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# Trade Unions Go Global!

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# Trade Unions Go Global!

## Abstract

Worker movements played a crucial role in making workplaces safer. Workplace safety is costly for firms but increases labour supply. A laissez-faire approach leaving safety of workplaces unknown is suboptimal. Safety standards set by better-informed trade unions are output and welfare increasing. Trade between a country with trade unions (the North) and a union-free country (the South) can imply a reduction in work standards in the North. When trade unions are established in the South, the North, including northern unions, tend to lose. Quantitatively, these effects are small and overcompensated by gains in the South.

JEL Code: J51, J81, F16, F21.

Keywords: occupational health and safety, trade unions, international trade, welfare.

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# 1 Introduction

The process of economic development and growth is a process of an endless introduction of new technologies. This is especially true for the early times of industrial revolution but also for today. When new technologies are introduced, their properties are not always well-understood. While a technology might promise a very efficient provision of a certain good, the same technology could also have side-effects the inventor did not think off. The history of the introduction of new technologies is full of countless examples.

Coal was used as a source of energy at least since the Roman Empire. Systematic coal mining, however, was not undertaken until the industrial revolution required a massive and steady supply of energy. Coal seemed the perfect solution. Mining, however, has its side effects. In 1831 a potential causal link between working in a coal mine and the black lung disease was first reported by a Scottish physician. Nowadays, black lung disease is accepted as a disease caused by repeated and year-long inhalation of small amounts of coal dust. It took more than 130 years, however, until this link was generally accepted. Only in the 1960s, after extensive political activities of various worker groups in Pennsylvania, Ohio, and West Virginia on the Appalachian coal fields, the black lung disease was recognized as an occupational disease. As a consequence, the Coal Mine Health and Safety Act was passed in 1969 implying more comprehensive rules on work conditions and also compensation of disabled mine workers (Smith, 1987).

There is an abundance of further examples for health and safety implications of work, including the “brown lung” disease caused by exposure to cotton dust (Botsch, 1993), the “white lung” disease caused inter alia by mining and the exposure to asbestos (Rosner and Markovitz, 1991), the health risk caused by radium (Clark, 1997), the spray machine conflict in the early 1900s (Frounfelker, 2006) or conflicts in the pottery industry (Stern, 2003). For an overview of the literature on the history of occupational health and safety (OHS), see Judkins (1986, p. 240).

A reading of these analyses reveals that side-effects of new ways of production only gradually become known. While there might be uncertainty about health implications of a certain job, there is initially often simply ignorance about health implications, sometimes just absence of any doubt. When workers then start sensing that “something goes wrong”, that work conditions cause health problems, these claims are often met with doubt, both by employers, but also by insurance companies or even the government. These analyses also make clear that worker movements, joint collective actions of individuals, are required to raise political awareness, to lobby for changes in work conditions and to eventually have regulatory changes towards more OHS measures implemented.

Similar conclusions about the importance of worker movements to spark off broader support not only for improved working conditions but also for the development of the modern welfare state can be drawn by looking at Germany. During the industrial revolution around 1850, the issues of poverty, working and life conditions of dependent workers provoked the

creation of organizations allowing the joint expression of the workers' interests (see e.g. Schneider, 2005, p. 15). While poverty and dependent work also existed in pre-industrial times, the contemporaneous rise of wealthiness of some and poverty of others was no longer accepted as "the will of God". The first trade union in Germany, founded in June 1848 by type setters, had as objective to secure the living standards of type setters fearing competition from the steam engine and technological progress (hence, there was income orientation) but also to build up mutual health and invalidity insurance systems (Schneider, 2005, p. 27). The worker movement, represented by unions and political parties, was also spurred by occupational injuries which almost caused "mass-causalities" (Tennstedt et al. 1993, p. XXI), partly due to the widespread use of new technologies and fast economic growth. These movements and associated political pressure caused Bismarck, the German chancellor, to put - inter alia - statutory accident insurance in force in 1884.

The upshot of this discussion about historical episodes of advanced OECD countries is threefold: (i) A safe work place, OHS in short, does not come for free: Achievements of the modern welfare state which are taken for granted today were hotly disputed in the past. (ii) There is a conflict of interest between unions and firms - which goes beyond pure wage bill issues. In many cases, industry, insurance companies and often also the government initially object to any demands for compensation or changes in health standards simply because there is no clear scientific medical evidence for the claimed nexus between certain symptoms and the professional activity. (iii) Unions<sup>2</sup> played a crucial role in pushing for OHS standards and prepared and fought for what is (almost generally) accepted today as a positive aspect of modern welfare states (see e.g. Brugiavini et al. (2001, ch. II.2.1), Agell (1999, p. F144) and the discussion following below). Only once workers succeed in forming large groups and in lobbying for their joint interests, there is enough political visibility such that changes in OHS regulations take place. To put it short, in the spirit of Freeman and Medoff's (1984) "collective voice": Trade unions have a "good face" as well.

The purpose of this paper is, first, to understand why it took worker movements (rather than the government or employers) to start the development of insurance mechanisms, why worker movements eventually led to the creation of government agencies which nowadays regulate OHS and what the determinants of endogenous OHS standards are. In a second part, the paper looks at our global world today, taking a more normative approach. Nowadays, OHS is hardly an issue in advanced OECD countries.<sup>3</sup> Employees are protected against excessive exposure to chemicals, there are radiation limits for medical personnel and for computer users sitting in front of a screen or using wi-fi. Construction workers have to wear helmets and are protected against falling by safety belts and regulations on how to construct scaf-

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<sup>2</sup>We will often use 'union' as short-cut for more informal worker groups, worker movements or worker associations. Union, as used here, does not necessarily describe a well-organized and at times bureaucratic huge institution as nowadays in some OECD countries.

<sup>3</sup>There is a lively literature on appropriateness of various OHS measures in "the North" measuring costs per statistical life and this is an important issue. We claim that OHS in developed countries today is hardly an issue relative to historic standards (or developing countries).

folds. But what about developing countries? There are considerable international differences in occupational safety records. While in OECD countries the annual number of work-related fatal accidents per 100.000 employees is estimated to lie around 4, occupational accident rates rise up to 10 for India or China or even above 20 for other Asian countries or sub-saharan Africa (Hämäläinen et al., 2006). Work conditions in many developing countries today resemble work conditions in OECD countries during the industrial revolution. When countries compete with each other over international investments, do these differences constitute “un-fair competition”? Is there a risk that “globalization” (think of international capital flows, especially foreign direct investments) cuts back the welfare state? Will OHS standards in the North have to fall? Condensing these issues and formulating them in an extreme way, should a country abolish achievements of worker movements in the North and adjust to work conditions in the South or should countries rather introduce or support worker movements in the South?

We construct a model which highlights the key ingredients for understanding the importance of worker movements in the past. Jobs have two effects on workers - they provide income and they affect health. In order to keep the analysis as simple as possible, we will assume that workers are entirely ignorant about the health implications of jobs - job choice is purely based on the wage paid by the employer. Returning to the coal miner example from above, workers were simply not aware of the potential risk of the black lung disease.<sup>4</sup> We consider an economy with one homogenous good and assume perfect competition on goods and labour markets implying inter alia full employment. Given the absence of any information on health risk of working, the production process exerts a negative externality on workers’ health. OHS standards can in principle reduce this negative externality but they also reduce TFP of firms, capturing the fact that OHS is costly. As long as health effects of working are disputed, no employer or government would concede better working conditions. The role of worker movements is to provide and confirm information about health-effects of working. An individual worker does not have enough time and makes too few observations to discern job-related health effects from other health effects. A group of workers, a union, has many members and thereby more observations. Learning is much faster and unions can thereby help internalize the externality. In standard trade union models, the objective of trade unions is to maximize the wage income of their members. We extend this arguably narrow perspective and portray trade unions as targeting both for high wage income and good health standards. We then find determinants of OHS standards by letting unions set OHS standards. This monopoly view of OHS-setting unions and employment-setting firms is - as in wage-setting models of unions - a short-cut to a more complete setup with endogenous union membership where workers form groups to increase the speed of learning.

Moving the perspective from the past to our global world today, we consider a rich North

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<sup>4</sup>We see this complete ignorance as a short-cut to a Bayesian learning setup where workers have a prior about health implications and it takes time to learn the true health consequences of a job. See Viscusi (1979, 1980) for various applications of Bayesian learning to uncertainty about health implications of jobs.

and a poor South. In addition to having more capital, the North has trade unions which set OHS standards.<sup>5</sup> There are (initially) no unions active in the South and OHS standards are therefore low. We allow for free trade in the final homogenous good and capital and analyze the effects on OHS standards in the North, on output and on welfare. Finally, we let trade unions go global and analyze the effects of an increase in OHS standards in the South on welfare of the North, of the South and of the world as a whole. We also study whether northern trade unions approve of the activities of trade unions in the South.

Some of our findings are as follows: Each firm individually is opposed to higher OHS standards as they reduce TFP and thereby profits. Unlike compensating differentials setups with complete information, competitive markets here are unable to take health effects of technologies into account: individuals can not judge with sufficiently high precision to what extent a certain job affects health. The laissez-faire factor allocation is characterized by inefficiently high sickness leaves. If better-informed firm-level trade unions set OHS standards, the positive effect on more health of their members balances the negative effect of lower employment due to lower TFP. If there are economy-wide or occupational unions, OHS standards are more comprehensive as unions also take the negative health effect on overall labour supply into account. If unions are not too extreme in their health preferences, higher OHS standards than those favoured by firms increase economy-wide output and increase welfare. The presence of unions is welfare-increasing.

Capital owners<sup>6</sup> favour higher OHS standards than individual firms. Capital owners see that an economy-wide increase in health increases labour supply and thereby returns to capital owners - as long as the positive health effect is not overcompensated by the negative TFP effect. Capital owners might even favour higher OHS standards than firm-level unions! Capital owners could never, however, be at the origin of improving work standards as they simply do not feel (in the literal sense of the word) health effects. They have no incentive to form “capitalists movements” as bad working conditions do not affect them. When we compare capital owners to economy-wide unions, unions desire higher OHS standards as they value health per se (capital does not become sick but workers do). Hence, both at the firm level and at the economy-wide level there is conflict of interest between unions on the one hand and firms and capital owners, respectively, on the other. But for some range of OHS, unions and capital owners agree on increasing OHS standards. This explains why - after some initial historical dispute and controversies over OHS standards - most OHS standards in OECD countries are no longer hotly disputed today.

