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Reducing Vulnerability in Critical Life Course Phases by Enhancing Human Capital

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ABSTRACT

This paper takes a demographic perspective and addresses differential vulnerability for men and women as they pass through their life cycles. A particular focus lies on differential vulnerability by level of education. The analysis starts with a global view on infant and child mortality and presents evidence that mothers' education is a key to reducing such mortality. Scenarios are presented that show how many millions of child deaths could be avoided in the longer run by more investments in female education in the near future.

Next the paper addresses the transition from education to employment and shows that education is a key determinant in reducing youth unemployment. Proceeding further in the life course, it demonstrates that vulnerability to becoming disabled in the age group 30-74 declines strongly with education level. Finally, the last section studies differential vulnerability at the national level using time series data on deaths from disasters where the aggregate levels of education are taken into account.

The paper concludes that over the entire life cycle of individuals, changes in behaviour that tend to be associated with more education (of mothers or the persons themselves) can be viewed as a potent factor in reducing child mortality, lowering the risk for unemployment at a young age, decreasing vulnerability to natural disasters, and finally limited the risk of falling into disability. These general long-term benefits of near-term investments in education hold for individuals as well as entire societies.

Introduction

This paper examines vulnerability over the life course with a specific focus on differentials not only by age and gender—as is conventional in demography—but also by level of education and with a focus on health. A significant body of scientific literature shows that changes in mental functioning, cognitive capacity and behaviour that typically result from education all lead to reduced vulnerability to virtually all threats to human well-being at all stages of life. Reducing vulnerability through educational attainment should be a key strategy for international policies aimed at not only empowering people, but also providing manifold positive consequences of education at individual and societal levels.

There are certainly many other factors in addition to education that influence vulnerability to the hazards discussed in this paper. Conventionally, economists and other social scientists have seen income as the primary determinant of vulnerability. Many studies on differential vulnerability have examined variations with respect to economic standing, often without testing empirically whether other observable individual or household characteristics might be more important. Place of residence, age, gender, size of household and social capital are among several other factors that have

been studied in this context and have been shown to have some independent effects. A review of the vast literature on these is beyond the scope of this paper. Recently at the Wittgenstein Centre for Demography and Global Human Capital, however, a series of studies have been carried out to systematically assess the relative importance of education compared to income and the other above-mentioned characteristics in reducing vulnerability and enhancing resilience. In cases ranging from infant mortality to disability in old age, and from being affected by malaria to falling victim to natural disasters, education has turned out to be the key characteristic in lowering vulnerability. These and other relevant studies will be discussed below in sections on specific vulnerabilities.

A recent review brought together a significant amount of evidence to demonstrate that the effects of education on better health and survival and several other desirable goals are indeed functionally causal (Lutz and Skirbekk 2014). The review summarizes findings from so-called natural experiments. While such evidence clearly strengthens the case for assuming a general functional causal relationship by showing that the mechanisms work in the expected direction under many different conditions, it falls short of establishing a strong causal relationship for all societies at all points in time. When experiments demonstrate causality for one specific population group in one country at one point in time, it is far from clear that this proven relationship also holds in very different cultures at diverse stages of social and economic development. To use such relationships as a basis for projecting the future effects of education in all countries in the world, we should not aim at demonstrating strong causality, but rather focus on establishing functional causality through assessing the following three criteria, as specified by Lutz and Skirbekk (ibid.).

First, there must be *strong, empirically observed associations* between the two factors studied. These associations should hold across different societies and for different sub-groups of populations as well as for different points in time, considering appropriate lag structures. The case for the assumption of a causal relationship is significantly strengthened if this association is observed both at the individual level, across people and households, and at the aggregate level, across societies, in particular when it can be found in longitudinal cohort studies.

Second, there must be a *plausible narrative about the mechanisms* by which one force influences the other. This explanation must also give specific attention to the sequence and timing of events according to the general principle that the cause must always transpire before the consequence. In the social sciences, it is important to consider that the expectation of a coming event also qualifies as a cause of behaviour, and not only the event itself. Along these lines, there is support from neurology that education changes the physiology of our brains and hence our perception of the world, our processing of that information, and, in consequence, our behaviour.

Third, *other obvious competing explanations* for the observed associations should be explicitly and systematically studied and ruled out as explaining the overall pattern of the observed

associations. This does not rule out other forces playing a minor and non-dominant role. The two main alternative explanations of observed associations are self-selection and reverse causality.

Lutz and Skirbekk (ibid.) demonstrate that these three criteria are being met in the case of education effects on health, mortality and fertility. The foundations of the effects of education on human behaviour are derived from modern cognitive neuroscience, which has shown that every learning experience and in particular repeated experiences physiologically change our brains by building new synapses that not only store the information content, but also become an integral part of what forms our sense of personality (Kandel 2007). While neuroscience still lacks a comprehensive understanding of the process of learning, neurological studies have confirmed beyond a doubt that brain volumes, cortical thickness and neurological structures can be affected by more education. It seems reasonable to assume that the cognitive functions that relate to our perception of the environment around us, our view of the future and our degree of rationality are also affected by our previous education experiences. In particular, empirical studies show that better-educated individuals tend to have a longer investment horizon and be more risk adverse (van der Pol 2011).

It should be plausible to extend this reasoning to education as a driver of the other outcome variables studied in this paper, namely, the probability of finding employment and general resilience to natural disasters. In all cases, education is associated with a higher degree of abstraction and counterfactual thinking that is necessary to prepare for risks that the person has not yet experienced but that can be reasonably assumed to pose a potential danger. When it comes to education and the possibility of finding a job, in addition to the cognitive effect and the additional skills acquired through education, there is also a so-called signalling effect. This implies that employers prefer to recruit people with a prestigious degree even though there is no evidence that their skill levels are actually higher.

In this paper, vulnerability refers to being susceptible to or unable to cope with the adverse effects of hostile environments, such as those due to natural hazards, economic crisis or persistent poverty. It addresses vulnerability across four different life domains: infant mortality, youth unemployment, adult disability and disaster deaths. While vulnerability may be specific to some types of hazards, people of certain socio-demographic characteristics are generally more vulnerable than others. For instance, young people are more susceptible to unemployment during economic downturns, whereas older adults, especially women, have a higher risk of disability. In all four cases, the paper presents evidence from different parts of the world and various stages of development to examine how vulnerability varies by level of education. For three of the topics, the paper combines assessments of the effects of education with alternative educational attainment scenarios to

demonstrate quantitatively how investments in education can lead to fewer avoidable deaths and disabilities in the future.

Assessment of the impact of alternative possible future education trends refers to the education scenarios in the International Institute for Applied Systems Analysis paper for the 2013 Human Development Report (UNDP 2013) and Lutz, Butz and KC 2014. These scenarios are now being used for the new set of global shared socio-economic pathways scenarios recently developed for the global climate change modelling community (KC and Lutz 2014). Because the scenarios are being employed in three of the following four sections, they are summarized briefly here.

The global education trend (GET) scenario is based on a Bayesian model that estimates the most likely future trajectory in education-specific progression rates to higher levels from the cumulative experience of all countries over the past 40 years. The resulting education trajectories for each country are not only considered to be the 'medium', but are also used as the standard against which all future education-specific fertility and mortality trajectories are being derived.

The constant enrolment rates (CER) scenario simply assumes that in each country the most recently observed levels of school enrolment, and hence educational progression, are frozen at their current levels. Since in many countries younger age groups are much better educated than older ones, even this scenario can lead to some improvements in adult education levels over the coming decades, but in the longer run implies stagnation. The fast track (FT) scenario assumes that a country will shift gears and follow the most rapid education expansion experienced in recent history, namely that of the Republic of Korea.

A fourth scenario, the constant enrolment number (CEN) scenario, is the worst case in that it assumes zero expansion of schooling. In the context of population growth, this implies that the proportion of children enrolled in school is actually declining over time.

The following four sections of this paper follow the individual life course while examining education-specific vulnerabilities. Starting with newborns and the vulnerability to infant and child mortality, it refers to the level of education of the mother and the child. In reference to young people's susceptibility to unemployment after leaving school, it takes into account the education of young women and men. It next considers vulnerability to disability in the age group from 30 to 74 years, according to education level. The last section studies differential vulnerability based on national time series data on deaths from disasters, taking into account aggregate national levels of education. Most studies presented are updated and further enriched versions of earlier published analyses by the authors.

