How Bad is Globalization for Labour Standards in the North?

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We analyse a world consisting of 'the North' and 'the South' where labour standards in the North are set optimally. There is an optimal level of standards as the latter are costly for firms but beneficial for workers. Higher standards can therefore increase output and welfare. Standards are exogenous in the South and are assumed to be suboptimal. Trade between these two countries can imply a reduction in work standards in the North. Moreover, when suboptimal standards in the South are increased, the North tends to lose out. Quantitatively, these effects are small and overcompensated for by gains in the South. The existing empirical literature tends to support our findings.

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1 Introduction

There is a widespread public perception in industrialized countries that globalization can lead to a deterioration of labour conditions. The claim is that rich countries that open their borders to trade with and FDI in poor countries are forced to reduce their labour standards in order to keep up with the increased competition. This would lead to what has been called a "race to the bottom" in labour standards.

Empirically, we know little about the effect of trade or FDI on labour standards in the North (see section 5 below for a detailed discussion). We do know, however, that there are considerable international differences in occupational health and safety (OHS) standards. In industrialized countries, employees are protected against excessive exposure to chemicals and there are exposure limits for radiation protecting medical personnel and 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. More generally speaking, there are many regulations in place

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targeted at guaranteeing safety at workplaces. But what about developing countries? If we are willing to concede a link between OHS standards and accident rates, the difference is substantial. 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). When countries compete with each other over international investments, do these differences constitute "unfair competition"? Can globalization potentially degrade labour conditions in the rich countries?

Given the scarcity of empirical knowledge, this paper first develops a theoretical framework that identifies conditions under which capital outflows in the form of FDI reduces labour standards in the North. Based on this framework, we then provide estimates of how important the effects of globalization are on OHS from a quantitative perspective. We focus our attention on three key questions: First, how do high OHS standards in the North affect international capital flows? Second, what are the repercussions of these capital flows on northern standards? Finally, what are the effects of rising OHS standards in the South?

Our framework is a simple two-country world with a capital-rich North and a capital-poor South. In addition to having more capital, the North has an institution that sets OHS standards optimally. OHS standards are assumed to have three effects on the economy. First, they reduce total factor productivity. This allows us to capture the fact that labour standards are costly for firms. Second, they have a 'pure health externality': The higher the OHS standards are, the higher the share of time a worker is healthy and can work. The worker values this health per se (as an argument in the utility function). Third, there is an 'aggregate labour supply externality': The higher the OHS standards are, the more hours a population of a given size can actually work.[2]

In most industrialized countries, OHS standards have been the outcome of a long and complex process that usually starts with the activities of trade unions and ends with the creation of governmental agencies specialized in OHS standard setting and/or enforcement. For some standards, the process might take many decades and usually involve (1) collecting job hazard information, (2) establishing the scientific link between job hazard and workers' health, (3) lobbing for and preparing the regulatory framework, (4) creating a governmental agency, and (5) enforcing the standards. The importance of trade unions in all of these stages, mainly historically but also at present, has been stressed by Donado and Wälde (2012). In the present paper, we would like to capture the interaction between 'the North' and 'the South' for current economies and do not take a historical perspective. We assume the existence of an institution which sets OHS standards in the North. This is typically a governmental agency. We equip this agency with a utility function which allows us to propose a very simple and tractable model that is able to provide key insights on the interplay between globalization and labour standards.[3]

In our model, there are initially no institutions in the South that could set OHS standards. Standards are therefore low in this country. We allow for free trade in the final homogenous good and capital and analyze the welfare impact on OHS standards in the North. As expected, we find that there are capital flows from North to South until the marginal productivity of capital is equal in both regions. Moreover, as in traditional factor movement models, the impact of

[2]There are convincing arguments that health also, and maybe predominantly so, affects institution building and through this economic growth (see e.g. Acemoglu et al., 2003). We have to neglect this aspect in our static analysis without negating its relevance.

[3]This immediately raises the question of why an institution is needed and why the market cannot guarantee the efficient level of labour standards. We will return to this in detail at the end of sect. 2.1.

globalization due to a better capital allocation is welfare increasing for both regions. However, since the capital stock in the North is reduced, we also find that workers' wage income decreases beyond the traditional distributional effect caused by factor movements. As the governmental agency takes labour income into account when optimally setting standards, the agency reacts by reducing its demands on high OHS standards. This has a negative effect on welfare in the North.

We then consider the impact of globalization when standards are increased in the South. Via the 'pure health externality', higher OHS standards have a positive welfare impact. Due to the additional 'labour supply externality', the marginal productivity of capital in the South increases as well. This leads to even more capital flowing from North to South. The impact of globalization due to a better capital allocation is also unambiguously positive in both regions. In the North, however, the government agency sets even lower OHS standards, further reducing northern welfare.[4]

When we calibrate our model, we ask how strong the two central predictions of the model are from a quantitative perspective. These predictions are: (i) FDI inflows into the South increase when labour standards improve the health of southern workers and (ii) capital outflows from the North lead to a reduction of work standards in the North. Concerning (i), we find quantities which are far from negligible: If the safety levels in the South were at the same level as in the North, capital flows to the South would amount to a 2.5% increase in the southern capital stock and southern GDP would be 2.7% higher. The latter result is in line with the empirical evidence from Bonnal (2010) who finds that a reduction in the rate of injuries in a country is associated with higher rates of economic growth. With respect to (ii), we find that labour standards in the North do fall when capital flows into the South, but this effect is small. When the South increases safety standards, the negative welfare impact in the North caused by a reduction in the northern labour standards is overcompensated for by the positive welfare impact in the South caused by better working conditions. Overall, world welfare increases due to globalization. Again, with an increase of southern safety levels in line with northern ones, northern GDP falls by 0.13% while world GDP as a whole would rise by 0.25%.

Our paper is related to various strands of the literature that could be classified into policy-oriented, empirical, and theoretical. First, there is a *policy-oriented* discussion on labour standards and the effect of globalization[5]. Srinivasan (1996, 1998) argues that endogenous labour standards will naturally differ between countries with different levels of development 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 setup, universal labour standards will not internalize country-specific inefficiencies. Elliot and Freeman (2003) are more favourable to including labour standards into WTO trading rules, while Bhagwati (1995) is against this. In his discussion, Maskus (2004)

[4] Our welfare results could remind of Matsuyama (1992) who studies the effect of a rise in TFP in the South on welfare in the North. Welfare consequences in his setup are generally ambiguous and depend inter alia on patterns of specialization and demand elasticities. We get more clear-cut results as we allow for one sector only and assume homothetic preferences. Our setup is more general in that we consider a two-country world as opposed to a small open economy. It would be interesting to study the robustness of our results in a framework that is closer to Matsuyama's.

[5] This literature in turn partially 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 more recent introduction and overview is by Viscusi (2007). For further related literature, see section 5.

agrees that "individual enterprise owners can gain from weak labor rights [...] even if the economy is generally harmed".[6] To the best of our knowledge, there is no paper that analyses the effects of FDI on standards, output and welfare as explicitly as we do.

Second, there is a sizeable *empirical* literature on labour standards and globalization (very broadly speaking). As the detailed discussion in section 5 will show, some of these analyses indirectly support our view, especially prediction (i) from above, and none contradicts it. There does not seem to be any study, however, which explicitly analyses our quantitative prediction (ii) on the impact of capital outflows on safety standards in the North. Our calibration results fill this gap.

Finally, our paper is related to the very small *theoretical* literature on globalization and labour standards. Zhao (2009) proposes a partial-equilibrium model with oligopolistic firms operating in three countries, one in the North and two in the South. In the North, firms bargain with trade unions over wages, employment, and labour standards. In the two southern countries, standards are very low because he assumes that unions are inexistent there. He finds that an improvement in southern standards increases multinational production in the South. This result is consistent with our prediction (i). Unfortunately, he does not study directly our prediction (ii). Other theoretical papers have only considered the consequences for the South and have exclusively focused on two types of labour standards: child labour (Dinopoulos and Zhao, 2007 and Doepke and Zilibotti, 2009) and freedom of association and collective bargaining rights (Schutz 2009).[7] Dinopoulos and Zhao's framework is a small open economy with a modern and an agrarian sector. Children are employed only in the agrarian sector. In their model-based analysis, they conclude that trade policies or FDI that increase the modern-sector output reduce the incidence of child labour. Doepke and Zilibotti analyse the effects of labour standards imposed by rich countries. They find that standards that rule out child labour in export sectors can actually imply that political support for ruling out child labour also in the domestic sector is weakened. Schutz provides support for our prediction (i) since he finds that stronger labour standards can attract capital into a country. However, as standards are exogenous in his paper, no conclusion can be drawn from it regarding our prediction (ii). Our paper contributes to this theoretical literature by introducing a general-equilibrium model with endogenous standards that allows to study the output and welfare effects of higher southern standards on the North and, in particular, to answer the question posed in the title of this paper.[8]

2 The two-country model

2.1 Basic structure

Our model economy consists of the capital-rich North and the capital-poor South. Both countries produce a homogenous aggregate good Y^i, where i denotes either North or South. A typical firm produces the quantity y^i by employing capital k^i and labour l^i, the latter of which

[6] Much more has been written in this relatively large but also very policy oriented literature. See sect. 5.2.2 below.

[7] There exists a broader theoretical literature that studies the impact of globalization on working conditions. However, this literature has almost completely ignored the impact on labour standards in particular and has focused more on the impact on wages and unemployment. Two examples of this broader literature include Egger and Kreickemeier (2008) and Koskela and Stenbacka (2010).

[8] For a theoretical analysis of South-South competition (potentially) leading to lower standards in the sense of "race to the bottom - from the bottom", see Chau and Kanbur (2006).

is measured in working hours. All firms use the same technology with TFP $A(s^i)$,

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

where capital and labour inputs have the usual neoclassical effects on output. We assume that all 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. Factors are paid their value marginal product.

The central focus of this paper is occupational health and safety (OHS) in a global world. This aspect is reflected in the production process via the TFP component $A(s^i)$. A job is safe(r) if a worker is (more) certain to return home in good health after 8 (or more) hours of work. We capture safer jobs by a higher $s^i > 0$.

Safe workplaces are clearly in the interest of the worker and, in many cases, OHS is also a central concern for employers. More often, however, there is a fundamental conflict of interest since OHS measures are costly. For modelling purposes, we go to the extreme and exclude firms from any benefits resulting from higher safety. We capture safety costs by letting OHS measures reduce TFP, $A_{s^i} < 0$,[9] where throughout the paper subscripts denote partial derivatives. Given the spot market assumption, a sick worker would simply be replaced by a new healthy worker.