Turning to OHS determinants, they depend inter alia on the level of development of an

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<sup>5</sup>Many advanced countries now have government institutions which regulate OHS standards (e.g. the Occupational Safety and Health Administration in the US or the Health and Safety Executive in the UK). When we talk about unions in the North, we think of the role unions played in the past. When we talk about southern unions, we think more of the present. A dynamic version of our model with capital accumulation and evolving institutions is left for future research.

<sup>6</sup>Capital owners here and in what follows denote of a federation of all capital owners in an economy. Individuals looking only at capital income in one specific firm would never agree on higher OHS standards.

economy, i.e. here on the capital per worker endowment. When health and income are bad substitutes, union OHS standards - and also those of a planner - increase in the development level of an economy. Hence, there are no “universal labour standards” that apply to each country at each point in time.

In a global world, capital outflows to the South are the lower, the closer OHS standards in the North are to the interest rate maximizing level, i.e. the OHS level favoured by capital owners. Capital flows from the North to the South per se are generally welfare improving. As capital flows reduce wage income of workers, trade unions react to outflows by reducing northern work standards. When OHS standards in the North prior to capital flows are lower than (or equal to) the socially optimal standards, this reduction in OHS standards reduces the welfare gains in the North from opening up to trade.

When trade unions are introduced in the South and the southern OHS standards rise, average health in the South increases while TFP of firms is reduced. To the extent that this OHS increase is not too large, marginal productivity of capital in the South goes up and makes the South more attractive for investors. Higher standards in the South therefore imply an increase in capital flows towards the South - capital does *not* go to where standards are lowest. The welfare effects in the North now generally look bleak: Additional capital outflows reduce welfare, the implied reduction in OHS standards as well. The South profits from higher standards and world welfare also tends to rise. Trade unions in the North, however, do not appreciate higher standards in the South as capital outflow reduces wages and northern OHS standards. This lowers welfare of northern trade union members. Given that unions in the South unambiguously gain, there is a clear conflict of interests between northern and southern unions. To put it simple, global trade unions are a good idea - but not for trade unions in the North! Fortunately, a quantitative analysis shows that losses in the North are very small and overcompensated by gains in the South.

## 2 Related literature

Our paper is related to various strands of the literature. First, there is a policy-oriented discussion on labour standards and the effect of globalization<sup>7</sup>. Srinivasan (1996, 1998) shows that endogenous labour standards will naturally differ between countries with different levels of development - as we find in our analysis - and that diversity in labour standards is not an argument against free trade. He also states that labour standards might not be provided efficiently in the presence of some market failures. Brown, Deardorff and Stern (1996, 1998) provide a broad overview and argue *inter alia* that in the case of market failures, minimum safety standards do not automatically restore Pareto optimality. For an international trade

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<sup>7</sup>This literature in turn builds on more micro-oriented analyses of risk and regulation of which labour standards are an example. An early survey of research on labour standards is by Dickens (1984). An excellent recent introduction and overview is by Viscusi (2007).



setup, universal labour standards will not internalize country-specific inefficiencies. We will extend their arguments and focus more strongly on the issue of inefficiencies and internalization. Elliot and Freeman (2003) are more favourable to including labour standards into WTO trading rules. Maskus (2004) in his discussion agrees that “individual enterprise owners can gain from weak labor rights [...] even if the economy is generally harmed”. This is exactly our starting point and the fundamental assumption we build into our model.

Second, there is an obviously huge literature on trade unions, and it would be impossible to provide a summary here which does any justice to the various substrands. While it seems fair to argue that most contributions attribute a distorting (efficiency-reducing) role to unions<sup>8</sup>, there are also quite some economists that find positive aspects in union behaviour: Brugiavini et al. (2001, ch. II.2.1) see unions as the precursor of the modern welfare state. They write on p.163 that “unions developed mutual insurance as part of associational self-help to compensate for the lack of private insurance or public social protection. At the same time, they mobilized [...] for the expansion of social rights. Increasingly, many of the protective functions that unions provided [...] came to be taken over by the state”.<sup>9</sup> A by now well-accepted argument was made by Freeman and Medoff’s (1984): By providing a “collective voice”, unions provide information which otherwise would not be available. Malcomson (1983) argues that unions increase efficiency as they improve the allocation of risk-bearing between firms and workers. Acemoglu et al. (2001) argue that unions induce training and provide insurance and Boeri and Burda (2008) show that workers prefer collective bargaining in the presence of market imperfections. Booth (1995, ch. 3.3) discusses efficiency increasing effects of unions and Agell (1999, p. F144), more generally, argues that “certain institutions may serve quite useful purposes” in the labour market. We provide OHS standards as an example of such a useful institution. We believe that this beneficial historical aspect of worker movements for nowadays modern societies and the role unions can play in developing countries today has not received sufficient credit so far. Our contribution lies in the emphasis and analysis, in the framework of a very simple model, of the informational and learning advantage of a union in a world with incomplete information and side-effects of new technologies.

Maybe most importantly, our view of multi-feature work places is related to but differs starkly from the equalizing differences approach of Rosen (1974, 1986). Equalizing differences are traditionally derived in setups with perfect information. When workers know about all job characteristics and all markets are competitive, factor allocation is efficient and any institution would be distorting. Given the historical situation and technological examples we have in mind, perfect information on the side of workers does not appear to be a realistic assumption.

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<sup>8</sup>Distortions can have their positive sides in second best worlds or when it comes to collecting rents. See Mezzetti and Dinopoulos (1991) for an example with an employment-oriented union in an international trade setup with imperfect competition.

<sup>9</sup>Historical evidence linking union growth to their provision of insurance (strikes, unemployment, sickness, burial cost) for the Netherlands and Britain is provided by van Leeuwen (1997). Quantitative evidence for the United States for union decline due to an expanding welfare state is provided by Neumann and Rissman (1984).

We therefore choose the other extreme and assume that workers are unable to learn anything about work-related health implications. While reality certainly lies inbetween, the justification for our assumption is simple: When new technologies become available, workers and often society as a whole does not know a lot about potential side-effects. Health implications can be very long-term and workers might simply not have the time to learn about these implications. Hence, abstracting from learning processes which take a very long time, we assume right away that learning by individual workers is impossible. As a consequence, decentralized factor allocation is inefficient. Trade unions, by contrast, consisting of a large number of workers, have access to many observations about jobs, can collect this information and can therefore learn more easily. In fact, we assume that unions have perfect information and can therefore internalize externalities, increase efficiency, output and welfare.

Finally, the rapidly growing literature on child labour touches upon some aspects covered also here. For example, Doepke and Zilibotti (2005) analyse how attitudes towards child labour regulation can change over time. Baland and Robinson (2000) derive determinants of child labour and generally find that child labour is inefficient. In contrast, Krueger and Donohue (2005) find that a child-labour ban is not necessarily welfare increasing. To the extent that child labour is bad for health and safety of children, our analysis implicitly studies the effects of trade unions and globalization on child labour. In fact, Doepke and Zilibotti (2005, p. 1494) mention that the “trade union movement played a key role in lobbying for the introduction of child labour regulation”. Baland and Robinson (2000, footnote 17) make a similar point. This literature, however, does not focus on unions as an institution as we do here and does not attempt to work out the potentially beneficial effects unions and their use of their market power can have.

### 3 Occupational health and safety in a closed economy

#### 3.1 The model

Our economy produces a homogenous good. Aggregate output amounts to  $Y$ . A typical firm produces the quantity  $y$  by using a technology with total factor productivity (TFP)  $A(\cdot)$  and by employing capital  $k$  and labour  $l$ , the latter of which is measured in working hours. All firms use the same technology which is given by

$$y = A(s) f(k, l), \tag{1}$$

where capital and labour inputs have the usual neoclassical effects on output. Given our historical perspective on what are now OECD countries or our focus on developing countries today, we assume that firms can hire from a spot market. There are no hiring or firing costs and it does not take any time to find a worker.

The central focus of this paper is OHS. This aspect is reflected in the production process in the TFP component  $A(s)$ . TFP in a firm or in a country is influenced by many factors starting

from very technology-specific aspects (like the age distribution of the capital stock or the management and communication skills of staff) and going to more economy-wide influences (like the institutional stability, the political regime, or the education level of workers). The more important factor influencing TFP for our arguments is OHS  $s$ . A job is safe(r) if a worker or employee is (more) certain to return home in good health after 8 (or more) hours of work. We capture safer jobs by a higher  $s > 0$ .

Safe workplaces are clearly in the interest of the worker, and in many cases, OHS is also a central concern for employers. If safety measures increase the smoothness of a production process, employers should be in favour of high safety standards. An accident in a coal mine costing not only lives of workers but also letting the production process break down for weeks is clearly not in the interest of the firm. In many cases, however, there is a fundamental conflict of interest. In the case of low-skill workers or workers needing only general (i.e. not firm-specific) human capital to perform their job and in countries where firms do not (have to) pay sickness-leave (i.e. whenever firms can easily replace their workers), firms have no economic interest in the state of health of their workers. Quite to the contrary, OHS measures are costly. A workplace where coal miners are well protected against the black lung disease or ore miners against silicosis is more costly than one without protection measures like ventilation systems. A worker who spends half an hour on dressing and undressing (helmets, safety glasses, gloves, entire suits etc.) is less productive than a worker who starts doing his job right away. We capture these costs by letting OHS measures reduce total factor productivity,  $A_s < 0$ .<sup>10</sup> Given the spot market assumption, a sick worker would simply be replaced by a new healthy worker.