Differential infant and child mortality by maternal education

When new citizens of the world are born, their first months are the most dangerous of their lives. In most populations, perinatal mortality is higher than mortality in any subsequent period. But even assuming initial survival, mortality risks are still elevated until around five years of age, particularly in developing countries. The reason lies primarily in a higher vulnerability to diarrhoeal and other infectious diseases often transmitted by unclean water as well as resulting from nutritional deficits. Since young children are entirely dependent on the care of adults—in most cases their mothers—the mother's educational level has been shown to be a key determinant of vulnerability.

The strong negative association between female education and fertility as well as child mortality rates is well established and described in full detail in Lutz et al. (2014). Here, a case is made for assuming a direct causal effect from the empowerment of women through basic education to changes in attitudes, behaviour and the relative standing of women in their partnership, extended family and society—these result in observed lower levels of fertility and child mortality rates.

Given this clear relationship between female education and demographic outcomes, alternative scenarios about future education trends of women could be expected to result in different levels of fertility and mortality. The following tables and graphs quantify these effects, which, with regard to population growth, go in opposite directions. Higher female education reduces birth rates, and at the same time improves the chances of survival for children already born. Yet the calculation that follows shows that the relationship between education and fertility is far more important than that between education and improved child survival, and as a result, better education is associated with a clear reduction in population growth.

This relationship is shown in table 1 for a number of least developed countries by comparing different demographic outcomes across various education scenarios. Under the most likely GET scenario for Ethiopia, for example, the population will increase from 83 million in 2010 to 172 million by 2060, which is more than a doubling due to current high fertility rates and a very young age structure. Under the FT scenario, the population in 2060 would only be 151 million, or more than 20 million less even when assuming identical education-specific fertility rates. Under the most pessimistic CEN scenario, the population would increase to 194 million. By 2060 the difference between the highest and the lowest education scenarios would be 43 million people, which is more than half the current population of Ethiopia.

Table 1 also lists the absolute number of births under the different education scenarios, which illustrates the reasons for these major differences in the population growth trajectories. By about 2060, the number of births in Ethiopia would be more than twice as high under the CEN scenario

(1.77 million) than under the FT scenario (0.88 million). As discussed above, the effect of different numbers of births on total population growth is moderated by variations in mortality that result from different levels of education. The last columns of the table show that the number of child deaths under the age of five would be 120,000 under the FT scenario, compared to 363,000 under CER and 403,000 under CEN.

Table 1: Different demographic outcomes from education scenarios

Figures are for a number of least developed countries, based on medium fertility assumptions.

		Population (in millions)				Births (in tens of thousands)				Under-five mortality (in thousands)			
	Year	GET	CER	FT	CEN	GET	CER	FT	CEN	GET	CER	FT	CEN
Bangladesh	2010	149	149	149	149	154	154	152	154	406	408	390	406
Bangladesh	2030	179	179	177	179	128	133	119	132	164	187	128	182
Bangladesh	2060	189	194	182	193	88	102	75	100	49	70	34	65
Benin	2010	9	9	9	9	18	18	17	18	114	116	112	115
Benin	2030	14	14	14	14	19	20	17	20	83	95	67	97
Benin	2060	21	22	19	22	17	19	13	20	38	52	23	55
Burkina Faso	2010	16	16	16	16	36	37	35	36	270	275	262	272
Burkina Faso	2030	27	28	26	28	43	48	35	48	220	252	160	251
Burkina Faso	2060	43	47	37	47	40	49	28	49	98	142	54	143
Burundi	2010	8	8	8	8	15	15	15	15	123	122	120	122
Burundi	2030	13	13	13	13	15	16	13	16	96	105	77	105
Burundi	2060	19	19	17	19	14	15	10	15	46	58	27	60
Cambodia	2010	14	14	14	14	16	16	16	16	58	58	57	58
Cambodia	2030	17	17	17	17	14	14	13	14	22	24	18	24
Cambodia	2060	19	19	18	19	10	11	8	12	7	10	4	10
Chad	2010	11	11	11	11	26	26	26	26	261	263	257	262
Chad	2030	18	18	18	18	30	32	27	32	230	249	187	250
Chad	2060	27	29	25	29	26	30	20	30	112	151	71	153
Democratic Republic of the Congo	2010	66	66	66	66	151	154	148	154	1444	1473	1396	1469
Democratic Republic of the Congo	2030	107	109	104	109	170	186	151	191	1301	1561	1007	1642
Democratic Republic of the Congo	2060	160	169	149	171	145	174	118	181	671	1000	444	1113
Ethiopia	2010	83	83	83	83	140	142	139	143	722	727	710	731
Ethiopia	2030	124	127	120	128	149	166	121	172	526	608	391	633
Ethiopia	2060	172	188	151	194	129	166	88	177	234	363	120	403
Guinea	2010	10	10	10	10	19	19	18	19	137	139	129	137
Guinea	2030	13	14	13	14	17	19	15	18	86	102	64	98

Guinea	2060	16	17	15	17	12	14	9	14	34	49	21	47
Haiti	2010	10	10	10	10	13	13	12	13	52	53	50	53
Haiti	2030	12	12	12	12	11	12	10	12	26	33	21	32
Haiti	2060	13	14	13	14	8	10	7	9	8	13	6	13
Lao People's Democratic Republic	2010	6	6	6	6	7	7	7	7	21	21	20	21
Lao People's Democratic Republic	2030	8	8	8	8	7	7	6	7	13	14	9	14
Lao People's Democratic Republic	2060	9	9	8	9	5	6	4	6	5	6	3	6
Madagascar	2010	21	21	21	21	36	36	35	36	93	91	89	92
Madagascar	2030	33	33	32	34	40	42	35	44	66	70	49	75
Madagascar	2060	50	51	44	53	37	40	26	43	34	40	17	45
Malawi	2010	15	15	15	15	34	34	33	35	204	207	200	209
Malawi	2030	26	27	25	27	48	52	40	56	204	238	152	268
Malawi	2060	48	53	42	57	52	67	38	77	141	223	86	285
Mali	2010	15	15	15	15	36	37	35	37	321	326	309	323
Mali	2030	26	26	25	26	42	45	34	45	259	294	186	292
Mali	2060	40	43	35	43	36	43	26	43	120	171	64	171
Mozambique	2010	23	23	23	23	43	44	41	43	290	292	277	290
Mozambique	2030	34	35	33	35	44	49	38	49	186	217	136	218
Mozambique	2060	46	49	41	49	38	46	27	46	84	124	47	127
Myanmar	2010	48	48	48	48	40	40	38	40	147	147	139	146
Myanmar	2030	52	52	51	52	32	34	27	33	77	86	51	80
Myanmar	2060	47	49	44	48	23	27	18	25	24	34	13	28
Nepal	2010	30	30	30	30	38	40	37	39	64	69	60	66
Nepal	2030	42	43	41	43	37	43	34	42	24	35	20	33
Nepal	2060	55	61	52	60	31	43	27	41	9	19	7	18
Niger	2010	16	16	16	16	40	40	39	40	284	286	278	285
Niger	2030	30	30	29	30	63	67	54	67	330	360	266	362
Niger	2060	62	67	54	67	78	92	58	93	250	331	150	340
Rwanda	2010	11	11	11	11	22	22	21	22	138	141	131	139
Rwanda	2030	17	17	16	17	24	27	20	27	113	133	80	135
Rwanda	2060	26	28	23	28	23	28	17	29	58	86	32	91
Senegal	2010	12	12	12	12	23	24	22	24	107	110	100	107
Senegal	2030	19	20	18	20	25	29	20	28	81	99	52	96
Senegal	2060	27	31	23	30	22	29	15	29	31	50	15	49
Sierra Leone	2010	6	6	6	6	11	11	11	11	93	94	89	93
Sierra Leone	2030	9	9	8	9	12	12	10	13	68	78	50	79
Sierra Leone	2060	12	13	11	13	10	12	7	12	33	46	19	48
Somalia	2010	9	9	9	9	20	20	19	20	174	177	170	176

Somalia	2030	13	14	13	14	21	23	17	24	146	175	107	181
Somalia	2060	17	19	15	19	15	20	11	20	64	107	37	113
Sudan	2010	44	44	44	44	71	71	70	71	331	329	322	330
Sudan	2030	65	65	64	65	74	78	68	80	267	309	212	325
Sudan	2060	88	91	84	92	63	75	53	78	148	233	103	256
Tanzania	2010	45	45	45	45	91	94	88	93	396	407	382	402
Tanzania	2030	73	75	70	75	107	117	91	120	273	314	207	330
Tanzania	2060	114	122	99	124	100	117	71	123	145	190	82	209
Uganda	2010	33	33	33	33	80	83	76	81	480	495	456	486
Uganda	2030	60	62	57	62	111	125	93	127	488	582	349	600
Uganda	2060	109	122	93	123	120	154	88	160	278	419	162	459
Zambia	2010	13	13	13	13	30	31	28	31	207	217	194	213
Zambia	2030	21	22	20	22	37	43	29	44	187	234	120	250
Zambia	2060	33	38	28	39	34	46	24	50	96	157	52	185

Note: Each year is the end of a five-year period (e.g., 2060 refers to the period from 2055 to 2060).