Utility of workers increases in consumption c^i and health $z(s^i)$ but with a decreasing slope. We assume that better safety measures s^i improve health, $z_{s^i} > 0$.[10] The utility function is given by

$$u^i = u\left(c^i, z\left(s^i\right)\right). \tag{2}$$

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

$$L^i = z\left(s^i\right) N^i, \tag{3}$$

where N^i denote potential employment (also measured in hours and assumed to be fixed) multiplied by the share $z(s^i)$ of time that workers are healthy and can actually work. More safety, implying more health, induces the 'pure health externality'. More safety also implies higher labour supply in each country – which we will call 'aggregate labour supply externality'.[11]

We finally turn to the institution that sets OHS standards. There is a long history of fights, disputes and political bargaining about labour standards motivated by health effects of certain types of occupations. This starts from the black lung disease first claimed to be related to working in a coal mine in 1831 and continues until today (think of the burnout syndrome or "Karoshi" in Japan). Worker associations and unions played an important role in establishing appropriate OHS standards (Donado and Wälde, 2012). This is still the case for developing countries today where governmental institutions are not as strong as in OECD countries. In modern OECD countries, however, health and safety standards are by and large regulated by government agencies.[12]

As we want to be very parsimonious in the modelling of OHS setting, we assume that there is an institution equipped with some utility function that sets standards. This institution could be a government agency or a union bargaining with employers. It could also represent

[9] One can always imagine that A initially increases in s but decreases above some threshold level.

[10] For empirical support, see e.g. Fletcher et al. (2010), Cottini and Lucifora (2013) and Barnay (2014).

[11] We acknowledge that standards more general than occupational health and safety standards can also imply a reduction in labour supply. Such standards include the length of work day and work week, minimum-age requirements for workers, vacation time and the like.

[12] This is the reason why we allow the union to set the standards and firms take standards as given (as opposed to a bargaining process between the two). A bargaining setup would move the outcome more towards a central planner solution as the latter weighs worker interests and capital owner interests. A central planner analysis is undertaken below to obtain first-best safety levels as reference points.

the outcome of some more complex political process left in the background where government, firms and unions interact. Whatever the precise mechanism, we assume that this institution only internalizes the pure health externality but not the aggregate labour supply externality. This amounts to saying that the institution has some market power but is not as powerful as a central planner.

An example for such an institution would be a firm-level or industry-level union or a government agency that sets standards for particular technologies. If workers are at least to some extent mobile across technologies, the institution cares about the direct health effect but not about the effect on labour supply as a whole.[13] Given preferences of households in (2), the utility function capturing this behaviour is given by

$$v^i = v\left(w^i l^i, z\left(s^i\right)\right). \tag{4}$$

Labour income of workers considered by our institution depends on the market wage w^i and on labour demand l^i of firms.[14]

One might be concerned about the focus of the institution on labour income $w^i l^i$ only. Institutions are in this sense very "pro-worker". We analyse the behaviour of a central planner further below and find that the qualitative behaviour is similar. In our numerical analysis, we also compare outcomes of a central planner standard and a standard set by our institution. We believe indeed, however, that government institutions focusing on worker issues tend to be more "pro worker" than other specialized government institutions.[15] Reasons for this orientation are to some extend also of a historical nature and go back to how these institutions were created.[16]

As pointed out before, the presence of any institution raises the question of why an institution is required. This paper takes the institution as given and asks what the implications of an institution that behaves according to its objectives in (4) are. Following the tradition of full-information compensating differential arguments (Rosen, 1974, 1986), we show in app. A that an institution is not required if workers are fully informed about health implications of a particular job. In fact, we would obtain similar results under the assumption of full information and without any institution. As argued in detail in Donado and Wälde (2012), however, full information does not seem to be a plausible assumption when it comes to occupational health and safety. It takes a lot of time for individuals to learn about health implications of certain jobs. Without an exchange of information among workers or without systematic collection of information by an institution, a decentralized economy is bound to be characterized by an inefficient factor allocation. Following this argument, we believe that our institutional setup is more plausible and "realistic" than a compensating-differentials setup under full information.

[13] Extending our analysis to allow the institution to take the aggregate labour supply externality into account is straightforward. The qualitative results presented below would not be affected.

[14] A standard issue arising in the modelling of institutions being active at the sectoral or firm level is the indeterminacy of the number of firms or sectors, at least in a simple setup as the one we chose here. We avoid this issue by normalizing firm or sector size in our quantitative application. Future work could explicitly model firm size by allowing for imperfect competition.

[15] Institutions in charge of banking supervision or supervision of incorporations should be more "pro capital owners".

[16] Judkins (1986, p. 240) provides an overview of the literature on the history of occupational health and safety.

2.2 Occupational health and safety

We now ask what the OHS standard in the North would be if standards are set by an institution whose objective function is given by (4). The first-order condition is (see app. E)

$$v_{wl} w l_A A_s + v_z z_s = 0 \tag{5}$$

and the safety level resulting from (5) will be denoted as s^v. The trade off is nicely revealed by (5) which shows the costs (the first term) and the benefits (the second term) of more safety. The costs are a reduction in utility v due to a reduction in the labour income wl. The labour income is reduced since a higher safety level decreases the total factor productivity A which in turn decreases the labour demand l. The benefits accrue since more safety increases health z which then increases utility.

2.3 Equilibrium

The North can carry out 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 insight, 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 the aggregate version of technology (1) and the equilibrium on the labour market (3), the marginal product of capital in the North is given by

$$r = r\left(s, K - \Delta\right) = A\left(s\right) \frac{\partial f\left(K - \Delta, z\left(s\right) N\right)}{\partial \left(K - \Delta\right)}, \tag{6}$$

where K is the endowment of the capital stock in the North and Δ are North-South capital flows. As this expression shows, 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. If the safety level s is too high, the TFP-reducing effect is stronger than the labour-supply effect.

Equilibrium on the world capital market requires equality of the factor rewards for capital,

$$r\left(s, K - \Delta\right) = r\left(s^*, K^* + \Delta\right), \tag{7}$$

where an asterisk now denotes southern variables. This equation determines Δ, given the exogenous autarky endowments K and K^*, an exogenous southern safety level s^* and the endogenous safety level s in the North, i.e. $\Delta = \Delta\left(s\right)$. The northern safety level continues to be determined by a government agency, a union, or a political process in the North as described by (5). An equilibrium in our setup is therefore given by (5) and (7). These two equations determine two endogenous variables: capital flows Δ from North to South and safety levels s in the North.[17]

[17] Keeping s^* exogenous simplifies the exposition. It would become endogenous if we introduced an equation in analogy to (5) for the South as well.

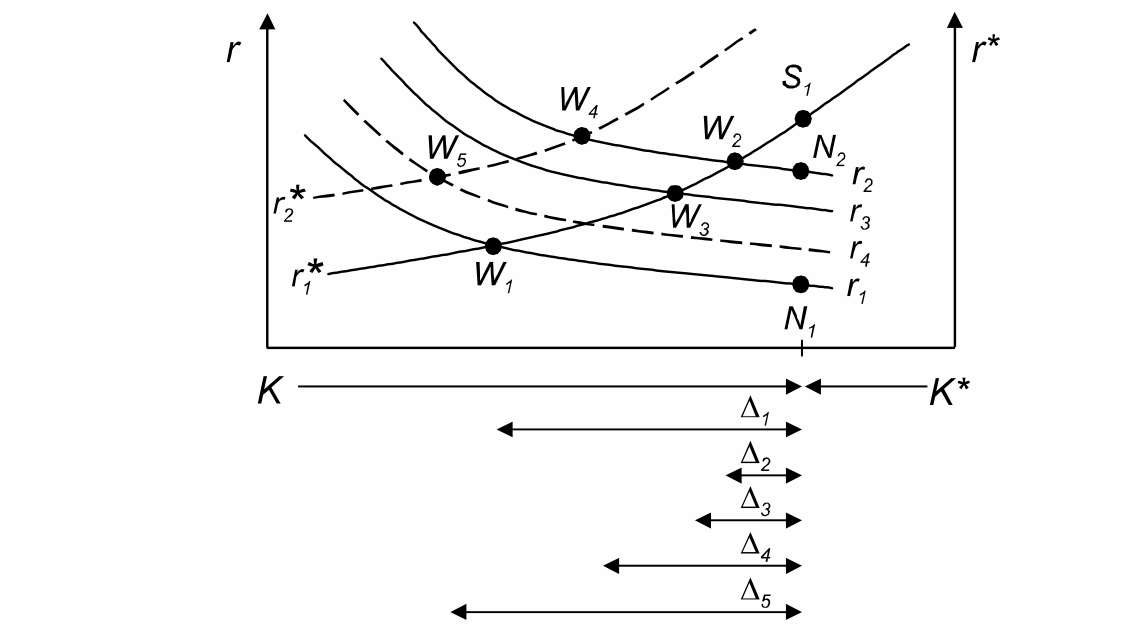

Figure 1 *Autarky equilibria N_i and S_i and world equilibria W_i with free capital flows*

The autarky equilibria in North (N_1) and South (S_1) and the initial world equilibrium on the capital market after globalization (W_1) are illustrated in fig. 1. 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 and 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. The initial loci are r_1 and r_1^*.

2.4 Benchmark cases

Before analysing the impact of globalisation on safety standards, we first need to study three reference cases. The first two ones are (i) the safety level a central planner would set in the North under trade, and (ii) the safety level that capital owners would set under trade. To obtain these safety levels, we need the objective functions of the central planner and capital owners. The former is given by

$$U(s) = U(C(s), z(s)), \tag{8a}$$

where

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

The latter reads

$$R(s) = r[K - \Delta(s)] + r^*(s) \Delta(s). \tag{8b}$$

A central planner in a two-country world maximizing welfare in the North, as in (8a), would take the effects of the safety level s on consumption $C(s)$ and health $z(s)$ into account. Consumption, in turn, depends on domestic production $Y(.)$ and on capital income from abroad, $r^*(s) \Delta(s)$. The central planner has structurally the same objective function (8a) as households in (2). The objective function of capital owners in (8b) adds domestic capital income to foreign capital income.

The optimality conditions that result from choosing an s that maximizes each of the two objective functions in (8) read (see app. E)

$$U_C \left[Y_A + \tilde{r}_A \Delta\right] A_s + \left[U_C \left[Y_L N + \tilde{r}_L N \Delta\right] + U_z\right] z_s = 0, \tag{9a}$$

$$\tilde{r}_A A_s + \tilde{r}_L z_s N = 0, \tag{9b}$$

where $\tilde{r}$ is the equilibrium interest rate. For reference below, the maximum safety levels resulting from conditions (9) will be respectively denoted by s^U and s^R.

The first terms of both optimality conditions in (9) show the costs and the second terms the benefits of an increase in the safety level from each agent's perspective. The costs originate from a reduction of TFP caused by an increase in the safety level, but the variables affected are different. In fact, a lower TFP implies in condition (9a) lower welfare U (due to a reduction in consumption), and in condition (9b) a lower interest rate.