An individual values consumption  $c$  and health  $z$  and both are determined by the job an individual chooses. A job is therefore a differentiated good as in Rosen (1974). Let  $z(s, m)$  denote the share of potential working hours that an individual is healthy and can work. Currie and Madrian (1999) summarize the literature on health and labour markets. They document a positive relationship between health and income with larger effects of health on hours than on wages. While it is true that the link between health and labour market participation is less clear-cut (Currie and Madrian stress that this could be due to an abundance of methodological problems), we feel safe to assume in what follows that longer working hours  $m$  under bad OHS standards are bad for health,  $z_m < 0$ , but safety measures  $s$  improve health,  $z_s > 0$ . Utility of workers increases in consumption  $c$  and health  $z(s, m)$  but with a decreasing slope,  $u_c > 0$ ,  $u_{cc} < 0$  and  $u_z > 0$ ,  $u_{zz} < 0$ . Letting all individuals work the same number of hours  $m$ , we can suppress  $m$  and use

$$u = u(c, z(s)) \tag{2}$$

as utility function. Health is important for two reasons: It matters per se and consumption rises due to longer hours worked. All workers are identical in their preferences.

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<sup>10</sup>This is the standard assumption in the literature on compensating differentials, see e.g. Rosen (1986). If  $A$  increased in  $s$ , no uncertain jobs would every be observed. One can always imagine that  $A$  initially increases in  $s$  but decreases above some threshold level.

On the aggregate level, consumption equals output  $C = Y$  and labour demand  $L$  equals labour supply,

$$L = z(s) N. \quad (3)$$

The latter is given by potential employment  $N$  (also measured in hours and assumed to be fix) times the share  $z(s)$  of time workers are healthy and can actually work. More safety, implying more health, implies higher labour supply.

We finally turn to trade unions. Depending on the degree of centralization of the negotiations and wage setting, the literature usually classifies countries in three groups (see e.g. Calmfors and Driffill, 1988): (1) highly decentralized systems with wage setting at the firm level (i.e. USA and Canada), (2) intermediate degree of centralization (most continental European countries), and (3) highly centralized systems with wage setting at the national level (i.e. Nordic countries and Austria). We will also consider different degrees of centralization and model the two polar cases of highly decentralized and a highly centralized systems.

In a decentralized setup, unions operate at the firm level and are therefore small relative to the economy as a whole. As we view spot markets as the best description of labour markets for activities as described in the introduction, there is no attachment of workers to the firm. Hence, membership of firm-level unions is just as volatile as employment at the firm. As a consequence, the union only cares about the overall well-being of the  $l$  workers in this particular firm. As households value consumption and health, we let unions value these quantities as well. Consumption depends on capital and labour income and union members might also have some capital income. Observing union activities, however, we find it more appropriate to model unions as institutions which focus on labour income or the employment situation in general. Unions neglect the capital market position of their members and focus on the wage sum of their members. Given historical examples about union behaviour in now OECD countries and preferences of households in (2), unions also care about a worker's health and a union's utility function reads

$$v = v(wl, z(s)), \quad v_{wl} > 0, \quad v_z > 0. \quad (4)$$

Labour income  $wl$  of union members depends on the market wage  $w$  and on labour demand  $l$  as chosen by the firm. Depending on the importance attached to each of these two objectives, the union might be called income-oriented or health-oriented.<sup>11</sup>

In some countries, unions are large or form a confederation. Their basic objectives are the same but they now represent not only the workers of a particular firm but the whole labour force,

$$V = V(wL, z(s)), \quad V_{wL} > 0, \quad V_z > 0. \quad (5)$$

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<sup>11</sup>For an introduction to the discussion on the appropriate specification of union preferences, see Oswald (1982) and Booth (1995, ch. 4). Note that even for modern Britain, there is evidence that physical working conditions is one important issue over which trade unions and management bargain (Millward et al., 1992, pp. 249-254).

The main difference to the firm-level union is that health now has two positive channels, as in individual preferences (2): health matters per se and through higher labour supply visible here through  $L$ . An alternative idea to economy-wide unions, also captured by (5), are occupation-specific unions. As long as a union takes the effect of standards on all workers into account (e.g. because a union represents all coal miners and not just those currently employed in one particular firm), beneficial labour supply effects through higher standards are internalized by the union.

### 3.2 Centralized and decentralized OHS setting

This section explores the behaviour of a planner and OHS levels in a decentralized economy. This allows us to understand the basic mechanism why trade unions in principle can have positive welfare and output effects.

- The planner

As all firms use the same technologies, we can simply insert aggregate capital endowment  $K$  into (1). After having inserted also the labour-market equilibrium condition (3), total output is given by

$$Y(s) = A(s) f(K, z(s) N). \quad (6)$$

Welfare comparisons require a social welfare function. As our static framework is agnostic about wealth distributions and preferences of households are identical, we use the individual utility function (2) and insert aggregate consumption. With homogenous firms, all workers will be equally healthy and we obtain

$$U(s) = U(C(s), z(s)) = U(Y(s), z(s)). \quad (7)$$

A social planner maximizing social welfare (7) chooses a safety level  $s^U$  that satisfies (see app. A.1)

$$\varepsilon_{UY} \varepsilon_{YA} \varepsilon_{As} = [\varepsilon_{UY} \varepsilon_{YL} + \varepsilon_{Uz}] \varepsilon_{zs}, \quad (8)$$

where for readability all elasticities throughout this paper are defined as positive quantities. Hence, the OHS elasticity of TFP and the inverse wage elasticity of labour demand require a minus sign in their definition,

$$\varepsilon_{xg} \equiv -\frac{\partial x}{\partial g} \frac{g}{x}, \quad \text{for } xg \in \{As, wL\} \quad \text{and} \quad \varepsilon_{ad} \equiv \frac{\partial a}{\partial d} \frac{d}{a} \quad \text{for } ad \notin \{As, wL\}. \quad (9)$$

Condition (8) balances welfare-increasing and welfare-decreasing effects of more safety. The left-hand side captures the cost of more safety caused by a lower TFP: A one-percentage increase in the safety level reduces the TFP and thereby output by  $\varepsilon_{YA} \varepsilon_{As}$  percent. Multiplying this with the output elasticity of welfare,  $\varepsilon_{UY}$ , yields the percentage reduction in welfare. For

maximum welfare, this negative effect of more safety has to be equal to the positive effect on the right-hand side. A one-percentage increase in safety increases the share of time working by  $\varepsilon_{zs}$  percent. This gives, multiplied by  $\varepsilon_{Uz}$  and by  $\varepsilon_{UY}\varepsilon_{YL}$  respectively, the percentage increase in utility due to better health and due to higher income.

If the planner focused only on output maximization (that is, if  $\varepsilon_{Uz} = 0$ ), the optimality condition giving the output-maximizing safety level  $s^Y$  would read

$$\varepsilon_{YA}\varepsilon_{As} = \varepsilon_{YL}\varepsilon_{zs}. \quad (10)$$

This condition balances the output-decreasing effect on the left-hand side with the output-increasing effect on the right-hand side. Interestingly, one can prove that for the general production function in (6) the welfare-maximizing safety level is always higher than the output-maximizing safety level,  $s^U > s^Y$ .<sup>12</sup>

- The decentralized economy

The standard view to a setup with multiple job characteristics is the equalizing-differences approach of Rosen (1974, 1986). According to this approach, workers enjoy (or dislike) job characteristics in addition to the wage and a worker's utility function would look like the one we use in (2). The difference to our approach consists in the criteria for choosing a job. In the equalizing-differences approach, workers have full information about job characteristics and the choice of jobs would depend both on health implications  $z(s)$  and on income leading to a consumption level  $c$ . Firms can therefore choose wage-safety pairs on a worker's indifference curve. The resulting market equilibrium would be efficient.

The crucial difference of our approach lies in our historical perspective of unions in nowadays OECD countries and the conclusions we draw about information. Workers do not have sufficient information (neither would society as a whole have) to perfectly evaluate the impact of work, a certain job or a specific technology on health. Workers could form expectations but their expectations need to be - absent perfect information - based on a prior in a Bayesian learning sense. Perfectly competitive firms taking a safety-wage trade-off into account would then set an inefficient safety level if the prior is not identical to the true distribution of the health impact of a job. When on the job, workers would of course gradually learn about health implications of work, but each single worker makes just a few observations, especially when health also depends on other factors than just work and certain health impacts come with a long delay or can not easily be observed (as the examples in the introduction have shown). There is simply not enough variation, econometrically speaking, there are not sufficiently many observations to draw firm conclusions and learning can take more than a life

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<sup>12</sup>Intuitively, the proof (see app. C.1) runs as follows: Let  $s$  maximize output in (6). Now add health to this objective function and obtain (7). As the health term monotonously increases in  $s$ , a somewhat higher health level is better as a marginal increase in health does not reduce output at  $s = s^Y$  but it does increase the health term. Hence,  $s^U > s^Y$ . Clearly, how much  $s^U$  exceeds  $s^Y$  depends on how strongly health is valued, how strongly health increases and how fast output drops when  $s$  increases.

time. To capture this idea in the simplest possible way, we assume here that workers choose employment based only on the wage and firms choose employment taking the wage rate as given. This will qualitatively imply the same type of inefficiency one would observe in a Bayesian setup (as employed e.g. by Viscusi, 1979, 1980). The advantage of this shortcut is clearly the much simpler analytical tractability.

Given this focus of workers on wages (and capital owners on returns), optimal firm behaviour yields the familiar equality between marginal productivities and factor rewards (subscripts denote partial derivatives),

$$w = A(s) f_l(k, l), \quad r = A(s) f_k(k, l). \quad (11)$$

In a laissez-faire economy, a firm fixes, in addition to the stock of labour and capital, the safety level  $s$ . The derivative of profits with respect to the safety level is  $d\pi/ds = A_s$ , i.e. it is negative. Firms only see the TFP-reducing impact of more safety. As a consequence, firms would like OHS standards to be as low as possible.<sup>13</sup> The comparison point to the central planner solution  $s^U$  or  $s^Y$  is a laissez-faire safety level of  $s^\pi$ . Given that we exclude negative safety levels, we can set  $s^\pi$  to zero. The resulting equilibrium is clearly inefficient.