Source: Lutz, Butz and KC 2014.

Even under the CER scenario in Ethiopia in 2060, which assumes that school expansion can keep pace with population growth, the absolute number of child deaths is estimated to be three times higher compared to the fastest case of education expansion. In this sense, the broadening of female education has significant consequences for population growth and development in general, and massive direct effects on child mortality.

So far, all discussions of the impact of alternative education scenarios have been combined with medium (the most likely) education-specific fertility and mortality assumptions. But the positive effects of education can be expected to be even stronger because future education-specific fertility rates would follow a higher trajectory—defined as gradual increases to a point 20 percent higher than the medium by 2030, and 25 percent by 2050 and thereafter—due to the higher absolute differences between the birth rates of the various education categories.

Table 2 shows the consequences of this case with an in-depth examination of two countries from table 1. In Ethiopia, under the CEN scenario, the most pessimistic for education, combined with high fertility, not only would population grow to the extremely high level of 238 million by 2060, but child mortality would be catastrophically high, with 638,000 child deaths from 2055 to 2060. This compares to the much lower number of 186,000 child deaths under the optimistic FT scenario. These two education scenarios result in projected child deaths that differ by a factor of 3.4, even when assuming identical trajectories of education-specific child mortality rates. The result is not so different for Nepal, where under the CER and CEN scenarios, more than two and half times as many children will be dying between 2055 and 2060 than under the FT scenario. This illustrates clearly

that mothers' education can indeed be a key factor in reducing child mortality in the future in the least developed countries.

Table 2: Different child mortality outcomes due to education scenarios for Ethiopia and Nepal

Figures are based on high-fertility assumptions.

		Under-five mortality (in thousands)			
	Year	GET	CER	FT	CEN
Ethiopia	2010	747	754	737	758
Ethiopia	2030	641	742	476	774
Ethiopia	2060	361	562	186	638
Nepal	2010	67	72	63	69
Nepal	2030	30	43	24	41
Nepal	2060	15	30	12	31

Source: Lutz, Butz and KC 2014.

These results dramatically illustrate how important progress in female education is for avoiding a significantly higher number of child deaths. It can even be argued that they underestimate the effects because they only consider individual and not community impacts. The literature has shown (Fuchs, Pamuk and Lutz 2010; Pamuk, Fuchs and Lutz 2011) that there are typically spillover effects, such as normative changes in favour of family limitation and wider availability of reproductive health services in communities with better-educated women. Particularly in countries that have experienced the most rapid voluntary fertility declines—such as Iran, Mauritius and the Republic of Korea—these community-level effects were highly relevant. A multi-level analysis of 22 countries in sub-Saharan Africa shows that an additional fertility decline of up to one child per woman is attributable to the aggregate effect of female education, in addition to individual effects (Pamuk, Fuchs and Lutz 2011).

Finally, the interaction between education and population growth goes both ways. Under the CEN scenario of high population growth due to high birth rates, the increase in the school-age population is such that even maintaining current school enrolment rates can be an uphill battle. In several African countries during the 1980s, the proportion of young cohorts in school actually declined, presumably because of the combination of cuts in education efforts due to economic and political problems and very rapid population growth. This resulted in an increase in the young population being out of school (KC and Lutz 2013). The halting of the fertility decline observed in some African countries around 2000 was associated with this stall in education of the relevant female cohorts. Although female education is an important force in lowering fertility, rapid growth in the number of children in a society in which resources do not grow at the same pace is an obstacle to

the expansion of education. For this reason, it is most effective from a policy perspective to increase female education while at the same time improving access to family planning programmes.

This section has clearly demonstrated that improving maternal education is a key strategy in reducing future child vulnerability to (by definition) premature mortality. The scenarios presented here up to 2060 under alternative education assumptions—but identical education-specific mortality rates—show that under the pessimistic education scenarios, there will be three to four times more child deaths in many of the least developed countries than under the scenarios assuming rapid improvements in education among young women.

Youth unemployment by level of education

A critical and vulnerable period for young people is the transition from education to the labour market. In many countries, high levels of youth unemployment make this passage quite difficult. This situation has dramatically worsened due to the recent economic crisis, even in some of the richest industrialized countries. Unfortunately, reliable statistical information on unemployment by age, gender and level of education is hard to obtain for many developing countries, unlike in Europe, which has regular and comparable labour force and employment surveys. Initial efforts by the authors of this paper failed to extract relevant information from public use samples of selected censuses in developing countries for an education-specific analysis of unemployment. The following analysis therefore focuses on European countries, for which EUROSTAT provides consistent time-series data on unemployment by level of education, as well as the United States of America.

BACKGROUND: YOUTH UNEMPLOYMENT AND EDUCATION

Youth unemployment is an indicator of young people experiencing difficulties in the transition from education to employment. When economic conditions do not favour job creation, young people in particular experience difficulties in finding and keeping jobs.

The Organisation for Economic Co-operation and Development (OECD) report *Education at a glance* (2013) emphasizes the importance of education in reducing the vulnerability of young people: "The distribution of unemployment within the younger generation sheds light on some of the factors that may increase the risk of joblessness, which, in turn, offers insights for policy responses. Most notably, educational attainment has a huge impact on employability, and the crisis has strengthened this impact even further. On average across OECD countries, 4.8% of individuals with a tertiary degree were unemployed in 2011, while 12.6% of those lacking a secondary education were. Between 2008 and 2011 the unemployment gap between those with low levels of education and those with

high levels of education widened: across all age groups, the unemployment rate for low-educated individuals increased by almost 3.8 percentage points, while it increased by only 1.5 percentage points for highly educated individuals. Without the foundation skills provided by a minimum level of education, people find themselves particularly vulnerable in an insecure labor market" (p. 13).

Several mechanisms result in this pattern of generally lower unemployment for more highly educated younger people. First, structural changes in the economies of many countries have led to new job creation in sectors such as information and communications technology that typically require higher skills. Second, when employers have a choice between a better and lower skilled person for any given job, it is a rational decision to offer the job to the former, expecting more productivity for a given salary level. On top of higher skills, there is a 'signalling effect' that leads to the recruitment of people with better education on paper, even when the actual skills have not been tested. This can lead to a crowding-out process. In a tight labour market, more jobs go to people with better education, thus resulting in relatively higher unemployment for those with lower levels of formal education. All these factors contribute to education differentials in unemployment.

The pattern can differ by a country's stage of economic development. While there is ample evidence that higher education increases the chances of employment in advanced economies, for developing countries, several studies suggest that "the nature of educational enrollment, attainment, and employment may be very different in rapidly changing societies, and these relationships are likely to change across historical time" (Yabiku and Schlabach 2009, p. 537). In transitioning societies, meaning those moving out of being predominantly agrarian, education systems often produce graduates faster than the economy can adjust, leading to a shortage of job opportunities in the formal sector for individuals with higher education. Two factors that contribute to this phenomenon in a number of developing countries are the high aspirations for finding a prestigious job that are often associated with higher formal education, and a situation where the chosen field of study does not match demand by the labour market. It is not unusual that graduates in one field have serious difficulties finding an appropriate job, while other fields lack qualified graduates.

EMPIRICAL EVIDENCE FROM EUROPE

As noted, empirical data on trends in youth unemployment by level of education is very unevenly distributed. Consistent data for a large number of European countries, however, is provided in table 3. It shows that adult unemployment is significantly lower than youth unemployment in all European countries with available data. This clearly indicates that the period of transition from education to entering the labour market is a particularly critical phase for young people. The burden of finding a job is usually placed entirely upon young people themselves; concurrently, older people in existing employment contracts are typically well protected by labour laws. The first reaction in

times of economic difficulties is often for companies to stop recruiting young people before considering sacking people who are already employed. Furthermore, when it comes to terminating employment contracts in crises, younger employees are frequently more likely to lose their jobs because they are often less protected by labour laws and cheaper to lay off than older workers.