The benefits described by the second terms of both conditions originate from an improvement in the health level z of the labour force. A higher health level implies in condition (9a) a higher welfare U (due to an increase in consumption and in health per se), and in condition (9b) a higher interest rate (due to an increase in the labour supply).

A third reference case that we also need is what we call the "laissez-faire" safety level. This is the safety level that comes from maximizing firms' profits $\pi = A(s) f(k,l) - rk - wl$ with respect to s. It is straightforward to see that the resulting safety level (denoted by s^π) is negative, $d\pi/ds = A_s < 0$. The reason is that firms only see the TFP-reducing impact of an increased safety. As a consequence, firms would like OHS standards to be as low as possible. Assuming that negative safety levels do not exist, we will set the laissez-faire safety level equal to zero: $s^\pi = 0$.

2.5 Ranking of safety levels

For our subsequent analysis, we make the following

Assumption 1 *Let the objective function of the planner (8a), the objective function of the safety-setting institution (4), and the production function (1) all take a Cobb-Douglas form: $U = C^\mu z^{1-\mu}$, $v = [wl]^\gamma z^{1-\gamma}$, and $y = Ak^\alpha l^{1-\alpha}$. Based on these functional forms, assume that $\alpha < \gamma$ and that $s^v > 0$ hold.*

How strong are these assumptions? First, a Cobb-Douglas specification is neither as general as possible nor is it excessively strong. Second, the output elasticity of capital, α, traditionally lies around 1/3. If the standard setting institution attaches an importance to income of at least $\gamma = 1/3$ or attaches an importance to safety of at most $1 - \gamma = 2/3$, then this condition will hold. We consider this to be a very weak assumption as well. Finally, the assumption that $s^v > 0$, which holds for plausible parameter values (see below), only guarantees that the safety-setting institution sets a positive safety level. We can then formulate

Proposition 1 *Under assumption 1 , the safety levels set by the firm, the safety-setting institution, the capital owners and the welfare planner under trade can be ranked as*

$$s^\pi < s^v < s^R < s^U. \tag{10}$$

Proof. See app. B.1. ■

In what follows, we will often refer to situations in which the ranking in (10) holds. One should therefore consider the sufficient conditions in assumption 1 when judging the plausibility

of this ranking or accept the ranking on intuitive grounds. Whenever a result is based on this ranking or parts of it, we will explicitly state this in the propositions or corollaries.

3 OHS under trade and capital flows

After having laid the ground for our analysis, we will now study the effects of "globalization", i.e. international capital flows, on safety standards and thereby on output and welfare.

3.1 Capital flows in a two-country world

We ask three questions here: First, in which direction will capital flow when our two economies open up for trade? Second, how do safety-setting institutions affect these international capital flows? Third, how do international capital flows affect the safety level chosen by these institutions?

Thinking of a scenario in which countries are in autarky and then open up for capital flows, let us begin by assuming that there are no safety-setting institutions in any of the two countries and that the safety standards are set at the low and invariant laissez-faire level s^{π}. Safety levels are therefore equal in both countries and the only difference between the two countries is that the North has more capital than the South ($K > K^*$). When the initial capital endowment before capital flows is given as drawn in fig. 1, 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, of a total volume of Δ_1, flows from the North to the South implying an equalization of returns to capital.

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 also one of the biggest recipient of foreign investments. When capital flows in "all" countries in the world are analysed, capital flows from the North to the South from the 70s to the mid 80s, reverses subsequently and flows 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 (Prasad et al., 2006, chart 4). If the world excluding the US is analysed, capital also flows from North to South (chart 3). Lane and Milesi-Ferretti (2007, 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 closest to our variable Δ in this long-run static equilibrium) or if the focus is on industrialized countries other than the US.[18]

As a preliminary result for the second question, we explore a simple general relationship between capital flows Δ and the safety level which will form the background of more specific findings further below. The general finding is given in

Proposition 2 *Capital flows Δ from the North to the South fall (rise) when safety standards s in the North rise (fall) if and only if safety standards are below (above) the level s^R which maximizes capital returns in the North,*

$$\frac{d\Delta}{ds} \lesseqgtr 0 \Leftrightarrow s \lesseqgtr s^R. \tag{11}$$

[18] 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).

Proof. See app.B.2. ■

The derivative (11) is very intuitive. An increase of s implies an increase in returns to capital in the North for all $s < s^R$. Returns are highest at s^R and fall for $s > s^R$. As capital flows to where returns are highest, capital flows Δ rise in s as long as s is "low" and fall when s are "excessive", i.e. $s \geq s^R$.

We now turn to the second question on the effects of safety-setting institutions on capital flows. For this purpose, we reintroduce endogenous safety levels in the North. In line with our general idea of suboptimally low safety levels in the absence of a safety-setting institutions as expressed in assumption 1, the autarky safety level s^v is higher than in the laissez-faire situation where s^π obtains. Also following assumption 1, the safety level s^v is lower than the safety level s^R that maximizes returns to capital investment. We now ask how the introduction of endogenous safety levels affects capital flows. We then find

Corrolary 1 *Given assumption 1, labour standards set by a standard-setting institution reduce capital flows from the North to the South.*

Given that the endogenous OHS level is below the capital-return maximizing point, $s^v < s^R$ as just discussed, the capital demand function in fig. 1 moves up from r_1 to r_2. The northern autarky equilibrium point now lies at N_2 rather than at N_1. As has been discussed after the expression for the marginal productivity of capital in (6), capital owners are actually in favour of higher safety levels as long as this has a positive effect on capital rewards (again, as long as $s^v < s^R$). 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 Δ_2 only. Higher (but not too high) safety levels reduce capital outflows from the North.[19]

Before we can tackle the third question, we need to explore the link between the endogenous safety level and the domestic capital endowment. We know that this safety level is a function of the capital stock used for production in the North. We can show this most conveniently for a CES specification of the objective function (4) for the safety-setting institution,

$$v = \left\{ \gamma \left[wl \right]^\lambda + \left[1 - \gamma \right] z\left(s \right)^\lambda \right\}^{1/\lambda}, \qquad \lambda < 1, \tag{12}$$

where the elasticity of substitution between income and health is given by $1/\left(1-\lambda\right)$. We can then prove

Proposition 3 *An increase (a reduction) in capital endowment K of the North leads to an increase (a reduction) in the*

(i) decentrally set safety level s^v as long as income wl and health $z\left(s\right)$ are bad substitutes in the creation of utility in (12), $\lambda < 0$. When they are good substitutes, the result is ambiguous,

$$\left\{ \begin{array}{c} \lambda < 0 \\ \lambda = 0 \\ 0 < \lambda < 1 \end{array} \right\} \Rightarrow \frac{ds^v}{dK} \left\{ \begin{array}{c} > \\ = \\ ? \end{array} \right\} 0.$$

[19] This derivative also sheds light on the question of North-South or South-North capital flows and their relation to institutions, as recently analysed by Matsuyama (2014). While we do not look at institutions that affect credit markets, we can get the same non-monotonic effect between institutional quality (labour standards) and capital flows. When s increases beyond s^R, we first observe a rise in capital inflows to the North and then a fall, once s is larger than s^R.

(ii) safety level s^U set by the planner as long as income and health are bad substitutes or independent for utility ($U_{Cz} \geq 0$) and *endowment K and safety are bad substitutes or independent in the provision of income ($C_{Ks} \geq 0$). When this is not the case, the result is ambiguous,*

$$\left.\begin{array}{c} U_{Cz} \geq 0 \text{ and } C_{Ks} \geq 0 \text{ (bad substitutes or independent)} \\ \text{either } U_{Cz} < 0 \text{ or } C_{Ks} < 0 \text{ or both negative (good substitutes)} \end{array}\right\} \Rightarrow \frac{ds^U}{dK} \left\{ \begin{array}{c} > 0 \\ ? \end{array} \right\}.$$

Proof. See app. B.3 for (i) and app. B.4 for (ii). ■

The proposition provides conditions under which an increase in wealth in the North (a higher capital endowment K) leads to higher standards in the North. The safety-setting institution would set a higher safety level if the elasticity of substitution between health and income is low. This can be understood by referring to the income and substitution effect. There is an income effect due to more capital which increases demand for health $z\,(s^i)$ and consumption, the two arguments in the utility function of the standard-setting institution (12). The price of health relative to consumption, however, rises the more capital there is and households tend to substitute health by income.

In the Cobb-Douglas case ($\lambda = 0$) these effects cancel. Safety levels do not change in the course of the 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 decrease 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, Flanagan, 2006, pp. 44-7). This is the bad substitution case ($\lambda < 0$) in our model. When a society becomes richer, it can afford higher health standards 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.

We would also like to stress part (ii) of this proposition. Our findings on the domestic safety level and the domestic capital stock from prop. 3 do *not* depend on the existence of some institution that might set a non-optimal safety level s^v. Conditional on a technical condition concerning the substitutability of the capital stock and safety on income (the sign of C_{Ks}), a central planner with utility function (8a) would set an optimal safety level s^U in the same manner as a safety setting institution. To put it short, even a central planner would give up on some of the health safety level if income drops due to a lower capital stock and if health and income are bad substitutes.

Let us now provide answers to the third question. Assume that the endogenous OHS s^v level does not respond to changes in the capital stock. This holds for the objective function (4) of our standard-setting institution if the former has a Cobb-Douglas structure, i.e. $\lambda = 0$ in (12) and for a Cobb-Douglas version of the planner's objective function (8a). We then find

Corrolary 2 *Let income and capital be characterised by a unitary elasticity of substitution ($\lambda = 0$). Globalisation in the form of international capital flows does not have an impact on domestic labour standards.*

Under the assumption of $\lambda = 0$, whether capital flows in or flows out (i.e. whether there is a rise or fall of domestic wage levels), is irrelevant for the endogenous safety levels set by the standard-setting institution or a planner. Under the empirically more plausible assumption of bad substitutes, however, we find

Corrolary 3 *Let income and health be bad substitutes in the utility function (12) of the standard-setting institution in the North, $\lambda < 0$ or for a planner. Capital outflows from the North then lead to a reduction of work standards s^v in the North.*

This is also illustrated in fig. 1. Starting from N_2 and S_1 as before, capital outflows will lead to a "temporary" equilibrium at W_2. However, 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 in 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.

3.2 Capital flows and welfare

Let us now turn to the welfare effects of international capital flows. Welfare in both countries in (8a) 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 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 Δ explicit, we obtain two expressions related to (8a),

$$C = Y\left(A\left(s\left(K-\Delta\right)\right), K-\Delta, z\left(s\left(K-\Delta\right)\right)N\right) + r^*\left(K^*+\Delta\right)\Delta, \tag{13}$$

$$C^* = Y^*\left(A^*\left(s^*\right), K^*+\Delta, z^*\left(s^*\right)N^*\right) - r^*\left(K^*+\Delta\right)\Delta. \tag{14}$$

We see that capital flows Δ 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. C.1)

$$\frac{dU}{d\Delta} = U_C\left[r^* - r + r^*_\Delta\Delta\right] + U_C Y_s\frac{\partial s}{\partial\Delta} + U_z z_s\frac{\partial s}{\partial\Delta}, \tag{15}$$

$$\frac{dU^*}{d\Delta} = -U^*_{C^*}r^*_\Delta\Delta > 0, \tag{16}$$

where again subscripts denote partial derivatives: e.g. U_C is the change in northern welfare due to an increase in consumption in the South.