- Capital owners

It is interesting to contrast this firm safety level to one which would be set by a federation uniting all capital owners in an economy. At the country level, the safety level  $s^R$  that maximizes capital income  $r(s)K$  of all capital owners is described by (see app. A.5)

$$\varepsilon_{rA} \varepsilon_{As} = \varepsilon_{rL} \varepsilon_{zs}, \quad (12)$$

where again the elasticities are defined as in (9). Here, capital holders do not only consider the TFP-reducing impact (on the left) but also the health-increasing impact (on the right) of more safety. The reason for this is that interest rates depend on output, and, as we already saw, output can be increased by increasing the workers' health in a country.

The safety differences between the planner, the firms and capital owners highlights the externality caused by the production process. If the planner focused on TFP only, as does each firm, OHS  $s$  would be as low as possible since this increases output (6). A low safety level, however, decreases the share  $z(s)$  of time a worker is healthy and can work. This reduces aggregate labour supply  $z(s)N$  and therefore output (6). Hence, the starting point of our analysis of the effects of union activity is a second-best world where production exerts a negative externality on health. Output in a laissez-faire economy is inefficiently low and adding an institution - a union in our case - that sets OHS standards can improve efficiency.

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<sup>13</sup>The same would be true for small "entrepreneurs" who invest in their own firm. Someone owning  $k$  in a firm and computing the safety level which maximizes  $rk$  would also find that it is optimal to reduce  $s$  as much as possible.

### 3.3 Endogenous OHS with trade unions

The previous section explored the effects of the negative production externality. We will now show that if trade unions are introduced, the distorting effect can be reduced or even eliminated. Why does the union have the knowledge and means required to do so? There are two reasons: First, unions have many members and the more members there are, the easier it is to learn about a job situation. Due to its size, the union can collect information more easily than individuals. Second, in contrast to a loose group of workers having no institutional connection, unions have the means to “prove” the link between bad work conditions and health. They can more easily monitor the credibility of individual claims about work conditions<sup>14</sup> and they also have the power to impose better working conditions. Unions are a means to overcome the information and credibility problem of individual workers.<sup>15</sup>

We will first analyse the principles of optimal union behaviour in a general setup. We compare the implied safety levels with those optimal for capital owners. This allows us to see under which conditions and to which extent there is a conflict of interest between unions and capital owners. We will then look at various examples (with Cobb-Douglas (CD) and CES production and utility functions) to reveal the precise determinants of welfare gains and potential conflicting of interests. This will show the potential but also the limits of union activity on social welfare. We will consider a decentralized system (firm-level unions) and a centralized system (trade union confederation).

#### 3.3.1 The general case

- Firm-level unions

In basically all OECD countries, today and in the past, unionised and non-unionised sectors coexist. Union densities change over time and sometimes unionized firms compete with non-unionized firms. Various explanations can be offered for both coexistence and varying union densities. In a competitive setup à la Rosen with heterogenous firms one can imagine that firms offering the more dangerous jobs are unionised while others are not. In the theoretical literature on “deunionisation”, Acemoglu et al. (2001) show how biased technological change can be the reason for both deunionisation and an increase in wage inequality. In their setup, workers have an explicit choice whether to unionize or not.

We abstract from these important issues as we want to contrast our approach to the canonical model of trade unions. In the traditional monopoly union model (see Dunlop, 1944, Oswald, 1982), unions set the wage, firms choose employment and unemployment is

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<sup>14</sup>The importance of unions to alleviate moral hazard problems has already been stressed by Beveridge in 1909 (quote taken from van Leeuwen, 1997, p. 786). Beveridge claims that unions of his time were in the best position to monitor the appropriate use of unemployment benefit payments.

<sup>15</sup>Firms can also learn faster than individual workers as a firm hires many workers. Once the firm has learned about negative health effects of a certain technology, however, it might not be in the firm’s interest to reveal its information as workers with health problems incurred in the past could then file claims.



the inefficient equilibrium outcome. We give unions market power as well, assuming that it is beneficial for workers to join a union and that unions succeed in learning better than workers about the work-health link and in solving the monitoring problem. This is our extreme shortcut to describing historical processes. Historically, worker movements do not have any market power when they start. Political parties are often the vehicle through which public attention and support increase. If new regulations then improve OHS standards, they are put into force by the government. Indirectly, however, these new regulations are set by worker movements and this is what we capture here. Unions use their market power not to set wages - as in the traditional model - but to set the safety level  $s$ . While unions in the real world are concerned with several issues of which wage negotiation is an important one, we focus here entirely on union activities related to improving work conditions as described in the introduction. Wages are perfectly flexible in our setup and there is no unemployment.

At the firm level, employment  $l$  in the union's objective function (4) is given by the firm's labour demand from (11) which through TFP is a function of the safety level,  $l = l(A(s))$ . The wage rate  $w$  and the firm's capital stock  $k$  in the labour demand function  $l(\cdot)$  are taken as parametric by the union. The choice of the safety level  $s^v$  is perceived by the union to affect labour demand through TFP and health  $z(s)$ . Assuming an interior solution, the first-order condition of maximizing (4) subject to  $l = l(A(s))$  is given with (9) by (see app. A.3)

$$\varepsilon_{vwl}\varepsilon_{lA}\varepsilon_{As} = \varepsilon_{vz}\varepsilon_{zs}. \quad (13)$$

As in the planner's trade-off, safety here also has a positive and a negative effect. The negative effect on the left-hand side comes through the reduction in labour demand by the firm as a result of the cost associated with a higher safety: A one-percentage increase of safety decreases TFP by  $\varepsilon_{As}$  percent and the labour demand by  $\varepsilon_{lA}\varepsilon_{As}$  percent. Multiplying this with  $\varepsilon_{vwl}$  gives the percentage reduction in utility. The positive effect on the right-hand side is the direct effect of more health on utility: A one-percentage increase in the safety level increases health by  $\varepsilon_{zs}$  percent which multiplied by  $\varepsilon_{vz}$  gives the percentage increase in utility.

The differences between the union's optimal  $s^v$  from (13) and the planner's  $s^U$  from (8) stem from three sources: First, the union might value health differently than the central planner, i.e.  $v(\cdot)$  might differ from  $U(\cdot)$ . In fact, the union might value health more (i.e.  $\varepsilon_{vz}$  might be greater than  $\varepsilon_{Uz}$ ) since all workers are affected by workplace conditions while not all consumers are, as some consumers might live on capital income only. Second, the union cares about labour income  $wl$  only and not about total consumption  $C$ . In other words, capital income of capital owners is not taken into account. Third, maybe most surprisingly, firm-level unions without fixed membership do not take into account the positive effect of an increased health on the labour supply and thereby on output, the  $\varepsilon_{UY}\varepsilon_{YL}\varepsilon_{zs}$  term in (8).

- The trade union confederation

The union confederation has the same objectives as the firm-level union even though it represents not only the workers from a particular firm but the whole labour force. Consequently, employment in the union confederation's objective function (5) is economy-wide

labour supply  $L = z(s^V)N$  and the wage rate from (11) is the general equilibrium wage level,  $w = w(A(s^V), z(s^V)N)$ . The safety level set by the confederation is denoted by  $s^V$ . The optimality condition is (see app. A.4), using again (9),

$$\varepsilon_{VwL}\varepsilon_{wA}\varepsilon_{As} = [\varepsilon_{VwL}[1 - \varepsilon_{wL}] + \varepsilon_{Vz}]\varepsilon_{zs}, \quad (14)$$

The optimality condition (14) again balances the positive and negative effects of a higher safety level. In contrast to the firm-level union, however, the union confederation does take into account the positive effect of an increased health on the labour supply, the  $\varepsilon_{VwL}[1 - \varepsilon_{wL}]\varepsilon_{zs}$  term. In fact, condition (14) has more in common with the welfare-maximizing condition in (8) than with (13). Comparing (8) and (14) makes clear that health per se has a similar impact on both conditions, the terms  $\varepsilon_{Uz}\varepsilon_{zs}$  and  $\varepsilon_{Vz}\varepsilon_{zs}$ . However, the main difference resides in the fact that the union confederation is only interested in the workers' income,  $wL$ , while the central planner considers the whole income, that is, the income of workers and of capital holders:  $Y = wL + rK$ .

### 3.3.2 An example

While intuitive, the first-order conditions of the planner, the unions or capital owners might not be satisfied. The positive effect of more health could always be stronger than the negative effect of a lower TFP - or vice versa. The conditions also reveal little about the central determinants of health and safety levels. We therefore now look at a specific example in which a unique optimum can be easily identified and the conflict of interest in our economy can be studied.

- Functional forms

Assume a CES form for utility functions with arguments income and health. The household utility function in (2) and the firm-level union's objective function in (4) are thus assumed to take the forms

$$u = \left\{ \mu c^\lambda + [1 - \mu] z(s)^\lambda \right\}^{1/\lambda}, \quad (15)$$

$$v = \left\{ \gamma [wl]^\lambda + [1 - \gamma] z(s)^\lambda \right\}^{1/\lambda}, \quad (16)$$

where  $0 < \mu, \gamma < 1$  and  $\lambda < 1$ . The confederation's utility in (5) and our example for the central planner's objective (7) are

$$V = \left\{ \gamma [wz(s)N]^\lambda + [1 - \gamma] z(s)^\lambda \right\}^{1/\lambda}, \quad (17)$$

$$U = \left\{ \mu Y(s)^\lambda + [1 - \mu] z(s)^\lambda \right\}^{1/\lambda}. \quad (18)$$

Let there be a CD production function at the firm level and therefore also on aggregate with  $0 < \alpha < 1$ ,

$$y = A(s) k^\alpha l^{1-\alpha}, \quad (19)$$

$$Y = A(s) K^\alpha [z(s) N]^{1-\alpha}. \quad (20)$$

Health is captured in all utility functions by  $z(s)$  with a weight of  $\mu$  for the households and the central planner and a corresponding weight  $\gamma$  for unions. Unions might value health differently than “normal” households as all union members are subject to health effects of working while households also include capital owners which are not exposed to health hazards. Likewise, income at the household or planner level is all income and can therefore be expressed by individual consumption  $c$  or aggregate output  $Y$ . Income taken into account by unions is labour income only, i.e.  $wl$  or  $wL$ . In all cases, the elasticity of substitution between income and health is given by  $1/(1-\lambda)$ . For  $\lambda \rightarrow 0$ , the CES functions (15) to (18) become CD functions, e.g.  $u = c^\mu z(s)^{1-\mu}$  and  $v = [wl]^\gamma z(s)^{1-\gamma}$  for (15) and (16).