Table 3: Youth and adult unemployment rates, 2008 and 2012

Country	2008			2012		
	Youth (15-24 years old)	Adults (25-64 years old)	Difference between youth and adult unemployment rates (percentage points)	Youth (15-24 years old)	Adults (25-64 years old)	Difference between youth and adult unemployment rates (percentage points)
Austria	8	3.2	4.8	8.7	3.7	5
Belgium	18	5.9	12.1	19.8	6.5	13.3
Bulgaria	12.7	5	7.7	28.1	11.1	17
Croatia	21.9	7	14.9	43	13.6	29.4
Cyprus	9	3.2	5.8	27.8	10.4	17.4
Czech Republic	9.9	4	5.9	19.5	6.1	13.4
Denmark	8	2.6	5.4	14.1	6.5	7.6
Estonia	12	4.7	7.3	20.9	9.1	11.8
European Union-27	15.6	6	9.6	22.8	9.2	13.6
Finland	16.5	5	11.5	19	6.2	12.8
France	18.6	6.1	12.5	23.8	8.4	15.4
Germany	10.6	7.2	3.4	8.1	5.2	2.9
Greece	22.1	6.7	15.4	55.3	22.4	32.9
Hungary	19.9	6.9	13	28.1	9.7	18.4
Iceland	8.2	1.9	6.3	13.5	4.5	9
Ireland	12.7	5	7.7	30.4	13.1	17.3
Italy	21.3	5.6	15.7	35.3	9	26.3
Latvia	13.1	6.9	6.2	28.4	13.8	14.6
Lithuania	13.4	5	8.4	26.4	12.3	14.1
Luxembourg	17.9	4	13.9	18.8	4.2	14.6
Malta	12.2	4.7	7.5	14.2	5	9.2
Netherlands	5.3	2.2	3.1	9.5	4.5	5
Norway	7.5	1.8	5.7	8.5	2.3	6.2
Poland	17.3	6	11.3	26.5	8.6	17.9
Portugal	16.4	7.2	9.2	37.7	14.5	23.2
Romania	18.6	4.7	13.9	22.7	5.8	16.9
Slovakia	19	8.5	10.5	34	12.2	21.8
Slovenia	10.4	3.7	6.7	20.6	8	12.6
Spain	24.6	9.8	14.8	53.2	22.8	30.4
Sweden	20.2	4.2	16	23.6	5.8	17.8
Switzerland	7	2.8	4.2	8.4	3.6	4.8

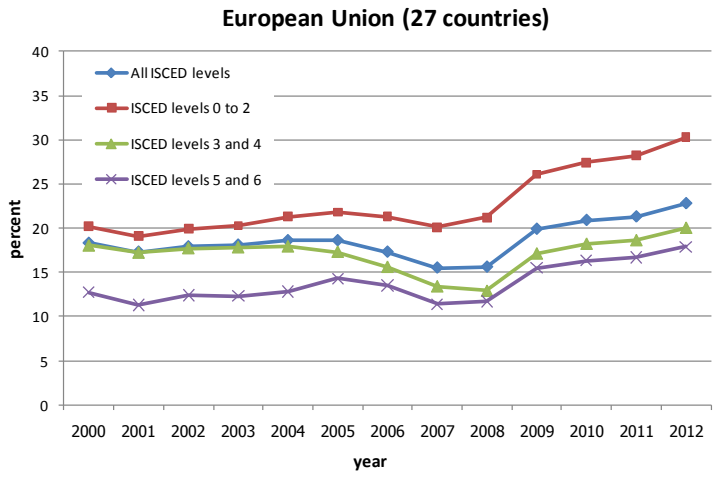
The former Yugoslav Republic of Macedonia	56.4	30.7	25.7	53.9	28.4	25.5
Turkey	18.5	8	10.5	15.7	6.9	8.8
United Kingdom	15	4	11	21	5.8	15.2

Source: EUROSTAT database, based on labour force survey data. Data retrieved on 25 June 2013. See http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Figure 1 shows the development of youth unemployment in the European Union since 2000. The education differentials in unemployment vary over time, but at any point between 2000 and 2012, higher levels of education are associated with lower levels of unemployment. The figure also clearly shows the effect of the economic crisis after the boom years ended in 2008. While youth unemployment rates increased for all education groups from 2009 onwards, the sharp differences by level of education remained unaffected by the crisis; actually, differentials still widened a bit as a consequence of the crisis. At the level of the European Union-27, the unemployment rate of young men and women in 2012 was 30 percent for the lowest education groups, 20 to 23 percent for the intermediate education groups, and only 18 percent for the highest education categories. Table 4 and figure 2 look at this pattern at the national level.

Figure 1: Youth unemployment rates by education level in the European region

Figures comprise rates for youth aged 15 to 24 for European Union-27 countries by levels of educational attainment. International Standard Classification of Education (ISCED) levels 0 to 2 encompass pre-primary, primary and lower secondary education; ISCED levels 3 and 4 upper secondary and post-secondary non-tertiary education; and ISCED levels 5 and 6 the first and second stages of tertiary education.



Source: EUROSTAT database, based on labour force survey data. Data retrieved on 25 June 2013. See http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Table 4: Youth unemployment rate (ages 15 to 24), by highest level of educational attainment, 2012

Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
		Total		
Austria	8.7	12.4	6.9	:
Belgium	19.8	32.8	16.2	14
Bulgaria	28.1	46.5	26.5	:
Croatia	43	61.5 (u)	42.1	45 (u)
Cyprus	27.8	30.1	25.1	30.5
Czech Republic	19.5	48.9	16.1	12.6
Denmark	14.1	16.6	11.2	13.7 (u)
Estonia	20.9	32.6	18.7	:
European Union-27	22.8	30.3	20	17.9
Finland	19	29.7	14.3	:
France	23.8	37.8	21.4	14.7
Germany	8.1	12.2	5.7	4.4
Greece	55.3	50.7	58	52.3
Hungary	28.1	44.7	25.5	18.9
Iceland	13.5	16.6	8.2	:
Ireland	30.4	50.4	29.9	17.9
Italy	35.3	40.2	33	33.3
Latvia	28.4	44.1	26.5	13.7 (u)
Lithuania	26.4	36.3 (u)	26.2	21.6 (u)
Luxembourg	18.8	22.6	16.6	:
Malta	14.2	22.8	9.9	:
Netherlands	9.5	13.3	6.8	5.1
Norway	8.5	10.4	5.8	7.2
Poland	26.5	33.2	26	22.5
Portugal	37.7	39.4	35.5	39.1
Romania	22.7	16.3	25.1	29.1
Slovakia	34	66	31	29.1
Slovenia	20.6	29.6 (u)	18.6	21.3 (u)
Spain	53.2	59.9	49.7	39.8
Sweden	23.6	38.6	18.1	14.1
Switzerland	8.4	7.4	9.3	7.9 (u)
The former Yugoslav Republic of Macedonia	53.9	63.1	49.3	61.8
Turkey	15.7	12.6	17.2	25.7

Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
United Kingdom	21	37.2	18.8	12.6
Males				
Austria	8.8	11.1	7.5	:
Belgium	20.4	33.7	15.5	14.1
Bulgaria	29.5	49.9	27	:
Croatia	42.3	57.3 (u)	42.1	:
Cyprus	28.8	33.9	27.2	27.2 (u)
Czech Republic	19.9	50.8	15.3	17.6 (u)
Denmark	14.8	17.1	11.6	:
Estonia	23.4	32.1	20.5	:
European Union-27	23.4	30.5	20.1	17.9
Finland	19.9	30.4	15.5	:
France	23.9	37	20.3	15
Germany	8.8	12.6	6	:
Greece	48.4	47.2	50.9	34.8
Hungary	28.8	43.9	25.8	:
Iceland	14.7	18.9	:	:
Ireland	36.4	56.1	34.3	22.1
Italy	33.7	38.5	31.2	26.1
Latvia	27.6	39	24.4	:
Lithuania	29.9	:	28.4	:
Luxembourg	18.9	22.5 (u)	16.8 (u)	:
Malta	13.9	19.3	10.1 (u)	:
Netherlands	8.9	11.7	6.7	5.4
Norway	9.9	11.4	6.9	14.8 (u)
Poland	24.1	31.4	23	19 (u)
Portugal	36.4	37.8	34.2	38.1
Romania	22.3	18.7	24.2	23.8 (u)
Slovakia	35	64.9	31.5	30.8 (u)
Slovenia	20.3	29.5 (u)	18.1	:
Spain	54.4	58.9	52.6	38
Sweden	25	40.5	19.3	16.5
Switzerland	8.8	7.9	9.3	9.8 (u)
The former Yugoslav Republic of Macedonia	55.2	64.8	51.6	59.7
Turkey	14.6	13.6	14.6	20.3
United Kingdom	23.6	37.3	21	16.1

