists employ (such as blue vs. white collar, or manual vs. non-manual workers). Yet, a limitation is that the DOT primarily focuses on physical conditions of work. Since physical occupational requirements may be correlated with psychosocial workplace conditions, the authors still may be estimating the joint effect of high physical requirements and low control possibilities at work. Ravesteijn et al. (2013) – arguably present the best evidence on the causal effect of workplace conditions to date using a Finnish Job Exposure Matrix including both physical and psychosocial occupational attributes. They find a negative effect of physical workplace conditions on health, and a negative effect of low job control at older ages. However, even with high-quality data, it is impossible to separate contemporaneous effects of occupation and health investments without making heroic functional form assumptions.

8 A recent study by Anderson and Marmot (2012) does find evidence that promotion on the job reduces the risk of heart disease.

5. Policy implications and research agenda

5.1 Main findings

In the Netherlands, apart from well-documented differences in self-assessed health, workers in university-level occupations are between 56 and 70 percent less likely to enter disability than elementary workers, and between 38 and 61 percent less likely to die at any given age. While this evidence tends to be taken as a reason for societal concern, both in general from a fairness perspective, and more specifically in relation to the proposed increase in the statutory retirement age, the association in itself is not sufficient to guide policy makers wanting to address these concerns. For a proper evidence-based policy response, more information is required on the mechanisms generating the association, both of a theoretical and an empirical nature.

In order to understand those differences in health across occupational groups, we sketched a dynamic theoretical model of individual behavior that describes optimal individual choices with respect to occupation and health, given the constraints imposed by their endowments and institutions. From the model we derived two core insights, which are illustrated with empirical evidence: (i) there is selection into occupation on basis of initial endowments, education, and health, (ii) the total effect of occupation comprises physical and psychosocial job demands, but additionally there will be behavioral responses to adverse working conditions, which can be compensating in the form of medical care and healthy consumption, or aggravating in terms of unhealthy behaviors.

We reviewed the knowledge to date, exploring both theoretical approaches that are able to explain the observed patterns, and the empirical evidence to date on the mechanisms underlying the linkages between occupation and health from an economic

perspective. We used the two core theoretical insights to structure our review of the existing literature on what is (not) known on the effects of occupation on health. Our reading of the literature is that at least half of the association between occupation and health is due to a selection effect, which reflects deeper disparities in health on the basis of socioeconomic background. Yet, recent evidence suggests that there also exists a causal effect of occupation on health, which mainly derives from physical work conditions and low job control at older ages.

5.2 Retirement policies in the Netherlands

In June and July of 2012, both houses of the Dutch parliament decided to gradually increase the Dutch statutory retirement age by two years, from 65 to 67 years old. The reform affected eligibility ages for both public pension benefits (AOW), which are equal for all recipients, and private pension benefits, which are related to contributions. Differentiation on the basis of occupational attributes or socioeconomic characteristics was on the negotiation table until the final stages of the negotiation process. A report by the Ministry of Social Affairs and Employment discusses the possibility of linking the retirement age to life expectancy or to the number of working years (Ministry of Social Affairs and Employment, 2009). Retirement after a given number of years in paid employment would lead to earlier retirement for individuals with lower levels of education, who are more likely to have lower incomes and to be in physically demanding occupations. The report expresses the desirability of policies designed to shield workers from workplace conditions that are very detrimental to health and emphasizes the need for timely career development guidance for older workers who are especially vulnerable to demanding workplace conditions, but who may still be able to

work in less demanding occupations. The report acknowledges that these policies have been implemented only recently and that older workers have not been able to anticipate the increase of the retirement age. The report makes a call for negotiations between employers and labor unions to define "hard" occupations, and proposes that older workers with a long work history in hard occupations be exempted from the increase in the statutory retirement age.

Eventually, the increase of the retirement age was passed into law with some haste, within three months after the resignation of the government in 2012, and before the elections. A coalition of the Christian, liberal, and green parties passed into law a uniform, gradual increase of the retirement age, thereby disregarding the pension agreement between employers and labor unions that had been reached seven months earlier. After the elections several months later, the new government of the labor party and the liberal party agreed to slightly amend the plans to more rapidly increase the retirement age such that it would reach 67 in 2021, but to simultaneously compensate older workers who had not been able to anticipate the higher retirement age. Workers between the ages of 61 to 65 with incomes between 16,000 and 32,000 Euros receive a bonus payment which peaks around the minimum wage of 18,000 Euros. The expenditures on these bonus payments are predicted to amount to 200 million Euros annually (CPB 2012). In 2011, the total household income of about 30 percent of households with a breadwinner between the age of 55 and 64 was in this income range –but one would expect that this overestimates the proportion of workers that are compensated by the bonus payments, because these are based on individual labor income for workers between 61 and 65 years old (CBS 2013).