Capital flows influence northern welfare through the "classic channel", the "efficiency channel" and the "health channel". The first term in (15) 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 flowed out 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.[20] As the gains from higher capital

[20] This effect is familiar from the literature on international factor flows in two-country worlds or in the case of *large* open economies. We are grateful to Juergen Meckl for discussion of this point.

rewards abroad compensate for the losses from the fall in 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". 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 for 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 ($\partial s/\partial \Delta < 0$, as discussed after fig. 1), a further reduction of s caused by capital outflows would increase inefficiencies in the North and thereby reduce output.

The final term in (15) $U_z z_s \partial s/\partial \Delta$ relates more to the government agency and its impact on higher OHS standards. The closer the endogenous safety level is to the social welfare-maximizing level s^U, the higher the social welfare is. If the endogenous safety level is lower than s^U, that is, if $U_z > 0$, any reduction in safety levels (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 already too low before capital flows. This reduction has a negative effect on efficiency and health per se. Welfare gains through capital flows are therefore reduced by negative OHS effects.[21]

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 $r - r^*$ that we see in (15) is zero in (16). It benefits, however, from the reduction of the domestic interest rate caused by inflows, $r^*_\Delta < 0$. There is no health channel as safety standards are exogenous in the South.

4 OHS standards in the South

We now ask how the results obtained so far are affected if a standard-setting institution is also introduced in the South. What are the welfare consequences for the North, the South, and the world economy and how would northern endogenous OHS standards react to this?

4.1 International capital flows and OHS

We stipulate that southern safety levels increase if a standard-setting institution is introduced in the South. If we assume that this new level is still lower than the interest-maximizing southern safety level (that is, if $s^* < s^{R^*}$), the result of an increase in the southern safety level will be as summarized in the following

Proposition 4 *If southern safety levels s^* are below the level s^{R^*} that maximizes returns to capital, then a rise in southern safety levels* increases *inflows of capital to the South and capital owners world-wide are better off. Otherwise, a rise of s^* decreases inflows of capital to the South.*

Proof. See app. B.5 ■

This proposition is illustrated in fig. 1. Raising s^* implies an increase of the capital demand curve from r_1^* to r_2^*. Capital owners are better off. The equilibrium moves from W_2 to W_4 and the flow of capital to the South increases from Δ_2 to Δ_4.

[21] Clearly, if one believes that OHS standards are excessive, i.e. above s^U, capital outflows leading to a reduction of safety levels would imply welfare gains caused by capital flows per se and by reduced OHS standards.

Of course the question concerning the plausibility of the assumption $s^* < s^{R^*}$ and the subsequent rise in returns arises. Why does it take an extra institution like the government or even a trade union to help capital owners to increase their returns from investment? The answer is simple: 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 safety levels. Firms are caught in a prisoners' dilemma. The need for higher safety levels is more pressing for workers as they are physically affected by 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.

At first glance, it might be surprising that allowing for higher standards in the South can increase capital inflows to this country. But, if TFP losses are not too large, northern investors simply profit from a healthier labour force in the South. This idea is supported by empirical evidence. For example, Alsan et al. (2006) find that an improvement in a population's health increases gross FDI inflows to low- and middle-income countries. More directly, Flanagan (2006) finds a significant negative correlation between fatal job accident rates and FDI inflows. See sect. 5 for more details.

What are then the consequences for safety levels in the North? The findings are parallel to those discussed in cor. 2 and 3. We summarize them in

Corrolary 4 *(i) Let health and income in the North be characterized by a unitary elasticity of substitution ($\lambda = 0$). An increase in the safety level in the South does not affect the safety level in the North.*
(ii) Let health and income in the North be bad substitutes ($\lambda < 0$). An increase in the safety level in the South reduces the northern safety level as long as $s^* < s^{R^*}$.

The first implication is simple to understand. While a rise in southern standards increase productivity of capital and thereby the flow Δ of capital to the South, the implied outflow from the North does not affect northern standards. Even though wages in the North fall, there are no effects on standards as the latter do not respond to wage changes.

The second implication builds on the intuition of cor. 3. Capital inflows into the South for $s^* < s^{R^*}$ imply capital outflows from the North. By cor. 3, northern safety levels fall for $\lambda < 0$ due to capital outflows. For $s^* > s^{R^*}$, a further rise of safety levels in the South reduce returns to capital in the South. Capital outflows from the South lead to capital inflows in the North and northern standards rise.

4.2 Global standards and welfare

What are the welfare implications of higher southern safety levels? Preserving s^* as an exogenous quantity, welfare effects for the North and South are (see app. C.2),

$$\frac{dU}{ds^*} = U_C r^*_{s^*} \Delta + U_C Y_s \frac{\partial s}{\partial s^*} + U_z z_s \frac{\partial s}{\partial s^*}, \tag{17}$$

$$\frac{dU^*}{ds^*} = -U^*_{C^*} r^*_{s^*} \Delta + U^*_{C^*} Y^*_{s^*} + U^*_{z^*} z^*_{s^*}. \tag{18}$$

These conditions look similar to those in (15) and (16) where the effects of capital flows were analysed. In fact, term one in (17) 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 health levels 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 Δ since $r^*_{s^*} > 0$. As opposed to (15), the classic channel here leads 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 them). 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 falls through this health channel as well.

Do these channels capture any concerns spelled out in policy discussions? On the one hand, commentators seem to be afraid of low labour standards in the South as this might reduce standards in the North. According to our view, northern standards can fall due to globalization as capital leaves the country. But are commentators also afraid of potentially rising standards in the South? Admittedly, this is not so often heard. What is heard, however, is the fear that the North might lose due to a catching up of the South. More knowledge, human capital, and better technologies in the South increase competition from the South and market shares of northern firms could be reduced. If this process of development goes hand in hand with better standards (as empirical work suggests), the fear of the South catching up could partially also be seen as of a fear of higher standards in the South.

Considering now the impact in the South, two new terms as compared to (16) 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 looses out due to higher interest payments to the North but gains from efficiency gains in production caused by higher OHS standards and from health per se.

4.3 Robustness

How robust are our findings if we depart from our one-sector economy and allow for Heckscher-Ohlin or Ricardo-type patterns of specialization? While leaving detailed analyses for future work, our discussions of the three channels from the previous section clearly suggest that they remain intact even in a model with many sectors.

As in the one-sector model, an increase in southern safety increases interest rates paid on previous investments made by the North. This classic channel leads to gains for the North. The efficiency channel would be negative as well under the assumptions spelled out above (the safety level in the North is below its output-maximizing level implying capital outflows from the North). The third channel capturing the direct welfare effects of lower standards in the North would be negative as well.

Specialization according to comparative advantage would open a fourth channel which is absent in our setup. The gains (or losses) from more (or less) specialization. If there was an increase of the safety level in the South in one sector only, this sector would expand relative to the other sector. If this is the sector where the South has a comparative advantage, both

countries would specialize more and there would be an additional source for gains in the North due to higher standards in the South. If the sector expands where the South has a comparative disadvantage (e.g. when standards increase in the manufacturing sector), gains from trade due to specialization in the North would fall. In either case, the central mechanism we stress in our paper remains intact. Higher standards in the South lead to capital outflows to the South yielding the implications discussed above in channels one to three.

5 Quantitative findings

Our model makes two central qualitative predictions: (i) FDI inflows increase when labour standards improve health/ productivity of workers so that returns to capital investment increase. (ii) Capital outflows from the North lead to a reduction of work standards in the North. The purpose of this section is to offer a quantitative picture of these predictions. How strong are these effects? Before we do so, however, we offer a brief overview of related empirical work. This will allow us to put our findings into a broader context and draw more convincing conclusions about the central question posed in the title of our paper.

There is relatively good empirical support for our first prediction. The second prediction will sound controversial to many. When we look at existing empirical work, however, there is no study which contradicts our view and there are some that indirectly support it.[22]

5.1 The effect of standards

The empirical literature can be classified into whether standards are used as an explanatory variable or whether standards are to be explained. When standards are used as explanatory variables, one can inquire into the effect e.g. on trade patterns. The OECD (2000) provides a summary of various studies. They ask whether labour standards influence or "bias" trade patterns in any way. While there are some surprising findings (higher standards reduce exports of skill-intensive goods), it is not always straightforward to draw conclusions from these findings. See Brown (2000) for a detailed appraisal.

One can also analyse the effects of standards on FDI. Flanagan (2006, p. 135 and tab. A6.3) points out that "with one exception, labor conditions in a country are not significantly correlated with the country's share of investment inflows. The exception is job safety: other things equal, investment shares are lower in countries with relatively high fatal job accidents rates." Other labour standards (like right for collective bargaining etc.) have basically no effect.

A study which does *not* explicitly use standards as an explanatory variable is undertaken by Alsan et al. (2006). They find empirical evidence that an improvement in a population's health increases gross FDI inflows to low- and middle-income countries. They measure population health by life expectancy. The study is useful for our question as a simple (yet conditional) conclusion can be drawn from it. *If* standards have a positive effect on life expectancy (something one would expect), better standards increase FDI.

[22] Before we proceed, it is worth pointing out that we do not take into account the huge empirical literature on the effects of trade or FDI on wages, relative wages or unemployment (see, for example, Hijzen et al. 2013). While this might sound obvious, some commentators conclude that trade cannot have an effect on standards as it has no effect on the wage structure. We believe that conclusions of this type are not really supported by evidence.

5.2 Determinants of standards

Generally speaking, the empirical literature finds that there are no harmful effects caused by trade or FDI on labour standards in the South. We did not find any explicit analysis of the effects on northern countries.

5.2.1 The child labour literature

In the child-labour literature, Edmonds and Pavcnik (2006) find that countries that trade more have less child labour. They attribute this relationship to the positive effect of trade on income. Levine and Rothman (2006) have basically very similar findings.[23] Neumayer and Soysa (2005) find that the effect of FDI is just as positive as trade. This effect is confirmed by Davies and Voy (2009). This suggests that globalization is not so bad for the South after all.