Country	All ISCED levels	Pre-primary, primary and lower secondary education (ISCED levels 0 to 2)	Upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4)	First and second stage of tertiary education (ISCED levels 5 and 6)
Females				
Austria	8.7	14.5	6.3	:
Belgium	18.9	31.1	17.2	14
Bulgaria	26	40.4 (u)	25.7	:
Croatia	44.3	67.8 (u)	42.1	52.4 (u)
Cyprus	26.7	:	21.8	31.6
Czech Republic	19	45	17.4	10.6 (u)
Denmark	13.5	16	10.9	:
Estonia	18	33.7 (u)	16.5	:
European Union-27	22	30	19.8	17.9
Finland	18	29	13	:
France	23.7	39.3	22.8	14.4
Germany	7.3	11.6	5.3	4
Greece	63.2	58.5	66.3	59.1
Hungary	27.3	46.5	25.2	21.8
Iceland	12.3	14.1	9.9	:
Ireland	24	41.2	24.7	15.3
Italy	37.5	43.9	35.3	36.6
Latvia	29.3	56	29.3	:
Lithuania	21.9	:	22.9 (u)	:
Luxembourg	18.6	23 (u)	16.3 (u)	:
Malta	14.6	29.5	9.8 (u)	:
Netherlands	10	15.1	7	4.9
Norway	6.9	9.3	4.5	4.6 (u)
Poland	30	39.5	30.8	24.3
Portugal	39.2	42.4	36.7	39.5
Romania	23.2	12.2	26.5	32.4
Slovakia	32.5	68.6	30	27.9
Slovenia	21	29.8 (u)	19.3	23.5 (u)
Spain	51.8	61.6	47	40.8
Sweden	22.2	36.9	16.8	12.5
Switzerland	8.1	6.8	9.3	6.6 (u)
The former Yugoslav Republic of Macedonia	51.8	58.6	44.7	62.9
Turkey	17.8	10.2	22.1	30.8
United Kingdom	18	37	16.6	9.4

Note: (:) denotes data not available, (u) data with low reliability.

Source: EUROSTAT database, based on labour force survey data. Data retrieved on 25 June 2013. See http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

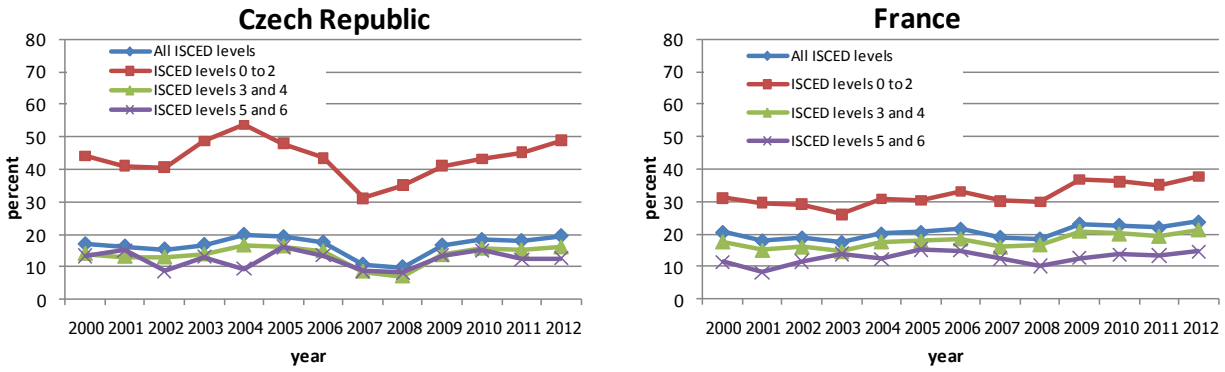
While table 3 clearly shows that young people are more vulnerable to unemployment than older ones, table 4 and figure 1 confirm that younger less-educated individuals are even more vulnerable. In the great majority of countries where reliable data is available (14 out of 21), young people with any kind of tertiary education have lower levels of unemployment than those who have at most a lower secondary education. There are interesting country deviations from the general pattern, however, that can be explained by specificities of education systems as well as rigidities in labour markets.

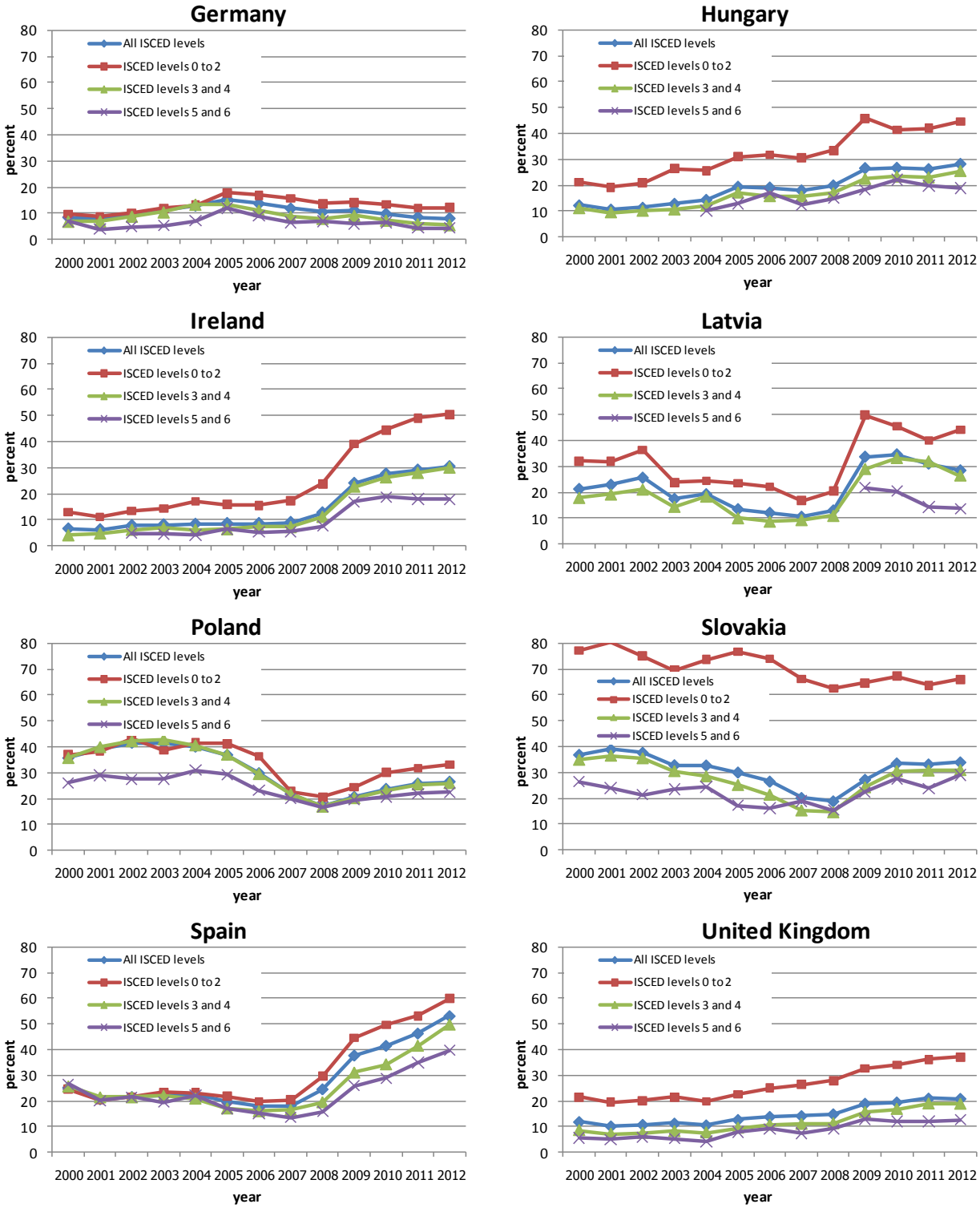
For every country in figure 2, the lowest education groups have significantly higher risks of unemployment than those with higher education. With respect to the economic crisis, however, the times series data for France and Germany show hardly any effect on youth unemployment, whereas in Ireland and Spain the impacts were most dramatic. In Ireland, unemployment among the least educated youth is currently 50 percent; it reaches 60 percent in Spain. For young adults with post-secondary education, unemployment is around 18 percent in Ireland and 'only' 40 percent in Spain. This interesting difference in the extent of the educational-unemployment differential may have to do with the rigidity of the labour market in Spain compared to Ireland, where the unemployment rates of the more highly educated have declined over the past five years.