5.3 Policy goals in the presence of a causal effect of occupation on health

To the extent that physical and psychosocial workplace conditions causally affect health, policymakers may choose to compensate the "losers" and to differentiate the retirement age depending on each individual's occupational history. Raising the statutory retirement age would especially hurt manual workers and workers with low job control. Workers with a long work history in demanding occupations, such as elementary- or low-level workers, could be allowed to retire at an earlier age if policymakers want to offset the inequality-enhancing consequences of the rise in the statutory retirement age. Similarly, workers in physically less-demanding occupations could be required to work until an older age.

It is important to keep in mind that (part of) the harmful effects of workplace conditions may already have received monetary compensation of the health risks by the employer through wage differentials. "Double compensation" of unhealthy work is to be avoided. On the other hand, to the extent that individuals in "hard" occupations can expect shorter life spans, they contribute to a collective pension scheme that they are less likely to benefit from. As we showed earlier, an estimated 16 percent of elementary workers do not even reach the age of 67, as opposed to 8 percent of university level workers. Therefore, the proportion of workers who contribute to the pension scheme but do not reach the statutory retirement age is twice as large for those in physically demanding occupations. And while in retirement, they also have much lower probabilities of reaching their 70th, 80th, 90th, etc. birthdays.

This begs the related question of whether retirement itself has an effect on health. Possibly, being idle due to (early)

retirement may be more harmful to health than even the hardest occupations. This would imply that differentiating (early) retirement by occupation might even increase the health inequalities. Recently, researchers reported mixed evidence of both positive and negative effects of retirement on health. Coe and Zamarro (2010), for instance, find a positive impact of retirement on health. Some of their results suggest that these effects are temporary, while others indicate a long-lasting effect. On the other hand, Bonsang et al. (2012) find that retirement has a negative effect on cognitive functioning, suggesting that prolonged labor force participation has positive consequences for mental health. Due to the conflicting evidence, we do not take into account the health effects of retirement itself, as far as our policy recommendations are concerned.

5.4 Policy goals if occupation is a marker of socioeconomic inequalities in health

To the extent that occupational type does *not* causally affect health, but only reflects deeper socioeconomic inequalities, occupation may just be a marker for poor endowments or a series of adverse health shocks. Since life expectancy is worse for people who are lower on the occupational ladder, a uniform increase of the retirement age will harm the welfare of these people disproportionately because it reduce their remaining lifetime in retirement by a larger proportion.

Health investment and occupational choice have opposite roles in our theoretical framework. Health investment improves health but comes at a monetary cost, while hard occupations are harmful to health but lead to higher earnings. Agents face a trade-off between health and consumption, with health yielding future benefits due to higher future earnings. Individuals who

do not invest in health can therefore afford higher consumption levels. The resulting disparities in health therefore may not reflect disparities in utility: some people simply choose to let their health deteriorate because they value consumption more. This could explain the decision to smoke or adopt an unhealthy diet, which can be viewed as negative health investment. From a fairness perspective, governments should not compensate individuals in poor health who might have "sold" their health by adopting unhealthy behaviors from which they derive utility. This would amount to a subsidy of unhealthy behavior.

A uniform increase of the statutory retirement age would hurt individuals with unhealthy behaviors in countries such as the Netherlands, where part of pension contributions are compulsory. It would lead to a larger proportional reduction of pension benefits for individuals with unhealthy lifestyles: their pension contributions are equal to the contributions of healthy individuals, while their pension benefits are cut by a larger fraction. A uniform increase of the statutory retirement age is therefore equivalent to a tax on unhealthy behaviors: it would have a negative effect on the difference between pension contributions and pension benefits for individuals with a lower life expectancy because of unhealthy behaviors. This would especially hurt individuals with low education and income, who are more likely to adopt an unhealthy lifestyle. For example, they are more likely to smoke or to be overweight (Cutler et al. 2011). This implies that a uniform increase in the statutory retirement age would favor the rich and highly educated individuals at the expense of individuals in lower socioeconomic classes.