Finally, let us choose functional forms for TFP and the share of time being healthy as related to OHS which have the properties discussed after (1) and (3),

$$A(s) = be^{-\phi s}, \quad z(s) = 1 - \bar{q}e^{-\chi s}, \quad (21)$$

where  $b$ ,  $\phi$  and  $\chi$  are positive constants. When  $s$  is very low, TFP is close to its maximum  $b$  and the share of healthy hours is close to its minimum  $1 - \bar{q}$ . Restricting  $\bar{q}$  to take values between zero and one, zero safety measures still imply that workers are on average healthy during  $1 - \bar{q}$  percent of the time. The higher  $s$  is, the closer TFP is to zero and the higher the average health  $z(s)$  is.

- Optimal safety levels

The existence of optimal safety levels follows from computing first-order conditions and checking the sign of the first derivative to the left and right of the optimum in general equilibrium. A general equilibrium perspective has been taken for the maximization procedure by economy-wide institutions (the planner and the nation-wide union). Firm-level unions compute their optimal safety level given the firm’s labour demand function. We take these optimality conditions and replace firm variables (like the capital stock  $k$ ) by aggregate variables adopting the standard symmetric equilibrium view with many identical unions.

Table 1 presents first-order conditions for CES utility functions (15) to (18) and corresponding CD results for  $\lambda \rightarrow 0$ , i.e. the safety levels for the welfare-maximizing and the output-maximizing planner and for both types of unions (see app. B.4).

The safety level  $s^Y$  in (b) chosen by a planner who maximizes output only (i.e.  $\mu = 1$  in (18)) is positive if the term in squared brackets is larger than one,  $(1 + (1 - \alpha) \chi/\phi) \bar{q} > 1$ . Given that  $\bar{q}$  is the share of time sick, this expression is larger than one only for a sufficiently small  $\alpha$  or  $\phi$  or a large  $\chi$ . A small  $\alpha$  implies a high output elasticity of labour. A planner

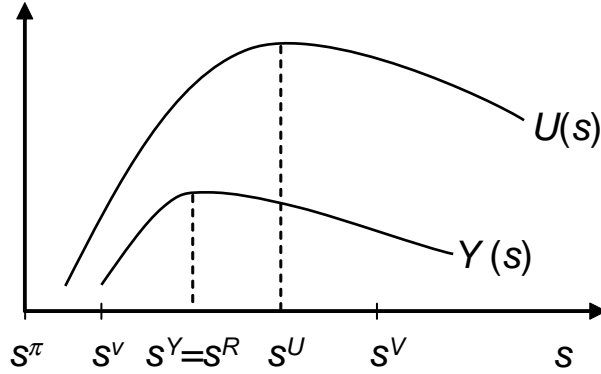
will therefore provide more safety when this has a stronger positive effect on output. When  $\phi$  is small, the cost of safety on TFP by (21) is not so strong and a planner will also provide more safety. Similarly with  $\chi$  : More safety, again by (21), increases health and labour supply strongly and the planner is induced to provide more safety. Let us assume that parameters are such that the planner indeed chooses a positive safety level  $s^Y$ .

	<b>CES utilities</b> (15) to (18)	<b>CD utilities</b> (15) to (18) for $\lambda \rightarrow 0$	
welfare-planner $s^U$	$\frac{\ln\left[\left(1+\frac{\varepsilon_{Uz}(s^U)}{\varepsilon_{UY}(s^U)}+1-\alpha\right)\frac{\chi}{\phi}\bar{q}\right]}{\chi}$	$\frac{\ln\left[\left(1+\left[\frac{1-\mu}{\mu}+1-\alpha\right]\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	(a)
output-planner $s^Y$	$\frac{\ln\left[\left(1+(1-\alpha)\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	identical to CES	(b)
firm-level union $s^v$	$\frac{\ln\left[\left(1+\frac{\varepsilon_{vz}(s^v)}{\varepsilon_{vwL}(s^v)}\alpha\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	$\frac{\ln\left[\left(1+\frac{1-\gamma}{\gamma}\alpha\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	(c)
confederation $s^V$	$\frac{\ln\left[\left(1+\left(\frac{\varepsilon_{Vz}(s^V)}{\varepsilon_{vwL}(s^V)}+1-\alpha\right)\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	$\frac{\ln\left[\left(1+\left(\frac{1-\gamma}{\gamma}+1-\alpha\right)\frac{\chi}{\phi}\bar{q}\right)\right]}{\chi}$	(d)

**Table 1** *Optimal occupational health and safety levels for (19) to (21)*

When looking at the signs of the first and second derivatives, one finds that  $s^Y$  is an optimum indeed and one obtains an “inverted U” shape for  $Y(s)$  from (20) as illustrated in fig. 1. To the right of  $s^Y$ , the positive effect of an increase in the safety level on health and thereby labour supply overcompensates the negative effect of lower TFP. This reverses to the left of  $s^Y$ .

The other expressions in table 1 are implicit for the CES utility functions, as the elasticities  $\varepsilon(\cdot)$  are functions of the safety levels. We will return to these forms further below. For the CD case, we also obtain straightforward solutions which can be given similar interpretations as for the output-maximizing safety level. The additional factor in (a), (c) and (d) are the preference parameters  $\mu$  and  $\gamma$ . When health is valued strongly, i.e.  $\mu$  and  $\gamma$  are low, the welfare, firm-level union or confederation safety levels, as expected, go up. Again, looking at the signs of the CD first and second derivatives shows that the optimal safety levels are maxima indeed.



**Figure 1** *Output and welfare as a function of occupational health and safety  $s$*

- Conflict of interests?

Who wants what in our economy? Given the richness of channels visible in the CD-results of table 1, we make a weak assumption concerning parameters which allows us to focus on the most realistic conflicts of interest:  $\alpha < \gamma < \mu$ . The output elasticity of capital,  $\alpha$ , is around 1/3. When comparing this to  $\gamma$ , the value attached by unions to labour income in (16) and (17), our assumption says that unions, even though they are health oriented, the weight they attach to labour income is at least 1/3. The second part of the assumption says that union values health more than society as a whole,  $\gamma < \mu$ . This also appears plausible as members of unions are all subject to health risks while society also consists of capital owners who are not.

Our economy is populated by the planner, the unions and the capital owners. The planner can appear either in its welfare or in its output-maximizing guise, unions and capital owners are both represented at the firm and the nation-wide level. With our assumption and CD results from table 1, we find (see app. C.2)

$$s^\pi < s^v < s^R = s^Y < s^U < s^V. \quad (22)$$

The output-maximizing planner and the capital owners agree on the safety level,  $s^R = s^Y$ . What maximizes output maximizes capital income  $rK$ , clearly a property of the CD structure of output in (20). The welfare-maximizing planner wants a higher safety level than the output planner,  $s^Y < s^U$ , see fn. 12.

Nation-wide unions desire a higher OHS level than the welfare planner due to  $\gamma < \mu$ . Nation-wide unions value health more than society as a whole. In fact, if society and nation-wide unions had identical preferences, unions could replace here the role of the central planner. They would internalize the production externality and would set the welfare-maximizing safety level.

When looking at capital and labour representatives at the firm level, we know already from the discussion after (11) that firms want the lowest possible safety level  $s^\pi$ . Concerning

unions, we find a surprising result: Firm-level unions want a lower safety level  $s^v$  than capital owners or a central planner who is purely interested in output maximization. The reason is that the central planner (and the capital owners) know about (and internalize) the benefits of more health for labour supply. The firm-level union sees positive effects from higher OHS standards only in its pure health effect and neglects labour supply effects (in fact, it looks at labour  $l$  in its objective function as the labour demand by firms which falls as TFP falls as a result of higher safety).<sup>16</sup>

Summarizing, the nation-wide union, given its “exaggerated” emphasis on health is in conflict with society as a whole which in turn wants higher OHS standards than output-maximizers and capital owners. The lowest safety providers are firm-owners and firm-level unions.<sup>17</sup> Comparing union output and welfare with a laissez-faire economy is straightforward when using fig. 1. Unions are welfare or output increasing if the safety level they set is to the left of  $s^Y$  and  $s^U$ , respectively. If they “overdo things”, i.e. if the union safety level is too far to the right of  $s^Y$  or  $s^U$ , they would still be beneficial to the economy if the negative effect on TFP is not too strong, i.e. if the decrease of output and welfare to the right of their maxima is modest. For illustration purposes, the ranking in (22) is also plotted in fig. 1.

### 3.3.3 OHS and development

Empirical analysis suggests (Hall and Leeson, 2007) a negative correlation between the development level of a country and the risk of injury while working. Should this give rise to policy concerns or is this a feature of an efficient development process?

Using the implicit-function theorem on CES safety levels as presented in table 1 shows that the reaction depends on the elasticity of substitution between income ( $wl$  for the firm-level union,  $wzN$  for the union confederation and  $Y$  for the planner) and health  $z$  (see app. D),

$$\left. \begin{array}{l} \text{bad substitutes} \\ \text{Cobb-Douglas (CD)} \\ \text{good substitutes} \end{array} \right\} \Leftrightarrow \lambda \begin{array}{l} \leq \\ \geq \end{array} 0 \Rightarrow \frac{ds^i}{dK} \begin{cases} > 0 \\ = 0 \\ =? \end{cases}, \quad s^i \in \{s^v, s^V, s^U\}. \quad (23)$$

Both the planner and the two types of unions would set a higher safety level if the elasticity of substitution between health and income is low. This can be understood by recurring to the income and substitution effect. There is an income effect due to more capital which increases demand for health  $z(s)$  and consumption, the two arguments in the planner’s utility function in (7). The price of health relative to consumption, however, rises the more capital there is and households tend to substitute health by income.