Davies and Voy (2009) use data from the ILO on labour force participation of children aged 10-14 as their dependent variable. They find in their regressions, instrumented, pooled or not, that FDI has a negative significant or a negative insignificant effect on child labour. The effect becomes insignificant when income is added as an explanatory variable. As income is highly significant in basically all of their regressions (tables 1 to 3), child labour seems to be a poverty problem but not an FDI problem. They conclude that FDI is a good instrument to combat child labour as FDI increases income.[24]

5.2.2 Informal discussions of labour standards

There is a huge literature which discusses labour standards and the effects of globalization in an informal way. This literature is very informative and full of details but cannot be used as a test for our model. An excellent introduction to issues surrounding labour standards and trade is provided by Basu et. al (2003). Aspects related to "races to the bottom" are discussed in this book by Singh (2003, part II, ch. 2). OECD (2000) has a short informal section on "race to the bottom". Various informal discussions stress that competition under perfect information limits firms' possibilities for reducing labour standards. It is acknowledged that this might not hold in second-best economies. Historical evidence concerning the US seems to suggest that there was a race to the bottom concerning child-labour before 1938.

Elliot and Freeman (2003, p. 126) conclude their detailed description of various case studies by stating that "trade pressure and incentives from consumers and governments can lead to improved labor standards in LDCs". In this sense, trade combined with the right incentives is beneficial for standards as well.

5.2.3 Investigating standards more directly

Turnbull and Wass (2007) provide a careful analysis of various case studies concerning the effect of reforms in ports. They argue that "globalization [...] brought in its wake a marked

[23] Edmonds et al. (2009) analyse the effect of India's 1991 trade tariff reform. While child labour has been on the decline in India generally speaking, the decline is attenuated in urban areas where tariff reduction hit the population most strongly. The interpretation of these results is less straightforward as the authors discuss themselves.

[24] One could argue that child labour and health standards are two different issues. Children can be imagined to work in safe conditions without any detriment to their health. While the World Health Organization argues that the worst forms of child labour are quickly declining, "there are still 215 million children caught in child labour and <...> 115 million in hazardous work" (ILO, 2010, p.5). Given these facts, we believe that looking at determinants of child labour is informative about determinants of health standards more generally.

deterioration in dock workers' terms and conditions of employment." They find that reforms generally worsen workers' working conditions. These results are not derived, however, by standard econometric analysis.

Neumayer and Soysa (2007) study the impact of FDI and of trade on the economic discrimination of women and on the incidence of forced labour. They find some evidence that trade openness improves both standards, but the impact of FDI is not significant.

The most comprehensive analysis is undertaken by Flanagan (2006). He uses various measures for standards as dependent variables. They include "weekly hours", "life expectancy" or "child labour" but also "fatal accidents" (on the job). As reported in tab. A3.3, GDP per capita significantly reduces fatal accidents (and also child labour or weekly hours). These results are less strong, however, when additional institutional variables are added as explanatory variables (tab. A3.4), at least for fatal accidents. In a panel analysis with fixed effects (tab. A4.1), the trade share and a measure of "open policy" has a negative impact on fatal accidents. Unfortunately, the complete results of regressions including GDP per capital and openness measures are not reported. One could conclude, however, that trade and higher GDP per capital reduce job injuries and improve standards. This is similar to the findings for FDI and trade on child labour cited above.

This positive conclusion is in line with Flanagan himself who, generally speaking, draws a very positive picture about the link between trade and standards. He also finds, however, that firms in import-competing sectors in the North tend to reduce (or at least do not increase) labour standards. (The same is true for some firms in export-processing zones.) He also states (p. 85) that "more open trade may be threatening the working conditions of some workers in industrialized countries".

5.3 Our quantitative predictions

We now return to our two-country world and calibrate it so that various targets are met. We then use this calibrated version in order to analyse the effects of international capital flows on northern safety and the effects of higher OHS standards in the South.

5.3.1 Calibration

We now assume a CES structure for the utility function of the standard-setting institution as in (12) and a Cobb-Douglas production function for firms,

$$y^i = A\left(s^i\right)\left(k^i\right)^{\alpha}\left(l^i\right)^{1-\alpha}. \tag{19}$$

The link between safety s and TFP $A(s)$ and the share $z(s)$ of the healthy workforce are assumed to follow

$$A(s) = be^{-\phi s}, \qquad z(s) = 1 - qe^{-\chi s}. \tag{20}$$

The parameter b gives the upper bound to TFP which is obtained under zero safety measures ($s = 0$). The elasticity of TFP with regard to safety is captured by ϕ. Similarly, q captures the share of sick individuals in an economy without safety measures and χ is the response elasticity with respect to s. Optimal safety levels for these functional forms are special cases of the general results in (9) and are provided in app. G.

Given these functional forms, we can now discuss our targets. As we would like to understand the implications of various policy experiments, we need an initial equilibrium which reflects the real world in a quantitatively sufficiently good way. Our initial equilibrium should satisfy four

targets. It should (i) display a reasonable endogenous share $z(s^v)$ of healthy workers in the North and (ii, iii) the GDP levels in the North and in the South should represent relative economic importance. The latter makes sure that the size of capital flows will take reasonable values and the predictions about the effects of changes in labour standards in the North are credible. Our fourth target relates s^v to s^Y_{aut}, where s^Y_{aut} is the safety level that maximizes output in autarky (see app. F.2). In app. F, we rank the safety levels in a similar way as in prop. 1, also for the Cobb-Douglas specifications of ass. 1, but for the autarky case. It turns out that the autarky level s^Y_{aut} is identical to s^R which implies that $s^v < s^Y_{aut}$. In other words, if we want to stick to ass. 1, we need to set parameters such that (iv) $s^v < s^Y_{aut}$.

The desired quantities for these targets are shown in the upper left part of tab. 1. 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. $z(s^v) = .98$. The relative economic importance of the North and the South is captured by setting Y equal to the GDP of the average G7 country and Y^* to the population-weighted mean of China and India.[25] Our calibration therefore captures the effect of integrating capital markets of the average of China's and India's economies with the capital markets of the average G7 country. Target (iv) is met by computing $z\left(s^Y_{aut}\right)$ and setting it equal to .99.

We further set various parameters at levels which correspond to observations in the data. This group appears in the upper right corner of tab. 1. Unconditional accident rates in non-industrialized countries are 3 times higher than in industrialized countries. If we correct for sectoral composition, we find that accident rates in non-industrialized countries are still 2 times higher.[26] In other words, non-industrialized countries "specialize" in risky activities. For our calibration, we use the ratios *without* correcting for sectoral composition. While it is true that sectoral composition explains half of the differences in accident rates,[27] a worker in an non-industrialized country does have a 3 times higher accident rate than a worker in an industrialized country. As a consequence, the absence rate due to health is, say, $3 * 2\% = 6\%$ in the South and therefore $z^* = .94$. The parameter q will determine (see the discussion after (20)) the share of healthy workers when there are no safety measures at all. If we are willing to assume that high accident countries (i.e. $z = .94$) are countries with close to no safety measures (i.e. $s = 0$), we can conclude that $q = .06$ from (20). The output elasticity $\alpha = .33$ for capital is standard and does not need further discussion. Population size N in the North is normalized to unity and population size N^* in the South corresponds to the ratio of the population size of China plus India to the population size of the G7 countries.

Parameters which are not reported in the table are ϕ, χ, λ and $K + K^*$. The parameters ϕ and χ from (20) matter only as their ratio $\Phi \equiv \phi/\chi$ (see app. G.5.2). The parameter λ is set equal to -1 (which is the bad-substitution case often referred to above) and does have only minor effects on parameters or equilibrium properties. The world capital stock was set to 300 which gives a reasonable interest rate of 4.9%.

[25] All nominal data is in 2006 PPP US$. All data is taken from World Bank (2008).

[26] We compute these numbers using data from Hämäläinen et al. (2009, tables A1-A6) for occupational fatal and nonfatal rates, and from the World Development Indicators for sectoral composition. We first regress fatal rates on a dummy equal to one if the country is an industrialized country. Our predicted rates are 3 times higher for non-industrialized countries. We then control for differences in sectoral composition by adding three variables: agriculture, industry, and services. These are respectively the share of total employment in agriculture, industry, and services in each country. For this second regression, our predicted rates are 2 times higher for non-industrialized countries. We obtain very similar magnitudes if we instead use nonfatal rates as a dependent variable. See app. B.6.

[27] For any accident in the North, there are 3 accidents in the South, i.e. accident rates are 3 times higher. Comparing within a given sector, for any accident in the North, there are 2 in the South. Hence, the increase of accident rates by 200% is explained by 100% within sectors and by 100% by sectoral composition.

We hit our targets $z(s^v)$, Y, Y^* and $z\left(s^Y\right)$ by calibrating the parameters b, b^*, γ and $\Phi \equiv \phi/\chi$, taking equilibrium equations (5) and (7) into account. The parameters are shown in the lower left corner of tab. 1. For a summary of the calibration equations, see app. G.5.[28]

endogenous quantities to be matched			
$z(s^v)$	Y	Y^*	$z\left(s^Y\right)$
.98	38,000[25]	5,800	.99

parameters from other data			
z^*	q	α	N^*
.94	.06	.33	$\frac{2422}{722}$

calibrated parameters			
b	b^*	γ	ϕ/χ
6.1	.79	.96	.0067

equilibrium quantities	
$\frac{K-\Delta}{K+K^*}$	$z\left(s^U\right)$
86.8%	99.7%

Table 1 *Calibrating the free capital flow equilibrium (see text for details)*

The calibrated values are in the range one would expect. Relative TFP between the North and South implied by b and b^*, is maybe a bit larger than usual. However, if differences in education and experience levels between workers in the North and South are taken into consideration, relative TFP would fall and become closer to standard ratios. The parameter with a relatively high value is γ, the weight attached by the OHS setting institution to labour income.

In the resulting equilibrium, summarized in the lower right corner of tab. 1, 86.8% of the world capital stock is used in the North. The health level of a welfare maximizing planner would be 99.7% i.e. it exceeds the output-maximizing level by 0.7%.

5.3.2 Quantitative globalization effects on northern safety

We can now provide an estimate of how much safety in the North fell (or rose) due to globalization. We know the stock of a country's wealth held abroad from estimates by Lane and Milesi-Ferretti (2007). This stock corresponds to Δ in our model. We can also obtain comparable stocks K^i of country's i capital that is used for domestic production from AMECO (2010). Based on these data, we make two assumptions. First, for countries in which Δ^i is positive (that is, for countries in which globalization implied a capital outflow), we assume that the capital stock in a hypothetical closed economy is equal to $K^i + \Delta^i$. This is clearly an extreme assumption since it implies that any unit of capital invested abroad is one unit lost at home (there is, however, evidence on the aggregate level supporting this assumption, see Desai et al., 2005). Second, for countries in which Δ^i is negative, we assume that the capital stock in a hypothetical closed economy is only K^i.

In both cases, we can compute the hypothetical safety level s_i^{hyp} in this hypothetical closed economy i with a capital stock of K^i (when Δ^i is negative) and $K^i + \Delta^i$ (when Δ^i is positive) by using expression (5). It is then straightforward to obtain the heath level $z\left(s_i^{hyp}\right)$ in such a non-globalized closed economy. The difference between this health level and the percentage of healthy workers as given in the data (we used .98 above in tab. 1 in our EU average) is the gain or loss caused by globalization.