But even in Spain, reports about massive increases in unemployment among university graduates have to be put into perspective. The data show that even under dramatic conditions where overall youth unemployment is at more than 50 percent, those with a university education have a 50 percent greater chance of finding a job than those with only basic education. A better education still reduces vulnerability to remaining unemployed.

Figure 2: Youth unemployment in selected European Union countries, 2000-2012

Youth ages 15 to 24 years by highest level of educational attainment.





Note: data points with low reliability for ISCED levels 5 and 6: Ireland (2002-2004), Czech Republic (2000-2011), Hungary (2004-2007), Poland (2000), Slovakia (2000-2006) and Latvia (2011, 2012).

Source: EUROSTAT database, based on labour force survey data. Data retrieved on 25 June 2013. See

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Table 5 shows comparable data for the United States, where the pattern of youth unemployment fully confirms the general pattern described for Europe. The differentials are in fact even greater, showing that young adults with only a high school education are about three times more likely to be unemployed than young people with a completed bachelor's degree. For high school dropouts, the situation is much worse; more than 30 percent do not have a job, making them four times as vulnerable as young adults with an undergraduate education.

Table 5: Unemployment rates among youth in the United States, 2010

Youth ages 16 to 24 years by educational attainment

Total		Less than high school completion		High school completion only		Some college or associate's degree		Bachelor's or higher degree	
18.8		**30.2**		**23.0**		**12.2**		**7.3**	

Source: http://nces.ed.gov/pubs2012/2012026/tables/table_27.asp.

This section has demonstrated that young people between the ages of 15 to 24 tend to be significantly more vulnerable to unemployment than their older peers. But this higher vulnerability does not apply equally to all younger people. For all countries with reliable and comparable statistics—unfortunately, only European nations and the United States—young men and women with low levels of education have by far the highest risk of going without a job. Data also indicate that unemployment risk monotonically decreases with higher levels of education in the majority of the shown countries. Particularly given technological advances and further automation of production processes, promulgating high-quality education that enhances the increasingly sophisticated skills demanded by labour markets is a key strategy for reducing young adults' vulnerability to unemployment risks.

Disability of adults aged 30 to 74 by level of education

For adults as they age, health becomes an increasing concern. With respect to individual life satisfaction and happiness as well as societal productivity, health status and its inverse—disability—play ever more pertinent roles. Particularly in the context of population ageing, there is growing concern over a worsening future problem of disability.

Many factors influence a person's health/disability status. They range from those related to genes to individual lifestyle to the quality of preventive and curative health care. When it comes to observable individual characteristics of people, there is overwhelming empirical evidence from

virtually all countries for which data exist that disability risk varies greatly by level of education for both men and women (KC and Lentzner 2010). This difference is best documented with male life expectancies, where the gap between the highest and lowest educational groups in various countries ranges from as much as 12 years in Eastern Europe to 3 to 4 years in Mediterranean countries. What is less well known and documented is that the prevalence of disabilities also tends to vary greatly with level of education. Since the risk of disability at the mid-adult age is much more prevalent among populations around the world than outright mortality, this section attempts to summarize the evidence on disability rates among adults aged 30 to 74.

Fairly good data have become available; those used here come from the World Health Survey (WHO 2000). It is a collection of sample surveys of adults aged 18 and older in 70 countries across the globe, as shown in appendix table A.1. Data were collected in 2002 and 2003 through personal interviews conducted in local languages using standardized survey instruments. Respondents provided information on demographic characteristics, health status, risk factors, access and use of health services, and health care expenditure, as shown in appendix table A.2. In this analysis, two health status indicators measuring the presence or absence of disability were defined based on responses on 'activity of daily living' (ADL) and 'self-reported health' (SRH).

As table 6 shows, 14 percent of the sample population in Eastern Europe is ADL disabled. In the other four regions, the proportion ranges from 9 percent in Africa to 5 percent in Latin America. These differences are greatly influenced by the fact that the population of Europe is on average much older than that of Africa. In addition to age, however, there are important differentials with respect to level of education. Table 6 presents the percentage of ADL disability in each education group in each region for the sample before standardizing by age. Eastern Europe appears to have the highest level of disability, followed by Africa and Asia, with Latin America and Western Europe showing the lowest levels. Eastern Europe also has the highest levels of disability across all levels of education. Regional and country differences in levels of disability must be viewed with caution due to the subjective nature of the questions, however, and the degree to which cultural and socio-economic factors may systematically impact reporting.

Table 6: Proportion of disabled in population by education level for world regions

Men and women aged 30 to 74.

Education	Africa	Asia	Western Europe	Latin America	Eastern Europe
None	0.12	0.16	0.20	0.13	0.37
Primary	0.07	0.08	0.10	0.07	0.29
Secondary	0.04	0.04	0.05	0.04	0.12
Tertiary	0.04	0.03	0.03	0.02	0.09

Total	0.09	0.08	0.06	0.05	0.14

Source: KC and Lentzner 2010, estimated using data from WHO 2000.

Table 7 shows the odds ratios resulting from a regression of ADL disability on age and education, separately for females and males. All values are significant at the 0.05 level or higher, except for those identified by 'ns' (not significant). The odds of reporting severe or extreme difficulty in mobility or self-care clearly increase by age; for Eastern European females, the odds are almost nine times as likely at ages 60 to 69 compared with ages 30 to 39. They are almost three times as likely for Asian and Latin American females. For men, the odds at ages 60 to 69 increase by as much as six times in Western and Eastern Europe compared with ages 30 to 39.

For both sexes and in all five regions (except for Eastern European males with at least a secondary education), the prevalence of disability declines significantly with increasing education. The odds of reporting ADL disability for a woman with no education compared with a woman with primary education are highest in Latin America (2.43 times) and least in Africa (1.19 times); for women with at least a secondary education, the odds are the least in Asia (0.46) and the highest in Eastern Europe (0.82).

These odds ratios can be used to calculate the odds (or proportion) of ADL disability for any combination of age and education groups for the different world regions. For example, the odds of reporting ADL disability for a woman aged 50 to 59 with at least a secondary education in Africa is 1.29 (2.08 times 0.62 as given in table 7). This implies that these women have on average a 29 percent higher probability of disability than the reference category, which is women aged 30 to 39 with only a primary education.

Table 7: Regression of ADL disability on age and education: odds ratios by world region

		Africa	Asia	Western Europe	Latin America	Eastern Europe
Female						
	Age (years)					
	30-39	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	40-49	1.39	1.27	1.62	1.55	2.58
	50-59	2.08	1.82	3.39	1.91	3.82
	60-69	3.49	2.92	4.07	2.92	8.77
	70-74	5.74	6.37	11.07	4.81	21.3
Education						
	None	1.19	1.74	1.93	2.43	1.73
	Primary	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	At least secondary	0.62	0.46	0.53	0.52	0.82
Male						
	Age (years)					

	30-39	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	40-49	1.09	1.58	1.39	0.93	2.87
	50-59	1.8[ns]	2.80	3.93[ns]	1.85[ns]	3.89
	60-69	3.26	4.50	6.02	3.16	6.19
	70-74	5.65	6.41	7.89	6.46	14.45
Education						
	None	1.38	1.21	2.00	2.35	2.56
	Primary	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
	At least secondary	0.75	0.65	0.88	0.61	0.64[ns]

Note: All values are significant at the 0.05 level or higher except for those identified by 'ns'.

Source: KC and Lentzner 2010, estimated using data from WHO 2000.

Table 8 shows results from an analysis of 10 countries in different regions. In general, the pattern of odds ratios above 1 for individuals with no education and below 1 for those with at least a secondary education persists across these countries. Brazil, the Philippines, the Russian Federation, South Africa and Turkey display these relationships for both men and women, although the values were not always statistically significantly different. In Viet Nam, a similar pattern is evident, although none of the odds ratios were statistically significant. In a few countries, some of the differences turn out to be insignificant, which is likely due to small numbers of cases in those education categories. The Pakistan sample, for instance, had only three women over age 60 with at least a secondary education; none reported ADL disability.

Table 8: Regression of ADL disability on age and education for 10 developing countries

Odds ratios for men and women aged 30 to 74.