<sup>16</sup>Departing from our parameter assumption would imply that a firm-level union sets a higher safety level than a central output-planner if it only values health enough. App. C.2 shows that  $s^v \leq s^Y \Leftrightarrow \alpha \leq \gamma$ .

<sup>17</sup>Again, departing from our assumption on parameters, one can show that for  $\gamma = \alpha\mu$  the firm-level union would set the same safety level as a planner  $s^v = s^U$  (see app. C.2).

In the CD case these effects cancel. Safety levels do not change in the course of development of a country. This would be the “universal work standard” case advocated by some who postulate that all countries in the world, irrespective of their level of development, should have the same OHS standards. When substitution is easy, it is not clear which effect is stronger. In this case, health standards could even go down when a country becomes richer. The substitution effect would dominate the income effect.

The case that seems to be empirically more relevant is the one in which work standards are higher, the higher the development level of a country is (Hall and Leeson, 2007). This is the bad substitution case ( $\lambda < 0$ ) in our model. When a society becomes richer, it can afford more health and as income is a bad substitute for health, OHS standards go up accepting that this reduces TFP and therefore dampens the increase in income. Our view that the positive link between development and OHS standards is also due to unions is also shared by Kahn (1990, p.481) who writes that “union workers implicitly trade off wage and benefits growth for occupational safety improvements”. In what follows, we will stick to this empirically plausible assumption that health and income are bad substitutes.

## 4 OHS under trade and capital flows

This section now takes a more global perspective on OHS standards. We will analyse a two-country world in order to understand the effects of “globalization” (i.e. international capital flows) on safety standards and thereby on output and welfare.

### 4.1 Capital flows in a two-country world

- Equilibrium

Let there be a country which we call “the North” with institutions as just described. This country can undertake FDI and trade the final homogeneous good with “the South”. In autarky, the South has a lower capital stock and safety levels are lower as well. For simplicity and without losing any insights, we consider the southern safety level to be exogenous. As the law of one price holds without barriers to trade, the single determinant for capital flows are international differences in the marginal product of capital. Using technology (6) and the equilibrium on the labour market (3), the northern marginal product of capital is given by

$$r(s, K) = \frac{\partial Y(s, K)}{\partial K} = A(s) \frac{\partial f(K, z(s)N)}{\partial K}. \quad (24)$$

As it is clear from (12), OHS standards  $s$  have an ambiguous effect on the interest rate: If the safety level is too low, capital owners are in favour of more safety since they see the overall positive effect of healthier workers. Again, however, if  $s$  is too high, the TFP-reducing effect is stronger than the labour-supply effect.

Allowing now for international capital flows and denoting North-South flows by  $\Delta$ , equilibrium on the world capital market requires equality of the factor rewards for capital,

$$r(s, K - \Delta) = r(s^*, K^* + \Delta), \quad (25)$$

where an asterisk denotes southern quantities.<sup>18</sup> This equation determines  $\Delta$ , given autarky endowments  $K$  and  $K^*$ , an exogenous southern safety level  $s^*$  and the endogenous safety level  $s$  in the North. The latter continues to be determined by unions in the North. When looking at optimality conditions for the firm-level union in (13) or the confederation equation (14) closely, we see that the capital stock is taken as parametric by the union. In a closed economy setup this definitely makes sense for the confederation as  $K$  is exogenous in our static model. For a firm-level union, the capital stock  $k$  is endogenous and the union could take into account how setting  $s$  affects the capital stock in a firm. Similar considerations could be undertaken by unions in a global world. Very sophisticated unions would take into account that setting safety standards has an effect on the capital stock in a country or, put differently, on capital in- or outflows. As we want to use the results from our closed economy analysis for the two-country world, we assume that unions continue to take the capital stock as parametric. Hence, the equation which fixes the endogenous OHS level  $s$  in the North is either (13) or (14). An equilibrium in our setup is therefore given by (25) and (13) or by (25) and (14). In both cases, two equations determine two endogenous variables: capital flows  $\Delta$  from North to South and safety levels  $s$  in the North.

As the discussion of (22) has shown, the impact of union behaviour depends strongly on how “comprehensive” their view and level of influence is. We can therefore conveniently consider firm and nation-wide unions as polar cases. To obtain clear-cut results when discussing the effects of OHS on capital flows and vice versa, we will assume that the safety level set by unions lies below the social welfare-maximizing level  $s^U$  (see fig. 1). Sometimes we also discuss situations where it is below the interest rate maximizing level  $s^R$ . Once these results are understood, the impact of unions more closer to the polar cases will be clear as well.

The equilibrium on capital markets is plotted in fig. 2. The horizontal axis shows the northern capital stock from the left and the southern from the right such that the total length of the horizontal axis reflects world endowment with capital,  $K + K^*$ . The vertical axis on the left shows the northern interest rate, the one on the right the interest rate in the South. Capital demand curves plot loci which give the interest rate as a function of capital used in the North and South, respectively.

- Capital flows

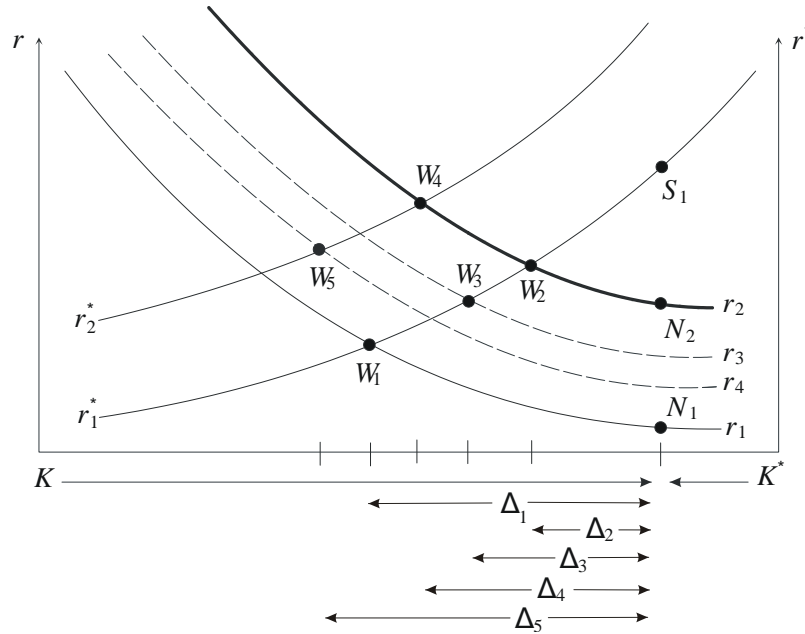
Thinking of a scenario where countries are in autarky and then open up for capital flows, let us assume first that countries in autarky differ only in their capital stock. There are no

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<sup>18</sup>Maybe one should not talk about flows in a static model. Strictly speaking,  $\Delta$  is the stock of capital installed in the South but owned by the North.



union activities and safety levels are identical and low. When the initial capital endowment before capital flows is given as drawn in fig. 2, factor rewards in the South at  $S_1$  are higher than in the North at  $N_1$ . With free capital flows, the new world-equilibrium point is at  $W_1$  where capital flows from the North to the South of a total volume of  $\Delta_1$  imply an equalisation of returns to capital.



**Figure 2** Autarky equilibria  $N_i$  and  $S_i$  and world equilibria  $W_i$  with free capital flows

Are capital flows from the North to the South a realistic description of reality? It is well-known that the US as one of the richest countries in the world is one of the biggest recipient of foreign investments. When capital flows of “all” countries in the world are analysed, capital flows from the North to the South from the 70s to the mid 80s to reverse subsequently and to flow South to North from the end of the 90s (Prasad et al., 2006, chart 2). If the focus is on FDI, however, capital always flows from North to South (chart 4). If the world without US is analysed, capital also flows from North to South (chart 3). Lane and Milesi-Ferretti (2006, fig. 9) make a similar point: Net foreign assets (i.e. accumulated flows) are positive for industrialized countries and negative for the US and emerging and developing countries. Capital flows from North to South are therefore a realistic view of the world if the focus is on FDI (which comes the closest to our capital stock  $K$  in this long-run static equilibrium) or if the focus is on industrialized countries other than the US.<sup>19</sup>

<sup>19</sup>If one focuses on gross flows, it is even more apparent that North-South flows are very relevant. Capital outflows from the US from 1960 to 2007 are on average 3.8 times higher than (absolute) net flows (BEA, 2008).

Second, if we introduce trade unions in the North, the autarky safety level is higher than without unions. Let us assume this OHS level is constant (e.g. institutions have CD preferences, see  $\lambda = 0$  in (23)). As long as this OHS level is not beyond the capital-return maximizing point (i.e. as long as  $s^v < s^R$ ), the capital demand function moves up from  $r_1$  to  $r_2$ . As discussed around (22), capital owners are actually in favour of higher safety levels as long as this has a positive effect on capital rewards. Starting with the same initial capital distribution, the starting points are now  $S_1$  and  $N_2$  and the new world-equilibrium point is  $W_2$ . Capital flows from the North to the South are now lower and amount to  $\Delta_2$  only. Higher (but not too high) safety levels reduce capital outflows.

When we return to the realistic situation in (23) where health and income are bad substitutes ( $\lambda < 0$ ), safety standards fall after capital outflows. Starting from  $N_2$  and  $S_1$  as before, capital outflows will lead to a “temporary” equilibrium at  $W_2$ . Falling OHS levels reduce the northern capital demand function to  $r_3$  and the final equilibrium point is  $W_3$ . Capital outflows are larger due to the fall in OHS levels in the North but still lower than under a situation without any northern OHS standards. Generally speaking, this contradicts the often stated view that capital flows to where standards are lower. If standards are so low that marginal productivity of capital suffers, capital will stay in the North.