The ratio of $\rho \equiv \left(K^i + \Delta^i\right)/K^i$ for G7 countries (excluding Japan for data inconsistency reasons) from 1991 to 2004 varies from 82.2% (i.e. $\Delta^i < 0$) for Canada in 1991 to 105.9% for Germany in 1991. For all years where $\rho < 100\%$, globalization actually *improved* health levels in the North as capital flowed into the country. Starting from our 98% health level under globalization from tab. 1, we obtain

[28] The matlab code is available from sites.google.com/site/alejandrodonado77 and waelde.com/pub.

Quantitative finding 1 *The range we attribute to globalization extends from an increase in the health level in the North from 97.85% without international capital flows to 98% (the Canadian case) to a decrease from 98.04% to 98% (the German case).*

These results are clearly *very* small and almost negligible. Even a reduction of the capital stock by 20% leads to an increase in the sickness rate from 2% to 2.15% only. The main reason for this very low capital-stock-to-health elasticity is the fact that the North is very close to the social optimum. At this point, the slope of health with respect to the capital stock is very low. As our estimates should be considered as an upper bound, we conclude that northern inhabitants should not worry too much about negative effects of capital outflows on northern health standards.

5.3.3 The quantitative effects of higher standards in the South

Qualitatively, we have seen that the North tends to lose out due to higher OHS standards in the South and only the South seems to gain. Should OHS standards in the South then be increased? We can provide a more convincing answer to this question by quantifying the effects. Starting from the equilibrium in tab. 1, our policy experiment consists of increasing the southern level z^* from .94 to the northern level of .98, or put differently, to decrease absence rates in the South from 10% to 2%.

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 94% to 98% in our counter-factual experiment corresponds to an increase of approx. $4/94 \approx 4.3\%$ (not percentage points), i.e. an increase of $4.3/1.5 = 2.8$ additional years in life expectancy. Such a change should imply an increase of inflows of $2.8 * 9\% \approx 25.2\%$. 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 25.2% increase in inflows implies a 2.5% increase in the capital stock. Hence, our policy experiment where we increase southern health shares from 94% to 98% should imply an increase of the southern capital stock of 2.5%.

We find that our capital flows amount to a 2.48% increase in the southern capital stock, i.e. they are extremely consistent with the findings of Alsan et al. (2006). We are therefore confident that our predictions on health and output are empirically of high relevance. Concerning health effects and output effects, we obtain

Quantitative finding 2 *International capital flows imply a decrease in safety levels s in the North which imply that the share $z(s)$ of time individuals are healthy decreases by 0.003%. GDP in the North decreases by 0.13% and increases in the South by 2.7% implying an increase of world GDP of 0.25%.*

Put differently, rising OHS standards in the South do have a theoretical but not a practical negative effect on work standards in the North. Similarly, higher southern standards do reduce domestic production in the North, but only by a negligible amount. In contrast, southern production increases considerably, leading to an overall increase in world output.

5.3.4 What does this tell us?

Given our brief survey of the empirical literature and given our quantitative results, what do we learn from this? Concerning our first prediction about FDI inflows, our findings are in line with the findings of Flanagan (2006) and (indirectly) Alsan et al. (2006) concerning the effects of standards as explanatory variables for capital inflows. We provide a theoretical setup which offers a possible explanation for their findings that lowering fatal job accident rates and increasing life expectancy increases FDI. The new condition we identify for these findings to be theoretically consistent says that OHS standards in the South are lower than the interest-rate maximizing safety level s^R. If this is the case, any improvement increases inflow of FDI. If some countries have well-functioning institutions and the safety level is close to s^R, the effect of an increase in OHS standards - while it could still increase welfare - might reduce FDI inflows.

Let us turn to the second strand of the literature inquiring into the determinants of standards (mainly in the South). According to our setup, it is no surprise to find no effect of trade and FDI in the South if the South lacks institutions which face and solve a health-wage trade-off as modelled here for the North in (4). Looking at the effects of FDI outflows on safety in the North, our second prediction claims that an outflow of capital in the North reduces standards in the North. If we translate this into an empirical statement, we need to be careful about "outflow of capital". What our model really predicts is that a reduction in the capital stock in the North (keeping TFP constant) reduces standards in the North. We therefore would *not* expect that large FDI outflows reduce standards if the domestic capital stock does not change. Similarly, large FDI outflows even with a reduction of the domestic capital stock would *not* reduce standards according to our model, if there is a simultaneous TFP increase which keeps labour income constant as in (4). Care should therefore be taken when trying to identify the effects of FDI outflows on capital stocks and wages.

Evaluating the second prediction given that we have seen here that the effects are probably very small and that FDI flows relative to stocks are also very small, we would conclude that globalization is bad for labour standards in the North - but only in a marginal sense. If globalization acts through the channels that we have looked at here, there is no need for big concerns.

6 Conclusion

There are three questions we pose in this paper: What is the effect of international differences in occupational health and safety (OHS) standards on international capital flows? What is the effect of these capital flows (i.e. "globalization") on OHS standards when the latter are endogenous? How does a rise in standards in the South affect northern standards and international capital flows?

International differences in OHS levels caused by endogenous and high standards in the North can lead to more or less capital in the North relative to a situation where standards are low. If the standard-setting institution in the North is moderate, capital flows to the South will be reduced (compared to an economy with low standards) as some level of health is better than none and marginal productivities of capital are higher under endogenous standards. Clearly, if standard-setting institutions 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. Concerning the second question, capital outflows from the North to the South reduce safety standards in the North. And finally, when standards increase in the South, output in the world as a whole will rise and so will welfare; but there are

strong distributional effects and the North might lose out.

The quantitative analysis has however shown that the effects of integrating capital markets on northern standards is not too high. A 1% reduction of the northern capital stock would lead to an increase in the sickness level of less than one tenth of a percentage point. Globalization effects on OHS standards through the channel we look at do therefore not provide an argument against globalization. The gains from higher OHS standards in the South for the South, however, cannot be neglected. The losses in the North caused by further capital outflows are again negligible and are by far overcompensated by gains in the South.

A Compensating differentials can imply efficiency

Is an institution really needed for setting OHS standards? An alternative could consist in firms that offer contracts with wage-safety pairs. This section analyses the implied equilibrium in a closed economy under full information in the tradition of Rosen (1974, 1986). Such a full-information equilibrium could be a very long-run equilibrium where all workers and firms have learned about the health implications of jobs.

Profits of firms are $\pi = A(s) f(k,l) - rk - wl$. They are maximized subject to a worker indifference condition $u(c, z(s)) \geq u_0$ implying that the wage-safety bundle (w, s) offered by the firm must be at least as good as the one offered by another firm. Consumption if working at this firm is given by $c = wz(s)n + \kappa$, where w is the hourly wage paid in this firm, $z(s)n$ is the total number of hours a worker can work given safety standards s in this firm, and κ is non-labour income which is independent of where the worker works. Given that there is no reason for the firm to offer more to the worker than just his outside option u_0, the inequality becomes an equality and the Lagrangian associated with this problem reads $\mathcal{L} = \pi + \lambda [u(wz(s)n + \kappa, z(s)) - u_0]$. The first-order conditions with respect to k, l, w and s are

$$Af_k = r, \qquad Af_l = w, \qquad \lambda u_c z n = l,$$

$$\lambda [u_c w z_s n + u_z z_s] = -A_s f.$$

The first two equations determine capital and labour input. The third and the forth jointly with the constraint $u(c, z(s)) = u_0$ determine the multiplier λ, the wage, and the safety level in this firm. Eliminating λ, writing $y_A A_s$ for $A_s f$, and rearranging gives the equation determining the safety level in this firm

$$u_c \left[y_A A_s \frac{zn}{l} + w z_s n \right] + u_z z_s = 0. \tag{22}$$

This condition is the firm-level counterpart of the optimality condition that results if a social planner chooses a safety level that maximizes welfare in a closed economy, which can be written as

$$U_Y [Y_A A_s + Y_L z_s N] + U_z z_s = 0. \tag{23}$$

Comparing (22) and (23) makes clear that aggregating (22) gives (23) since at the aggregate level $C = Y$, $zN = L$, and $w = Y_L$. In other words, in a closed economy with perfect information, the equilibrium is efficient.

In an open economy, the condition that maximizes welfare is given by (9a) which we reproduce here for convenience:

$$U_C [Y_A A_s + Y_L z_s N + [\tilde{r}_A A_s + \tilde{r}_L z_s N] \Delta] + U_z z_s = 0. \tag{24}$$

Comparing (22) and (24) makes clear that aggregating (22) only gives (24) for a small economy that is not able to influence the world interest rate $\tilde{r}$ when setting different safety levels, that is, when $\tilde{r}_s = 0$ so that $\tilde{r}_A A_s + \tilde{r}_L z_s N = 0$. This implies that for a small open economy, the compensating-differentials equilibrium is efficient under perfect information.

If the economy is big enough and is able to influence the world interest rate when setting different levels, then the compensating-differentials equilibrium (24) is not efficient. The reason for this is that at the firm level $\tilde{r}$ is taken as given but at the country level the central planner could influence $\tilde{r}$. Only the central planner is able to exploit his market power at the international level when choosing different safety levels.

More generally speaking, however, the assumption of full information about health implications of various jobs is empirically not convincing. We therefore believe that a description of the standard-setting mechanism would always involve some institution like unions or a governmental agency.

B Proof of propositions

B.1 Proof of proposition 1

This proof has four parts. The first part shows why we assume $s^\pi = 0$. The second part shows under which conditions $s^\pi < s^v$. The third part shows under which conditions $s^v < s^R$. The fourth part shows under which conditions $s^R < s^U$.

(i) The derivative of the firm's profit function, $\pi = A(s) f(k,l) - rk - wl$, with respect to the safety level is negative for any safety levels, $d\pi/ds = A_s < 0$. Assuming that negative safety levels do not exist, a firm would choose $s^\pi = 0$.