	Females			Males		
	No education	Primary	At least secondary	No education	Primary	At least secondary
Brazil	2.36	1.00	0.45	2.23	1.00	0.55
China	3.24	1.00	2.22[ns]	3.97	1.00	0.61[ns]
Ethiopia	0.86[ns]	1.00	0.70[ns]	2.18	1.00	1.19[ns]
India	0.90[ns]	1.00	0.50	0.91[ns]	1.00	0.65
Pakistan	3.42[ns]	1.00	2.37[ns]	0.73[ns]	1.00	0.36
Philippines	1.93	1.00	0.47	1.26[ns]	1.00	0.50
Russian Federation	3.25	1.00	0.94[ns]	8.96[ns]	1.00	0.64[ns]

South Africa	1.16^{ns}	1.00	0.34	2.50	1.00	0.66^{ns}
Turkey	2.13	1.00	0.40	1.61	1.00	0.38
Viet Nam	1.49^{ns}	1.00	0.34^{ns}	1.51^{ns}	1.00	0.64^{ns}

Note: All values are significant at the 0.05 level or higher except for those identified by 'ns'.

Source: KC and Lentzner 2010, estimated using data from WHO 2000.

The introduction to this paper stressed that there is a strong case for assuming functional causality for the effects of education on health. For this reason, it makes sense to assume that these differentials also hold for the future. One may argue that differentials may change over time as increasingly large segments of populations receive more education. But at least with respect to educational mortality differentials—where time series data exist—rapid expansions in overall education have not led to a narrowing of the differentials. In some cases, they seem to have widened over time. As a simple benchmark in the following simulation exercise, a constant pattern of age- and education-specific disability rates is assumed.

PROJECTING THE LEVEL OF ADULT DISABILITY

This section looks at the potential impact of the growth of formal education on adult health across broad geographical regions. It contrasts the conventional approach, which only differentiates by age and sex, with an education-specific approach that explicitly includes education differentials as a source of population heterogeneity, in addition to age and sex. As will be seen, the future looks very different under these two approaches.

Both projections used the Wittgenstein Centre's world population projections by age, sex and education for the period 2010 to 2100 (Lutz et al. forthcoming) as the numerical basis. First, a constant age/sex profile of ADL disability was applied without considering observed educational differentials. This was then applied to a projection of the future age and sex structure of the population. A second set of calculations factor in the education/disability relationships obtained from the World Health Survey analysis for three different education scenarios. More than 100 countries covering approximately 90 percent of the world's population were grouped into five regions for this exercise. The population projections themselves are extensively documented elsewhere (ibid.) and need not be described here.

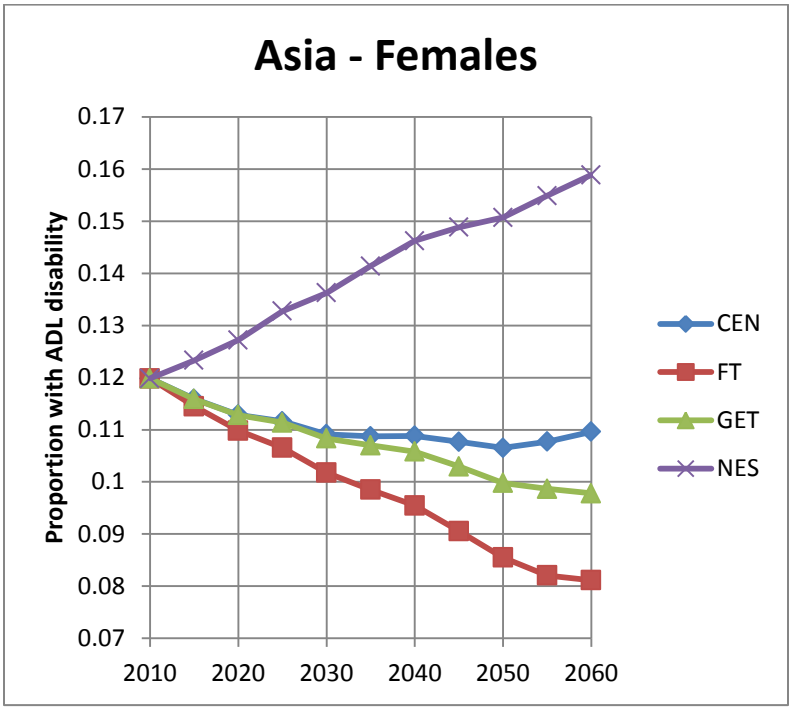
The results of these alternative projections of disability are shown in figure 3 for women aged 30 to 74 for three selected world regions. Without factoring in education and only considering the age pattern of disability (labelled the no-education scenario or NES), the conventional forecast shows a significant increase in future disability rates simply as a function of rapid population ageing,

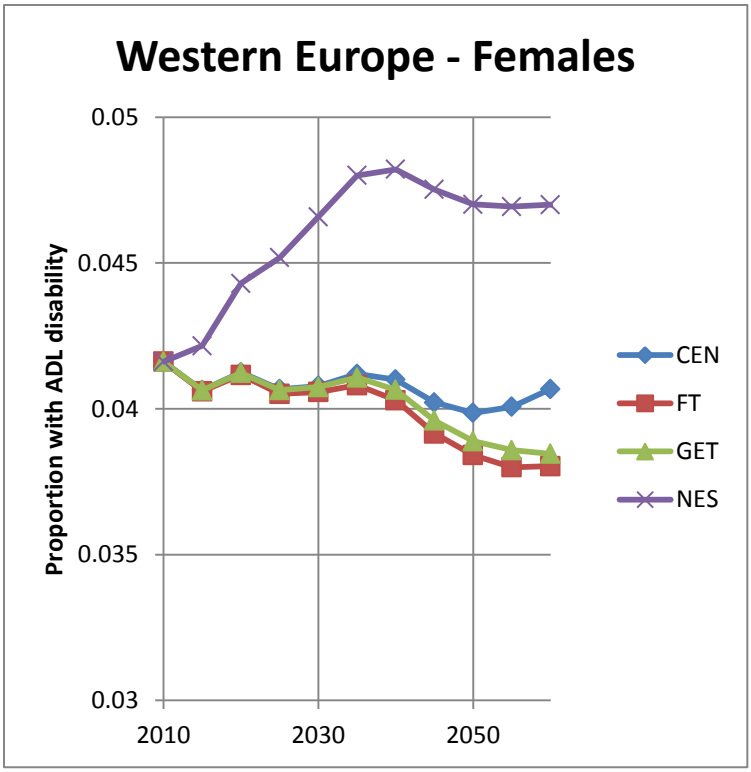
combined with the fact that older people have a higher prevalence of ADL disability. This projected increase is particularly strong in Asia, where due to rapid fertility decline, population ageing over the coming decades will be even faster than in most other continents; it is also very pronounced in Western Europe. Since the population in sub-Saharan Africa is still very young and will continue to grow rapidly over coming decades, this ageing effect is only visible in the longer run.

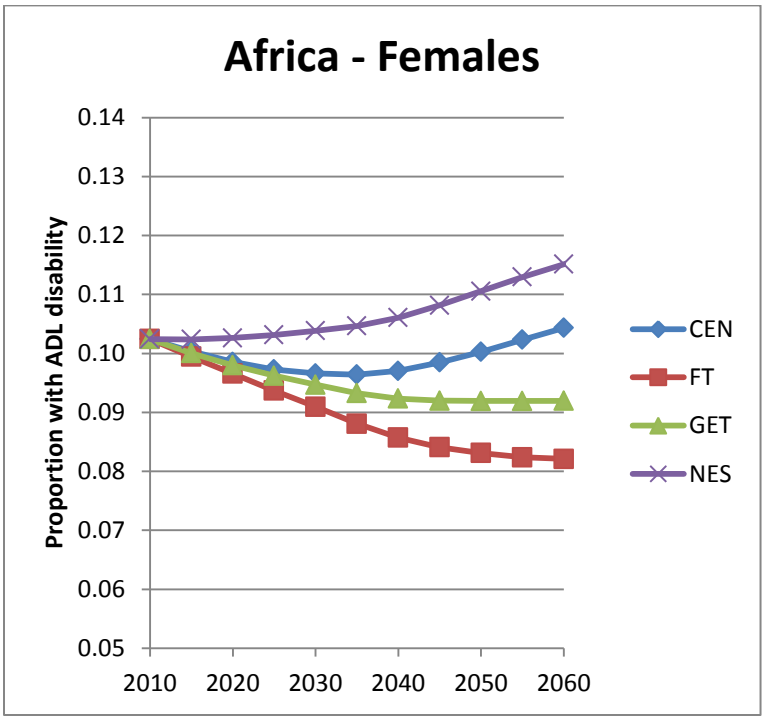
Once education is explicitly factored into the model, the picture looks completely different. Under all three scenarios, there will actually be reductions in disability by 2050 for adult women aged 30 to 74. Again, the gap between the two kinds of projections is most pronounced for Asia. The reason is that while Asia is rapidly ageing, elderly people will also be much better educated. This results from the very fast expansion of schooling among young Asians over the past decades. In some countries, such as China and the Republic of Korea, a majority of the adult population had no formal schooling in the 1960s. Today, young cohorts are very well educated and even among the best educated in the world in the Republic of Korea. While today's elderly still have very low levels of education, this will not be the case in the future, a finding that holds for all three future education scenarios. As shown by the CEN scenario, even no further improvements in school result in a much lower level of overall disability than when education is simply not factored into the model, i.e., when the apparent heterogeneity by level of education is disregarded. The most rapid improvement in disability is clearly shown under the very optimistic FT scenario.