## 4.2 Capital flows and welfare

Let us now turn to the welfare effects of international capital flows. Welfare in both countries by (7) is a function of consumption and health. In the North, endogenous OHS standards  $s$  and therefore health are a function of capital flows,  $z(\cdot) = z(s(K - \Delta))$ . In the South, health  $z^*(s^*)$  is exogenous due to exogenous safety levels  $s^*$ . Consumption in the North is given by domestic production (6) plus capital income from abroad,  $Y + r^*\Delta$ , while in the South it is domestic production minus capital income paid to foreign capital owners in the North,  $Y^* - r^*\Delta$ . Making the dependence of consumption on capital flows  $\Delta$  explicit,

$$C = Y(A(s(K - \Delta)), K - \Delta, z(s(K - \Delta))N) + r^*(K^* + \Delta)\Delta, \quad (26)$$

$$C^* = Y^*(A^*(s^*), K^* + \Delta, z^*(s^*)N^*) - r^*(K^* + \Delta)\Delta, \quad (27)$$

we see that capital flows  $\Delta$  affect the northern consumption level through TFP, the capital stock, labour supply and the northern interest income. For the South, only the southern capital stock and the interest payments are affected. Computing the welfare effects of capital flows then gives (see app. E.1)

$$\frac{dU}{d\Delta} = U_C [r^* - r + r^*\Delta] + U_C Y_s \frac{\partial s}{\partial \Delta} + U_z z_s \frac{\partial s}{\partial \Delta}, \quad (28)$$

$$\frac{dU^*}{d\Delta} = -U_{C^*} r^* \Delta > 0, \quad (29)$$

where again subscripts denote partial derivatives: e.g.  $r_{\Delta}^*$  is the change in the southern interest rate due to capital inflow into the South.

Capital flows influence northern welfare through the “classic channel”, the “efficiency channel” and the “health channel”. The first term in (28) starting with  $U_C$  is the classic channel which says that if the southern interest rate  $r^*$  does not react to capital flows from the North (that is, if  $r_{\Delta}^* \Delta = 0$ ), there are welfare gains as long as the foreign interest rate is larger than the domestic one ( $r^* > r$ ). This is the well-known condition for gains from capital mobility. However, if a sizable amount of capital has already flown and the southern interest rate falls when more capital flows (that is, if  $r_{\Delta}^* \Delta < 0$ ), there might not be gains from additional capital flows. In fact, in a two-country world, welfare-maximizing capital flows should stop before the domestic interest rate equals the foreign one.<sup>20</sup> As the gains from higher capital rewards abroad overcompensate the losses from the fall in the foreign capital rewards when capital flows just start, we conclude that overall there are gains from international capital flows.

The second term,  $U_C Y_s \partial s / \partial \Delta$ , can be called the “efficiency channel” and might be best understood with the help of fig. 1. If the planner in the North maximized output and set OHS standards equal to  $s^Y$ , this term would be zero,  $Y_s = Y_A A_s + Y_L z_s N = 0$ . The negative TFP effects of safety (the expression  $Y_A A_s$ ) would just be compensated by the positive labour supply effect  $Y_L z_s N$ . If, however, OHS standards were below the output-maximizing safety  $s^Y$ , that is if  $Y_s > 0$ , and noting that an outflow of capital reduces the safety level ( $\partial s / \partial \Delta < 0$ , see (23)), a further reduction of  $s$  due to capital outflows would increase inefficiencies in the North and thereby reduce output.

The final term in (28)  $U_z z_s \partial s / \partial \Delta$  is more related to trade unions and their impact on higher OHS standards. The closer the union-set safety level is to the social welfare-maximizing level  $s^U$ , the higher the social welfare is. If the union safety level is lower than  $s^U$ , that is, if  $U_z > 0$ , any reduction in safety (due to capital outflows) reduces welfare. Consequently, the welfare effect of reduced OHS standards is negative.

Combining all three channels, capital flows increase northern welfare due to a more efficient factor allocation but reduce welfare since less capital implies lower OHS standards which were too low already before capital flows. This reduction has a negative effect on efficiency and on health per se. Welfare gains through capital flows are therefore reduced by negative OHS effects.<sup>21</sup>

For the South, however, the welfare effects are unambiguously positive. For each unit of capital flowing into the country, it pays the local marginal product. Hence, the term  $r - r^*$  we see in (28) is zero in (29). It benefits, however, from the reduction of the domestic interest

<sup>20</sup>This effect must be known from the literature on international factor flows in two-country worlds or in the case of large (i.e. not small) open economies. So far, however, we have been unable to find a reference. We are grateful to Juergen Meckl for discussion of this point.

<sup>21</sup>Clearly, if one believes that OHS standards are excessive, i.e. above  $s^U$ , capital outflows implying a reduction of safety levels would imply welfare gains due to capital flows per se and due to reduced OHS standards.

rate due to inflows,  $r_{\Delta}^* < 0$ . There is no health channel as safety standards are invariant.

## 5 Trade unions go global!

This section is motivated by the general discussion about the desirability of trade unions and their role in a global world. Given competition between the North and the South, can the North afford to have “old-fashioned” institutions like trade unions? Do not “modern global times” require to abolish unions such as to make a country more “competitive”? Or should governments rather encourage activities of trade unions also in the South?

In order to address these questions, we now ask how the results obtained so far are affected if trade unions are also introduced in the South. What are the welfare consequences for the North, the South, and the world economy and how would northern trade unions react to this?

### 5.1 International capital flows and OHS

We stipulate that an increased presence of trade unions in the South would increase southern safety levels. If we assume that this new safety is still lower than the interest-maximizing southern safety (that is, if  $s^* < s^{R^*}$ ), an increase in the southern safety level will increase the capital demand curve from  $r_1^*$  to  $r_2^*$  (see fig. 2). Capital owners are better off. Of course the question arises why it takes trade unions to help capital owners to increase their returns to investment. The answer is simple, however: In a society with few economic institutions and no well-functioning financial systems, each capital owner is basically an entrepreneur who owns his own firm. OHS standards imply costs but there are no institutions which would allow capital owners to coordinate their activities and credibly jointly increase the safety level. Firms are caught in a prisoners’ dilemma. The need for higher safety levels is more pressing for workers as they are physically affected through negative health effects. Hence, even though each individual firm in the South will be opposed to higher OHS standards, capital owners as a group will gain.

For an invariant safety level in the North (the CD case with  $\lambda = 0$  in (23)), this implies that the equilibrium moves from  $W_2$  to  $W_4$  and the flow of capital to the South increases from  $\Delta_2$  to  $\Delta_4$ . For the bad-substitution CES case ( $\lambda < 0$ ), capital outflows to the South reduce safety levels in the North. If safety levels were below the interest rate maximizing level  $s^R$ , capital demand in the North would be reduced from  $r_3$  to  $r_4$  and the equilibrium would move from  $W_3$  to  $W_5$ . Capital outflows from the North would increase from  $\Delta_3$  to  $\Delta_5$ .

At first sight it might be surprising that an introduction of trade unions in the South can increase capital inflows to this country. But, if TFP losses are not too strong, northern investors simply profit from a healthier labour force in the South. This idea is supported by Alsan et al. (2006) who find empirical evidence that an improvement in a population’s health increases gross FDI inflows to low- and middle-income countries. If trade unions can play

a similar role in the South today as they played historically in nowadays OECD countries, trade unions are good for health and growth of a developing country.

## 5.2 Global unions and welfare

- The North and the South

What are the welfare implications if trade unions in the South increase the southern safety level? Preserving  $s^*$  as an exogenous quantity, welfare effects for the North and South are (see app. E.2),

$$\frac{dU}{ds^*} = U_C r_{s^*}^* \Delta + U_C Y_s \frac{\partial s}{\partial s^*} + U_z z_s \frac{\partial s}{\partial s^*}, \quad (30)$$

$$\frac{dU^*}{ds^*} = -U_{C^*}^* r_{s^*}^* \Delta + U_{C^*}^* Y_{s^*}^* + U_{z^*}^* z_{s^*}^*. \quad (31)$$

These conditions look similar to those in (28) and (29) where the effects of capital flows were analysed. In fact, term one in (30) corresponds to the classic channel above. In contrast to above, however, we start from an integrated world economy with  $r = r^*$  and capital flows are now induced by changes in southern OHS standards  $s^*$ . However, this term is now positive since we are making the plausible assumption that the southern safety level  $s^*$  is lower than the interest-maximizing safety level  $s^{R^*}$ . The second term is the efficiency channel and the third term is the direct health channel. More safety in the South has a positive effect on interest payments but reduces output and the health level in the North.

We saw above that capital flows increase northern welfare but falling OHS standards can reduce these welfare gains. What remains here on balance? First of all, an increase in southern safety increases interest rates paid on previous investments  $\Delta$  since  $r_{s^*}^* > 0$ . As opposed to (28), the classic channel leads here to gains for the North: Higher  $s^*$  increases returns for investors as higher labour supply in the South increases marginal productivities of capital in the South (by more than lower southern TFP would reduce it). The second, efficiency, channel is negative if the safety level in the North is below its output-maximizing level (i.e.  $Y_s > 0$ ) and if more safety in the south implies capital outflows from the north and thereby a reduction of safety levels in the North, i.e.  $\partial s / \partial s^* < 0$ . The third channel does not bring good news for the North either: If OHS standards  $s$  and thereby the average health level fall, welfare goes down through this health channel as well.

For the South, two new terms as compared to (29) appear. The second and third term can easily be identified as the efficiency and health channels in the South. Term one is negative; terms two and three are positive: The South loses from higher interest payments to the North but gains from efficiency gains in production due to higher OHS standards and from health per se.

- The conflict between northern and southern unions

There are numerous examples in the media where northern trade unions help establish southern unions. One often mentioned reason is that unions in the South increase southern wages which reduces low-wage competition in the North. Looking at trade union cooperation in more detail, however, quite some authors have suggested that international cooperation has been rather marginal (see, for example, Northrup and Rowan (1979), Enderwick (1985), pp. 147-154, and the references therein, and Gordon and Turner (2000)). Our model suggests one possible reason why there is actually a conflict between northern and southern unions. Both unions benefit from capital flows. More capital means higher wages and, as a consequence, higher safety levels. Both enter the objective function of unions positively. Building up a union in the South implying higher safety levels results in a capital outflow and northern union members lose.