(ii) The safety level s^v of a safety-setting institution comes from (5), which can be expressed, using elasticities, as in (53), $\varepsilon_{v,wl}\varepsilon_{lA}\varepsilon_{As} = \varepsilon_{vz}\varepsilon_{zs}$. Plugging the elasticities computed in app. D for a Cobb-Douglas production function and a Cobb-Douglas objective function v of the standard setting institution (that is, for $\lambda = 0$ in app. D.2)

$$\begin{aligned} \varepsilon_{v,wl} &= \frac{1}{1+\frac{1-\gamma}{\gamma}}, \\ \varepsilon_{lA} &= \frac{1}{\alpha}, \\ \varepsilon_{vz} &= \frac{1}{1+\frac{\gamma}{1-\gamma}} \end{aligned}$$

into (53), using the particular forms in (50),

$$\begin{aligned} \varepsilon_{As} &= \phi s, \\ \varepsilon_{zs} &= \left[z(s)^{-1} - 1\right]\chi s \end{aligned}$$

and rearranging yields

$$\frac{1}{1+\frac{1-\gamma}{\gamma}}\frac{1}{\alpha}\phi s = \frac{1}{1+\frac{\gamma}{1-\gamma}}\left[\frac{1}{1-qe^{-\chi s}} - 1\right]\chi s$$

$$\Leftrightarrow s^v = \ln\left[\left(1 + \frac{1-\gamma}{\gamma}\alpha\frac{\chi}{\phi}\right)q\right]\frac{1}{\chi}.$$

For s^v to be positive, we therefore need to assume that

$$\left(1+\frac{1-\gamma}{\gamma}\alpha\frac{\chi}{\phi}\right)q>1,$$

which leads to $s^\pi < s^v$.

(iii) The safety level s^R maximizing the interest rate comes from (9b), which can be expressed, using elasticities, as in (61), $\varepsilon_{\tilde{r}A}\varepsilon_{As}=\varepsilon_{\tilde{r}L}\varepsilon_{zs}$. Plugging the elasticities computed in app. D for a Cobb-Douglas production function into (61), using the particular forms in (50),

$$\begin{aligned}
\varepsilon_{\tilde{r}A} &= \frac{1}{1+\left[\frac{A^*}{A}\right]^{\frac{1}{1-\alpha}}\frac{z^*N^*}{zN}},\\
\varepsilon_{As} &= \phi s,\\
\varepsilon_{\tilde{r}L} &= [1-\alpha]\frac{1}{1+\left[\frac{A^*}{A}\right]^{\frac{1}{1-\alpha}}\frac{z^*N^*}{zN}},\\
\varepsilon_{zs} &= \left[z\left(s\right)^{-1}-1\right]\chi s,
\end{aligned}$$

and rearranging yields

$$\frac{1}{1+\left[\frac{A^*}{A}\right]^{\frac{1}{1-\alpha}}\frac{z^*N^*}{zN}}\phi s=[1-\alpha]\frac{1}{1+\left[\frac{A^*}{A}\right]^{\frac{1}{1-\alpha}}\frac{z^*N^*}{zN}}\left[\frac{1}{1-qe^{-\chi s}}-1\right]\chi s$$

$$\Leftrightarrow s^R=\ln\left[\frac{\phi+[1-\alpha]\chi}{\phi}q\right]\frac{1}{\chi}.$$

Now, $s^v < s^R$ if

$$s^v=\ln\left[\left(1+\frac{1-\gamma}{\gamma}\alpha\frac{\chi}{\phi}\right)q\right]\frac{1}{\chi}<s^R=\ln\left[\frac{\phi+[1-\alpha]\chi}{\phi}q\right]\frac{1}{\chi}$$

$$\Leftrightarrow \frac{1-\gamma}{\gamma}<\frac{1-\alpha}{\alpha}\Leftrightarrow\alpha<\gamma,$$

which is one of the assumptions in ass. 1.

(iv a) We first show that for the closed economy, $s^R < s^U_{aut} \Leftrightarrow \mu < 1$. To see this, note that the planner safety level s^U in (9a) can be expressed using elasticities as in (58). Plugging the elasticities computed in app. D for a Cobb-Douglas production function, a Cobb-Douglas U (that is, for $\lambda=0$), and a closed economy (that is, for $\Delta=0$), and the elasticities $\varepsilon_{YA}=1$ and $\varepsilon_{YL}=1-\alpha$ into (58), using the particular forms in (50), and rearranging yields

$$\frac{1}{1+\frac{1-\mu}{\mu}}\phi s^U_{aut}=\left[\frac{1}{1+\frac{1-\mu}{\mu}}[1-\alpha]+\frac{1}{1+\frac{\mu}{1-\mu}}\right]\left[\frac{1}{1-qe^{-\chi s^U_{aut}}}-1\right]\chi s$$

$$\Leftrightarrow s^U_{aut}=\ln\left[\left(1+\left[\frac{1-\mu}{\mu}+1-\alpha\right]\frac{\chi}{\phi}\right)q\right]\frac{1}{\chi}.$$

Now, $s^R < s^U_{aut}$ if

$$s^R=\ln\left[\frac{\phi+[1-\alpha]\chi}{\phi}q\right]\frac{1}{\chi}<s^U_{aut}=\ln\left[\left(1+\left[\frac{1-\mu}{\mu}+1-\alpha\right]\frac{\chi}{\phi}\right)q\right]\frac{1}{\chi},$$

which holds for $\mu < 1$. As $0 < \mu < 1$ by the nature of the Cobb-Douglas utility function in assumption 1, this always holds.

(iv b) We now show that $s^U_{aut} < s^U$. Note that $\mu < 1$ implies that $s^R < s^U_{aut} < s^U$ or more compactly that $s^R < s^U$. To see this, consider the expression for s^U in the open economy given by (58) which can be rewritten as

$$\frac{\varepsilon_{As}}{\varepsilon_{zs}} = \frac{\varepsilon_{UC}\left[\varepsilon_{YL} + \varepsilon_{\tilde{r}L}\frac{\tilde{r}\Delta}{Y}\right] + \left[1 + \frac{\tilde{r}\Delta}{Y}\right]\varepsilon_{Uz}}{\varepsilon_{UC}\left[\varepsilon_{YA} + \varepsilon_{\tilde{r}A}\frac{\tilde{r}\Delta}{Y}\right]}.$$

Since the world interest elasticities computed in (46) and (47) imply that $[1-\alpha]\,\varepsilon_{\tilde{r}A} = \varepsilon_{\tilde{r}L}$, and we can compute $\varepsilon_{YA} = 1$ and $\varepsilon_{YL} = 1 - \alpha$, we now obtain

$$\frac{\varepsilon_{As}}{\varepsilon_{zs}} = 1 - \alpha + \frac{\varepsilon_{Uz}\left[1 + \frac{\tilde{r}\Delta}{Y}\right]}{\varepsilon_{UC}\left[1 + \varepsilon_{\tilde{r}A}\frac{\tilde{r}\Delta}{Y}\right]},$$

which simplifies for the Cobb-Douglas utility function for the planner to

$$\frac{\varepsilon_{As}}{\varepsilon_{zs}} = 1 - \alpha + \frac{1-\mu}{\mu}\frac{1 + \frac{\tilde{r}\left(s^U\right)\Delta\left(s^U\right)}{Y}}{1 + \frac{1}{1+\Psi}\frac{\tilde{r}(s^U)\Delta(s^U)}{Y(s^U)}},$$

where we defined

$$\Psi \equiv \left[\frac{A^*}{A\left(s^U\right)}\right]^{\frac{1}{1-\alpha}}\frac{z^*N^*}{z\left(s^U\right)N}.$$

It is also possible to plug expressions for ε_{As} and ε_{zs} from (51) and (52) to obtain

$$\frac{\phi}{\left[z\left(s^U\right)^{-1} - 1\right]\chi} = 1 - \alpha + \frac{1-\mu}{\mu}\frac{1 + \frac{\tilde{r}\left(s^U\right)\Delta\left(s^U\right)}{Y(s^U)}}{1 + \frac{1}{1+\Psi}\frac{\tilde{r}(s^U)\Delta(s^U)}{Y(s^U)}}. \tag{25}$$

For the case of $\Delta = 0$ (which holds for a closed economy and for an open economy for certain cases), we obtain

$$\frac{\phi}{\left[z\left(s^U_{aut}\right)^{-1} - 1\right]\chi} = 1 - \alpha + \frac{1-\mu}{\mu}. \tag{26}$$

As the LHS of (26) increases in s^U_{aut}, the value of s^U in (25) is larger than s^U_{aut} in (26) if the RHS of (25) is larger than the RHS of (26). This is the case if

$$\begin{aligned}
\frac{1 + \frac{\tilde{r}\left(s^U\right)\Delta\left(s^U\right)}{Y(s^U)}}{1 + \frac{1}{1+\Psi}\frac{\tilde{r}(s^U)\Delta(s^U)}{Y(s^U)}} &> 1 \Leftrightarrow \\
1 + \frac{\tilde{r}\left(s^U\right)\Delta\left(s^U\right)}{Y\left(s^U\right)} &> 1 + \frac{1}{1+\Psi}\frac{\tilde{r}\left(s^U\right)\Delta\left(s^U\right)}{Y\left(s^U\right)} \Leftrightarrow \\
1 &> \frac{1}{1+\Psi} \Leftrightarrow 1 + \Psi > 1 \Leftrightarrow \Psi > 0,
\end{aligned}$$

which is always true.

B.2 Proof of proposition 2

Use (7) to define

$$\Omega \equiv r\left(s, K-\Delta\right) - r\left(s^*, K^*+\Delta\right) = 0 \tag{27}$$

and compute with the aid of the implicit function theorem

$$\frac{d\Delta}{ds} = -\frac{\partial\Omega/\partial s}{\partial\Omega/\partial\Delta} = -\frac{r_s}{-r_2 - r_2^*}, \tag{28}$$

where the subscript 2 denotes the derivative with respect to the second argument. Since $r_2 < 0$ and $r_2^* < 0$, the denominator in (28) is positive, and the sign of $d\Delta/ds$ is the same as the sing of $-r_s$.

Given our assumption that $s^v < s^R$, we know that $r_s > 0$, i.e. the return to capital rise in safety levels when we go from s^π to s^v. Hence, $d\Delta/ds < 0$. For all other s such that $s \geq s^R$, we would have $r_s \leq 0$ and thus $d\Delta/ds \geq 0$.

B.3 Proof of proposition 3 (i)

The proof has two parts.