Individuals are likely to respond to an increase of the "tax" on unhealthy behavior by adjusting their health investments, but the direction is not clear *ex ante*. Individuals could increase

health investments to increase their life expectancy beyond the age of 67, in order to reap the benefits of retirement. However, the benefits of extending life expectancy between the ages of 65 and 67 are reduced by the increase of the statutory retirement age, which could lead to lower health investment. Or quite possibly, individuals may believe that their behavior will not meaningfully alter their life expectancy and will not adjust their behavior. Which of these effects dominates is an empirical question.

We've seen that a uniform increase of the retirement age may disincentivize unhealthy behavior because the benefits of living beyond the age of 67 increase. This may be desirable from the perspective of the individual if individuals fail to maximize their life-time utility – for example, because they lack the necessary information. However, if individuals have full information, they may purposefully choose an unhealthy lifestyle when maximizing utility. This reasoning, along the lines of the rational addiction model (Becker and Murphy 1988), would imply that distortion through such a "tax" on unhealthy behavior would in fact reduce individual lifetime utility. Living in good health is not always optimal from the point of view of the individual. A discussion of the social desirability of disincentivizing unhealthy behavior should address the question whether intervention is desirable from the perspective of the individual.

We have argued that a uniform increase of the statutory retirement age favors the wealthy in terms of its distributional implications. Alternatively, a differentiated retirement age could be either distributionally neutral or pro-poor – for example if poorly educated, low-income individuals in "hard" occupations were allowed to retire at a younger age. Although we may not want to reward individuals for adopting unhealthy behaviors by exempting them from the higher retirement age, policymakers may wish

to compensate individuals with a bad set of initial endowments (such as adverse childhood circumstances, or those who were unlucky to have suffered health shocks early on). These are more likely to be individuals at the lower end of the health and income distributions who are still in the labor force. Obviously, disability insurance schemes already provide some protection to less healthy individuals, who are no longer in the labor force. A mild differentiation of the retirement age would be distributionally neutral if individuals with a lower life expectancy – and thus a lower expected time in retirement (due to bad endowments or adverse shocks) – would be allowed to retire at a younger age. The differentiation in the statutory retirement age could be based on, for example, the differences in (healthy) life expectancies, as proposed by, for instance, Bovenberg et al . (2006).

5.5 Policy recommendations

Our analysis provides support for the gradual implementation of changes to the retirement age, in order to allow people to anticipate the changes and to adjust their behavior accordingly. Our policy recommendations may be summarized as follows. First, workers whose poor health is caused by occupational characteristics should be exempted to the extent that their occupational health damage was not compensated through a wage premium. This is the case for individuals with poor endowments who face a severely constrained occupational choice set. Physical workplace conditions seem most detrimental to the health of workers in elementary and low occupations, who are most exposed to physically demanding occupational attributes. Workers at older ages should receive assistance with respect to career development aimed at maintaining their productivity.

Workers in physically demanding occupations may be financially compensated because they disproportionately suffer from a uniform increase in the retirement age. The extent to which Dutch bonus payments sufficiently compensate these workers is unclear. The statutory retirement age should be lower for manual workers, to obtain distributional neutrality of the reform. However, the retirement age of workers in "easy" occupations could be raised even further to achieve budgetary neutrality and to reflect vast differences in health and life expectancy across occupational classes.

Current work by Ravesteijn et al. (2013) could provide some guidance on the identification of occupational characteristics that are especially harmful to health. The POLS data provides information on the degree of physical and psychosocial demands for a large set of occupational titles in the Netherlands — and this could be used to construct a ranking of occupations. A person's statutory retirement age should be based on the individual's occupational history in order to prevent strategic job switching as one nears retirement age. Currently, no information on the occupational titles, work history or educational attainment at the individual level is available in the Netherlands, in contrast to , for example, Finland. This is essential to retrospectively identify work histories. We recommend the collection of this type of information if a differentiated retirement age is considered. To some extent, new longitudinal data collection efforts initiated by TNO could fill this gap. The large annual NEA (*Nationale Enquete Arbeidsomstandigheden*; n=25,000), which has been the most important source of cross-sectional information on health and work since 2003, was recently expanded with a panel data component (n=10,000) that started in 2007 and has had annual follow-ups since. If these could be linked to the registries, then

a whole new set of research questions could be addressed. Moreover, the NEA panel was recently complemented by the international study STREAM (*Study on Transitions in Employment, Ability and Motivation*), which involves a longitudinal data collection effort among 12,000 workers in the age range of 45 to 65 from 2011 to 2013. If these efforts prove insufficient, the history of income of individuals may be used as an imperfect proxy. In the meantime, a differentiated statutory retirement age may be achieved by making the retirement age conditional on the number of years in employment, which would equally favor workers in physical occupations.