- The world as a whole

What should we now conclude from these ambiguous results for global activities of unions? The North tends to lose, northern unions are definitely worse off and only the South seems to gain from higher OHS standards in the South. Should trade unions go global?

exogenous parameters							endogenous quantities to be matched				
$\alpha$	$\bar{q}$	$\lambda$	$\phi$	$N$	$N^*$	$z^*$	$z(s)$	$Y^{North}$	$Y^{South}$	$z(s^Y)$	$r = r^*$
.33	.3	-1	.1	$1^a$	$\frac{2422^b}{722}$	.9	.98	38,000 <sup>22</sup>	5,800	$\geq z(s)$	5.0%
calibration parameters							equilibrium quantities				
$b$	$b^{South}$	$\chi$	$\gamma$	$K + K^*$			$K^{North}$	$K^{South}$			
13.6	1.6	10.8	.95	300			84.3%	15.7%			

**Table 2** *Calibrating the free capital flow equilibrium*

*a: normalized to one*

*b: ratio of population of China and India to population of G7 countries in 2006<sup>22</sup>*

We can make an argument in favour of more global activities of trade unions by looking at trade union effects quantitatively. In the European Union, 2% of working days are lost due to health issues related to work (Parent-Thirion et al., 2007, Table 7.3), i.e.  $z(s) = .98$ . Taking into account that accident rates in non-industrialized countries are 4 to 6 times higher than in industrialized countries (Hämäläinen et al., 2006), the absence rate due to health is, say, 10% in the South ( $z^* = .9$ ). We start from a free-capital flow equilibrium given by (25) and (13). We assume a CES utility function as in (16) such that the optimal firm-level union safety level is implicitly given by (c) from tab. 1. We want this initial equilibrium to reflect health levels  $z$  and GDP per capita broadly consistent with the average G7 country for the

North and the population-weighted mean of China and India for the South (see tab. 2).<sup>22</sup> We can then analyse the effect of an increase of the safety level in the South which decreases absence rates in the South from 10% to 2%.

Some of our parameters are purely exogenous and we “do not touch them” for our analysis. These parameters appear in the upper left corner of tab. 2. Robustness analysis has shown that modifying them does not affect the basic quantitative result reported below. Endogenous quantities which need to be matched are shown in the upper right part. In addition to health and GDP, we also need to make sure that our endogenous health level  $z(s)$  implies a safety level below the output and interest rate maximizing level  $s^Y$ , i.e.  $z(s^Y) \geq z(s)$ . This makes the quantitative analysis consistent with our discussion of safety rankings in (22). We also require the interest rate to be in a plausible range.

The parameters used to obtain the to-be-matched quantities are shown in the lower left corner. All of these values are in the range one would expect. Relative TFP between the North and South implied by  $b$  and  $b^*$  (compare (21) for the link between  $b$  and TFP), is maybe a bit larger than usual; if differences in education and experience levels between workers in the North and South is taken into consideration, however, relative TFP would go down and become closer to standard ratios. The parameter with a relatively high value is  $\gamma$ , the weight attached by unions to labour income. Such a high value is required, however, simply to make sure that  $z(s^Y) > .98$ . Remember that we consider the firm-level union as one polar case as opposed to the sector- or economy-wide union. The calibration analysis could also have used a weighted mean of  $s^v$  and  $s^V$  and no such extreme value for  $\gamma$  would have been required.<sup>23</sup> The world capital stock is a pure shift parameter affecting the equilibrium interest rate. By modifying  $K + K^*$ , any desired interest rate can be obtained. As capital flows and health effects are not sensitive to the interest rate,  $K + K^*$  was set to 300. In the resulting equilibrium, 84.3% of the world capital stock is used in the North.

Starting from this equilibrium, we increase the Southern level  $z^*$  from .9 to the Northern level of .98. The implied capital flows from the North to the South constitute the “real test” for our calibration as these flows should be consistent with the estimates of Alsan et al. (2006). They find that every additional year of life expectancy implies a 9% increase in FDI inflows to low- and middle-income countries. Average life expectancy in their sample is 64.6 years, i.e. one can translate an additional year into a  $100/65\% \approx 1.5\%$  increase in hours worked. Increasing hours worked from 90% to 98% is an increase of approx. 9% (not percentage points), i.e. an increase of  $9/1.5 = 6$  additional years in life expectancy. Such a change should imply an increase of inflows of  $6*9\%=54\%$ . As 1\$ of inflows amounts to an increase of domestic investment of 1\$ (on the aggregate level, see Desai et al., 2005) and investment to capital stock ratios are around 10%, a 54% increase in inflows implies a 5.4% increase in the capital stock. We find that our capital flows amount to a 6.7% increase in the

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<sup>22</sup>All nominal data is in 2006 PPP US\$. All data is taken from World Bank (2008).

<sup>23</sup>Understanding why a high  $\gamma$  implies a high  $z(s)$  is difficult as this mechanism acts through the calibration. Parameters like  $b$  and  $\chi$  are endogenous and some variables are exogenous.

southern capital stock, i.e. they are very consistent with the findings of Alsan et al.

Given these satisfactory quantitative properties of our model, we will now use it to predict GDP and health effects. International capital flows imply a decrease of safety levels  $s$  in the North which imply that the share  $z(s)$  of time individuals are healthy decreases by 0.008%. GDP in the North decreases by 0.4% and increases in the South by 7.6% implying an increase of world GDP by .8%. Put differently, southern unions have a theoretical but not a practical negative effect of work standards in the North. Higher southern standards do, however, reduce domestic production in the North by a small amount but increases southern production considerably, leading overall to an increase in world output.

## 6 Conclusion

The starting point of this paper was the belief that an institution like trade unions which has been around for more than a century and is active in almost all countries in the world can not only be detrimental to economic production and welfare of a society. Studying activities of workers' associations and trade unions beyond wage negotiation has shown that trade unions play a major role in providing workplace safety - at least in providing information about the necessity of measures that assure occupational health and safety (OHS). Trade unions did perform this role historically in nowadays OECD countries and do play such a role today in certain industrializing economies.

The first central question of this paper is whether these OHS activities of unions can assign unions an output and welfare increasing role. Our analysis has shown that output and welfare effects of unions depend on union objectives and, more importantly, on the degree of centralization in an economy. Firm-level unions set lower OHS standards than economy-wide unions as the former neglect the positive labour supply effect of higher OHS. Firm-level unions are just as short-sighted (i.e. focused on this one firm) as firms and treat employment as the outcome of labour demand decisions by the firm. They provide OHS only as they value health of their members per se. Economy-wide unions fully internalize the positive labour supply effect due to more OHS and therefore set higher safety standards. In fact, ruling out distributional effects from variations in the size of the labour force (i.e. assuming a Cobb-Douglas technology), economy-wide unions which attach the same importance to health as society as a whole set the social welfare-maximizing OHS standards. Even with a firm-level union, output and welfare increases compared to a laissez-faire economy.

Can other institutions play a similar role as unions do? We have seen that capital owners - as opposed to individual atomistic firms - would also internalize economy-wide labour supply effects and value health of workers. Capital owners trying to maximize their revenue would increase overall output and welfare of an economy as compared to a laissez-faire economy but never up to the social welfare-maximizing point. The incentives for capital owners to form a coalition and internalize the negative health externality, however, are much lower than for workers. Capital owners "do not feel health hazards". It is only the workers who are



directly confronted with risk at work. Hence, workers' associations are the most probable institution to initially play this output and welfare increasing role. After some time, when general awareness in society about OHS standards or particular health issues has grown, the role of trade unions can be taken over by society as a whole, i.e. by some voting process through a government. This might be the reason why in the US, UK, Germany and many other OECD countries, governmental agencies nowadays take care of OHS standards and provide various types of work and health related insurances - and partly make them even compulsory.

The second central question of our paper is the role unions can play in a global world. What happens to international capital flows when unions are active in the North and OHS standards are high but unions are absent in the South? It depends. If unions in the North are moderate, capital flows to the South will be reduced as some health level is better than none and marginal productivities of capital are higher with unions. Clearly, if unions put a lot of emphasis on health or even when the social planner maximizes welfare, some capital will be driven out of the country due to high OHS standards - but still less than in a laissez-faire economy.

When unions become active in the South, output in the world as a whole will rise and so will welfare. There are strong distributional effects and the North might lose, as will unions in the North. A quantitative analysis has shown, however, that for the world as a whole higher OHS standards in the South increase output. These distributional effects point to the potentially beneficial effects of side payments from unions in the South to unions in the North. If this cooperation can be achieved, Pareto gains from globalization should be possible.

The paper has various shortcomings which can be overcome in future work. Can unions play a role in industrialized countries today where OHS standards are set by government agencies? One would have to start with an analysis where some firms or sectors are unionized while others are not. A partial unionization would also be useful to understand the effects of unions in the South better. Any increasing role would come gradually and unions would not become monopoly unions instantaneously. Second, the assumption of ignorance on the side of workers and perfect information of unions can be replaced by a Bayesian learning approach. One can expect that the relative degree of risk-aversion of workers (with respect to labour income relative to health effects) will determine whether "optimistic" workers (their prior predicts a higher expected share of time being healthy than a certain job actually implies) accept higher or lower wages than the perfect information compensating differential wage. One can then also analyse precisely the incentives for workers to join a union (thereby also capturing the fact that no real-world economy is 100% unionized) and understand how joint learning increases welfare. Third, one can undertake a more systematic quantitative historical analysis of unions across sectors or countries. The evidence presented in the introduction suggests that in countries where workers were allowed to form unions developed stronger welfare states than countries where unions were suppressed. Is it true - beyond simple examples from some countries - that the share of organized labour say "a decade after" the industrial revolution is

a good predictor for the “size” of the welfare state some 100 years later? All these extensions would allow to understand better to what extent joint action and cooperative behaviour - as opposed to an individualistic view of society - is important for forming modern human societies.

## 7 Appendix<sup>24</sup>

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<sup>24</sup>The appendix containing all the derivations referred to in the text is available upon request.

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