(i) Using our results from app. D.2, we can compute

$$\frac{\varepsilon_{vz}}{\varepsilon_{v,wl}} = \frac{1-\gamma}{\gamma}\left[\frac{z\left(s^v\right)}{wl\left(A\left(s^v\right)\right)}\right]^\lambda,$$

which after aggregation (we use here the symmetric equilibrium assumption and replace firm-level by aggregate variables) is given by

$$\frac{\varepsilon_{vz}}{\varepsilon_{v,wl}} = \frac{1-\gamma}{\gamma}\left[\frac{z\left(s^v\right)}{w\left(K, s^v\right) L\left(A\left(s^v\right), K\right)}\right]^\lambda.$$

As on the aggregate level labour demand equals labour supply, we use $L\left(A\left(s^v\right), K\right) = z\left(s^v\right) N$. The wage rate that results from the Cobb-Douglas production function is $w\left(K, s^v\right) = A\left(s^v\right) K^\alpha \left[1-\alpha\right] \left[z\left(s^v\right)\right.$ Total wage income is therefore $wL = \left[1-\alpha\right] A\left(s^v\right) K^\alpha \left[z\left(s^v\right) N\right]^{1-\alpha} = \left[1-\alpha\right] Y\left(s^v\right)$. This allows us to compute

$$\frac{z\left(s^v\right)}{w\left(K, s^v\right) L\left(A\left(s^v\right), K\right)} = \frac{z\left(s^v\right)^\alpha}{A\left(s^v\right)} \frac{1}{\left[1-\alpha\right] K^\alpha N^{1-\alpha}}.$$

Since $z_s > 0$ and $A_s < 0$, we can conclude that $\frac{\partial z/wL}{\partial s^v} > 0$ and $\frac{\partial z/wL}{\partial K} < 0$, so that

$$\lambda \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0 \Rightarrow \frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial s^v} \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0, \quad \frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial K} \left\{ \begin{array}{c} < \\ = \\ > \end{array} \right\} 0. \tag{29}$$

(ii) Plugging some of the elasticities from app. D into the general first-order condition giving s^v, equation (53), and after rearranging, we can define

$$H \equiv \frac{\phi}{\alpha} - \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}\left(s^v, K\right)\left[\frac{1}{z\left(s^v\right)} - 1\right]\chi = 0.$$

With the aid of the implicit-function theorem, we can now compute

$$\frac{ds^v}{dK} = -\frac{\partial H/\partial K}{\partial H/\partial s^v}, \tag{30}$$

where

$$\frac{\partial H}{\partial K} = -\frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial K}\left[\frac{1}{z\left(s^v\right)} - 1\right]\chi,$$

and

$$\begin{aligned}\frac{\partial H}{\partial s^v} &= -\left[\frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial s^v}\left[\frac{1}{z} - 1\right] + \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}\frac{-1}{z^2}z_s\right]\chi \\ &= \left[\frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}\frac{z_s}{z^2} - \frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial s^v}\left[\frac{1}{z} - 1\right]\right]\chi.\end{aligned}$$

We can conclude with (29) that

$$\lambda \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0 \Rightarrow \frac{\partial H}{\partial s^v} \left\{ \begin{array}{c} ? \\ > \\ > \end{array} \right\} 0, \ \frac{\partial H}{\partial K} \left\{ \begin{array}{c} > \\ = \\ < \end{array} \right\} 0. \tag{31}$$

The derivative $\partial H/\partial s^v$ is positive for $\lambda > 0$ only if

$$\left[\frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}\frac{z_s}{z^2} - \frac{\partial \frac{\varepsilon_{vz}}{\varepsilon_{v,wl}}}{\partial s^v}\left[\frac{1}{z} - 1\right]\right]\chi > 0.$$

The proposition follows from (30) and (31).

B.4 Proof of proposition 3 (ii)

Welfare is given by $U\left(s,K\right) = U\left(C\left(s,K\right),z\left(s\right)\right)$ and s^U is determined by the first-order condition

$$H\left(s,K\right) \equiv U_s = U_C\left(C\left(s,K\right),z\left(s\right)\right)C_s\left(s,K\right) + U_z\left(C\left(s,K\right),z\left(s\right)\right)z_s\left(s\right) = 0,$$

or, more compactly, by

$$H \equiv U_C C_s + U_z z_s = 0. \tag{32}$$

The derivative that we are looking for can be computed with the aid of the implicit-function theorem,

$$\frac{ds^U}{dK} = -\frac{\partial H/\partial K}{\partial H/\partial s}, \tag{33}$$

where

$$\frac{\partial H}{\partial K} = U_{CC}C_K C_s + U_C C_{sK} + U_{zC}C_K z_s, \tag{34}$$

$$\frac{\partial H}{\partial s} = U_{ss} < 0. \tag{35}$$

Note that the derivative in (35) is equivalent to the second-order condition which we assume to

be negative to guarantee a maximum. This means that the sign in (33) is completely determined by its numerator, $\partial H/\partial K$, since $\partial H/\partial s < 0$ and the whole fraction is multiplied by a minus sign. We therefore only need to focus on finding the sign of $\partial H/\partial K$ to determine the sign of ds^U/dK.

We know per assumption that $U_{CC} < 0$, $U_C > 0$, $z_s > 0$. Moreover, in a closed economy, $C = Y$, so that per assumption $C_K = Y_K > 0$. In an open economy, income is given by domestic production plus foreign capital income,

$$C = Y + r\Delta. \tag{36}$$

An increase in endowment with domestic capital K increases income, $C_K = Y_K + r_K\Delta + r\Delta_K > 0$. To find the sign of C_s, note that from the first-order condition (32)

$$U_C C_s + U_z z_s = 0 \Leftrightarrow C_s = -\frac{U_z z_s}{U_C}, \tag{37}$$

which implies that $C_s < 0$ since U_z, z_s, and U_C are all positive per assumption.[29] The sign of C_{sK} depends on whether s and K are bad substitutes ($C_{sK} > 0$), good substitutes ($C_{sK} < 0$) or independent ($C_{sK} = 0$) in the creation of income. Similarly, the sign of U_{zC} depends on whether z and C are bad substitutes ($U_{zC} > 0$), good substitutes ($U_{zC} < 0$) or independent ($U_{zC} = 0$). To summarize, the signs in (34) are

$$\frac{\partial H}{\partial K} = \underset{(-)}{U_{CC}}\underset{(+)}{C_K}\underset{(-)}{C_s} + \underset{(+)}{U_C}\underset{(?)}{C_{sK}} + \underset{(?)}{U_{zC}}\underset{(+)}{C_K}\underset{(+)}{z_s}.$$

The first term in this equation is clearly positive, while the second and third terms depend on the substitutability or independence of s and K and of z and C. If both are bad substitutes or independent ($C_{sK} \geq 0$ and $U_{zC} \geq 0$), we unambiguously find that safety set by the planner increases in endowment, $ds^U/dK > 0$. The bad substitutability between s and K and between z and C finds support in empirical work (see Hall and Leeson, 2007 and Flanagan, 2006: 44-7). If $C_{sK} < 0$ and $U_{zC} < 0$ (good substitutes), then the sign of $\partial H/\partial K$ is ambiguous since the last two terms in (34) are now negative while the first term is still positive. We thus have

$$\left.\begin{array}{c} C_{sK} \geq 0 \text{ and } U_{zC} \geq 0 \text{ (bad substitutes or independent)} \\ \text{either } C_{sK} < 0 \text{ or } U_{zC} < 0 \text{ or both negative (good substitutes)} \end{array}\right\} \Rightarrow \frac{ds^U}{dK}\left\{\begin{array}{c} > 0 \\ ? \end{array}\right\}.$$

As we can write $U_{zC} = U_{Cz}$ and $C_{sK} = C_{Ks}$ and changing the order for comparison purposes with result (i) from this prop. 3, we get the result in the main text,

$$\left.\begin{array}{c} U_{Cz} \geq 0 \text{ and } C_{Ks} \geq 0 \text{ (bad substitutes or independent)} \\ \text{either } U_{Cz} < 0 \text{ or } C_{Ks} < 0 \text{ or both negative (good substitutes)} \end{array}\right\} \Rightarrow \frac{ds^U}{dK}\left\{\begin{array}{c} > 0 \\ ? \end{array}\right\}. \tag{38}$$

B.5 Proof of proposition 4

Using (27) and with the aid of the implicit function theorem we can compute

$$\frac{d\Delta}{ds^*} = -\frac{\partial\Omega/\partial s^*}{\partial\Omega/\partial\Delta} = -\frac{-r_{s^*}}{-r_2 - r_2^*}, \tag{39}$$

[29] Note that this also implies that the welfare maximizing safety level is higher than the consumption maximizing safety level.

where the subscript 2 denotes the derivative with respect to the second argument. Since $r_2 < 0$ and $r_2^* < 0$, the denominator in (39) is positive, and the sign of $d\Delta/ds^*$ is the same as the sing of r_{s^*}.

Given our assumption that $s^* < s^{R^*}$, we know that $r_{s^*} > 0$, i.e. the return to capital rise in safety levels when we go from s^{π^*} to s^*. Hence, $d\Delta/ds^* > 0$. For all other s^* such that $s^* \geq s^{R^*}$, we would have $r_{s^*} \leq 0$ and thus $d\Delta/ds^* \leq 0$.

B.6 Empirical accident rates

In this appendix, we explain how we obtain the occupational injury ratios that we use in our calibration.[30] We first estimate the following regression

$$injuryrate_i = \alpha + \beta\ advanced_i + \varepsilon_i,$$

where $injuryrate_i$ is the occupational injury rate in country i and $advanced_i$ is a dummy equal to one for advanced countries. The data for *injuryrate* come from Hämäläinen et al. (2009, tables A1-A6). They define "nonfatal injury rates" as the number of occupational accidents per worker, and "fatal injury rates" as the number of occupational fatalities per 100,000 workers. Our definition of an advanced country is from the World Fact Book (www.cia.gov/index.html).

	Fatal 1	**Fatal 2**	**Nonfatal 1**	**Nonfatal 2**
	(1)	(2)	(3)	(4)
α	16.292	17.905	13379.6	13197.2
	(0.500)***	(6.084)***	(416.1)***	(4906.6)***
advanced	-10.927	-8.946	-9020.2	-7272.8
	(0.756)***	(0.936)***	(619.3)***	(753.9)***
agriculture		0.046		57.3
		(0.063)		(51.6)
industry		-0.0002		-3.1
		(0.093)		(75.6)
services		-0.057		-26.3
		(0.061)		(49.0)
# obs.	303	303	303	303
R^2	0.517	0.565	0.524	0.577
Average advanced	5.365	8.959	4359.4	5924.4
Ratio of non-advanced to advanced	3.037	1.999	3.069	2.228

Notes: Robust standard errors in parenthesis clustered at country level
*** p<0.01, ** p<0.05, * p<0.1

[30] The data set and Stata program are available from sites.google.com/site/alejandrodonado77 and waelde.com/pub.

In columns 1 and 3 from the table, we report the coefficient estimates of this simple regression, separately for fatal and nonfatal injury rates. According to the results in column 1, in nonadvanced countries, there is an average of 16.292 fatalities per 100,000 workers. To obtain the average for advanced countries, we subtract 10.927 from 16.292 to obtain 5.365 fatalities per 100,000 workers. This average is reported at the bottom of the table. We can then compute the nonadvanced/advanced ratio of fatal injuries (also reported at the bottom of the table) as 16.292/5.365 = 3.037. Following the same steps, in column 3, we obtain a similar ratio of around 3 using nonfatal injuries.

In columns 2 and 4, we control for differences in sectoral composition by adding three variables: *agriculture*, *industry*, and *services*. These variables come from the World Development Indicators and are respectively the share of total employment in agriculture, industry, and services in each country. Following the same steps as before, we obtain from these regressions nonadvanced/advanced ratios of around 2. We thus find that controlling for sectoral composition reduces the nonadvanced/advanced ratios from 3 to 2.

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