The literature suggests that at least half of the strong health disparities across occupational classes is caused by underlying socioeconomic factors. A uniform increase of the statutory retirement age disproportionately lowers the welfare of individuals with bad endowments, persistent health shocks, and unhealthy lifestyles. To achieve distributional neutrality, workers with an unlucky draw of endowments and shocks should be allowed to retire at a younger age to reflect their shorter life expectancies, while those with more lucky draws should be required to work until an older age. Occupational class is only one of many markers of poor endowments and persistent adverse health shocks. We propose using a wider array of indicators to determine the retirement age in order to prevent people from engaging in strategic behavior (such as switching occupations at a certain age to be eligible for early retirement). The retirement age should be based on a weighted index of educational attainment, occupational class and lifetime income and wealth.

This paper has presented scientific evidence on the consequences of policy proposals with respect to the statutory retirement age. As section 5.2 illustrates, political outcomes may

depend on momentum and bargaining between stakeholders. As highly detailed differentiation may be politically infeasible, policymakers may prefer broad-brush approaches –such as differentiation on the basis of income– to achieve desired distributional outcomes, or may even decide not to differentiate at all.

5.6 Research agenda

Our suggestions for future research are threefold. First, we believe much more effort should be devoted to conceiving more credible strategies to identify causal effects of occupation on health. While the panel data approaches of Datta-Gupta and Kristensen (2008), Robone et al. (2011) and Ravesteijn et al. (2013) seem promising, an alternative strategy would be to look for exogenous variation in occupational characteristics to obtain quasi-experimental evidence. An increasingly popular strategy is to exploit natural experiments: changes in regulation such as in Cottini and Lucifora (2010), unanticipated firm downsizing, plant closures, or even schooling reforms that affect occupational choices. These quasi-experimental changes generate random-like variation that can be used to study the health effects of changes in jobs and/or their characteristics. If, in addition, such information can be linked to longitudinal information on job characteristics and health, then far more powerful research designs can be used.

Second, as the theory section clearly illustrates, observed health outcomes across occupational groups may be the result of a behavioral response to changing job conditions rather than the direct effects of occupational characteristics. It is well known that health behaviors differ across occupational groups – in the Netherlands, smoking prevalence is close to 50 percent in elementary occupations versus slightly more than 20 percent in

university-level occupations. The literature suggests that at least part of these differences in health behaviors is caused by (first) occupation (Kelly et al. 2011). Future research should focus on disentangling the direct effects of occupation and the indirect effects resulting from behavioral response. For policy purposes, it makes a big difference if the health differences by occupation result from the workplace conditions themselves or from any other health-enhancing or health-harming behavior associated with occupations. A related issue is that there may also be compensation of a policy measure itself; thus, an increase of the retirement age could affect many decisions earlier in life – for example, in terms of savings or investment in education.

Third, future research should also focus on separating the contributions of the various physical and psychosocial aspects of workplaces. Failing to do so could mean that harmful effects are attributed to one occupational characteristic – while in fact this characteristic is only a marker for other latent characteristics causing the health damage. While there is convincing evidence both from the epidemiological literature (e.g. Bernard, 1997) as well as the economic literature (Fletcher et al. 2011, Ravesteijn et al. 2013) that harmful physical characteristics of occupations impact health, there is more controversy on the impact of psychosocial aspects of occupation. Since adverse physical and psychosocial job conditions tend to be clustered, much remains to be learned on the relative contributions of physical and psychosocial job aspects in relation to health. Such instruments as the DOT (*Dictionary of Occupational Titles*; US) or the FINJEM (*Finnish Job Exposure Matrix*) may be used to pin down the job characteristics that prove to be most harmful or risky to health, and these tools should be exploited more to disentangle the most health-damaging aspects of work.

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Netspar

Long and healthy careers?

In this paper Bastian Ravesteijn, Hans van Kippersluis and Eddy van Doorslaer (all EUR) investigate the relationship between occupation and health, and confirm that – also in the Netherlands in recent years – workers on a lower step of the occupational ladder on average report worse health, have a higher probability of disability and die earlier than workers in higher occupations. They sketch a theoretical framework to better understand the mechanisms underlying these disparities. This paper discusses how future research may try to overcome some of the crucial identification issues. They relate their findings to current policy issues with respect to occupational safety and the statutory retirement age, and discuss how future research could contribute to improved policy advice.