Of the three regions, the picture is a bit different in Africa because of continuous rapid population growth. Under the very pessimistic CEN scenario, which assumes that no new schools are being built, the educational composition of the population actually worsens over time due to larger and larger young cohorts. As a consequence, this scenario will also result in lower education of the adult population and higher disability. Under the medium GET and very optimistic FT scenarios, the future prevalence of disability is expected to decrease.

Figure 3: Projected prevalence of ADL disability for women aged 30 to 74







Source: KC and Lentzner 2010, estimated using health data from WHO 2000, and population projections from Lutz, Butz and KC 2014.

In conclusion, the vulnerability of men and women to disability varies greatly among countries and across age groups. There are also significant and consistent differences with respect to the level of education—the scenarios presented above reveal a very different future once education is explicitly factored in. Instead of the ubiquitous projections that indicate massive increases in future disability rates as a consequence of population ageing, this analysis reveals that adult disability for women aged 30 to 74 may decline even in the rapidly ageing populations of Asia and Western Europe. This has important consequences beyond individual health and well-being as it may allow people to stay longer in the labour force and increase the productive potential of ageing societies.

Differential vulnerability to natural disasters by level of education

This final section addresses vulnerability to natural disasters, which can also be viewed as a proxy for likely future vulnerability to the possible consequences of climate change. Vulnerability to natural disasters is of significant interest in its own right as a source of premature death, particularly in developing countries. But it becomes even more relevant through the assumption that the mechanisms by which such vulnerability is either enhanced or reduced are isomorphic to those that affect the resilience or vulnerability to likely future climate change. This study of differential

vulnerability therefore has significant relevance beyond specific disasters studied. A better understanding of risk factors associated with currently observed vulnerabilities to natural disasters can inform conclusions about risk factors associated with future climate change, in particular with respect to the likely higher frequency and intensity of tropical storms, extreme flooding and severe droughts.

This type of vulnerability affects people at all stages, although the intensity of the risk tends to differ by age. While there is some evidence that infants and the frail elderly are more vulnerable because they directly depend on the help of others, for the years in between, other factors tend to dominate the differentiation of risk. These range from household characteristics associated with economic standing, such as the construction and stability of houses, to the ecological setting, to individual behavioural variables. One individual characteristic that in the past has not received enough attention in risk studies is educational attainment. A series of recent studies has clearly demonstrated its decisive role in risk reduction.

In general, in the field of population-environment interactions, there is increasing recognition that people not only differ with respect to their contribution to climate change but also in their adaptive capacity. A recent summary states: "The evidence is clear that demographic differences fundamentally affect people's contributions to environmental burdens, their ability to participate in sustainable development, and their adaptability to a changing environment" (from the statement of an international scientific panel as published in *Science,* Lutz et al. 2012). Nonetheless, the future adaptive capacities of societies and the differential vulnerability of their members are among the least studied aspects of the important question of how dangerous climate change will be for future human well-being. For example, several studies that try to assess the impact of climate change on future malaria deaths in eastern Africa combine projected changed climate conditions for 2080 with today's public health capabilities, population distributions, human capital and general adaptive capacities. But such assessments can be misleading. Even as the climate will likely change over the coming decades, so will demographic structures and associated socio-economic capabilities.

The central hypothesis in this section is that education can play an important role in reducing the negative impacts of extreme climate events on human mortality. The mechanisms through which education can reduce vulnerability to natural disasters and climate change are described in detail in Muttarak and Lutz (2014). Education is one important way for individuals to acquire knowledge, skills and competencies that can directly or indirectly influence their adaptive capacity. Most directly, literacy and numerical skills obtained through formal education imply better access to relevant information, such as early warnings for tropical storms or seasonal predictions of drought (Patt, Ogallo and Hellmuth 2007; Moser and Ekstrom 2010). There is also evidence that education enhances cognitive skills and the willingness to change risky behaviour, while at the same time

extending the personal planning horizon (Behrman and Stacey 1997, Neisser et al. 1996, Nisbett 2009). Education enhances the acquisition of knowledge, influencing values and priorities as well as the capacity to plan for the future and improve allocation of resources (Glewwe 1999; Thomas, Strauss and Henriques 1991). Besides that, as described in the previous section on disability, education leads to better health and physical well-being (Fuchs, Pamuk and Lutz 2010; Baker et al. 2011; KC and Lentzner 2010) and is positively related to 'life' skills—e.g., basic practical knowledge on nutrition and health practices, government institutions and organization—as well as problem-solving skills (Moll 1994; Ishikawa and Ryan 2002; Schnell-Anzola, Rowe and LeVine 2005). Consequently, it is reasonable to assume that when facing natural hazards or climate risks, educated individuals are more empowered and adaptive in their responses, preparation and recovery from disasters. Furthermore, better-educated societies have greater social, economic and institutional capabilities necessary for successful adaptation to climatic change (KC and Lutz 2013).

When the effects of education are studied, the question of endogeneity often arises. At the aggregate level, there can be either reverse causality or joint determination of the factors studied. Societies with a high average level of education generally tend to be more developed and perform well on other development indicators such as health and living standards. It could therefore be possible to assume that the apparently positive effects of education on reducing vulnerability are actually the results of, for example, better infrastructure and health facilities in a country. To study this issue, it is necessary to explicitly include these other factors in the analysis.

At the individual level, in addition to the possibility of reverse causation, there is also the chance that the effect could be explained by selectivity, for example, that certain stronger individuals become both better educated and more resilient to disasters. Endogeneity and causality in the effects of education at the individual and societal levels are extensively discussed by Lutz and Skirbekk (2014). When assessing the effect of educational attainment, the issue of identifying the direction of the effect is made significantly easier by the fact that the time when the educational attainment was reached (through schooling) tends to be significantly earlier than the time at which vulnerability is assessed. For example, a 50-year-old woman will have achieved an education on average more than 30 years ago. Her current vulnerability is independent of the possible effects of recent disasters on the school system or her individual chance to have accessed an education. Hence, in the spirit of the discussion at the beginning of the paper, there are many good reasons to assume that there is indeed functional causality in the effect of more education on reducing vulnerability.

It has recently been acknowledged that the impacts of climate change are not distributed evenly across population groups and countries (Parry et al. 2007). Accordingly, extant research has investigated socio-demographic differences in impacts of, responses to and recovery from natural disasters and extreme climate events. The poor, elderly, children, women, ethnic minorities and

immigrants are commonly the most vulnerable groups (Clark et al. 1998). The elderly, children and women typically have less physical strength and ability to escape from danger, compared to men at prime ages (Yeh 2010). The poor and minority groups are more likely to live in sub-standard housing and disaster-prone areas. Mortality and morbidity from natural disasters are much higher among these sub-populations (Neumayer and Plümper 2007, Frankenberg et al. 2011). Furthermore, low-income groups generally face more obstacles during the phases of response, recovery and reconstruction (Masozera, Bailey and Kerchner 2007). Studies on social vulnerability commonly highlight poverty/income as a main characteristic explaining inequalities in all aspects of disasters (Fothergill and Peek 2004).

At the macro level, economic inequalities in impacts from natural disasters have also been reported across communities, regions and nations (Cavallo and Noy 2010). Fatalities in low-income countries are generally much higher than those of higher income nations (Kahn 2005), while macroeconomic recovery is slower in the former compared to the latter (Noy 2009). Apart from economic factors, however, recent studies show that social characteristics such as literacy levels, degree of openness to foreign trade and political environment are also associated with disaster impact (Toya and Skidmore 2007, Noy 2009). This suggests that income alone does not explain differential vulnerability. Likewise, the findings that countries with higher levels of education suffer less from the impacts of natural disasters imply that investment in human capital may be a practical tool to prepare for an increasing number of extreme climate events.

NEW EMPIRICAL EVIDENCE

Based on the rationale described above, this paper hypothesizes that formal education could directly or indirectly reduce vulnerability and enhance adaptive capacity. Recent efforts in that direction include empirical analyses at the individual, household, village and national levels, as well as global time series assessments.

A study on the disaster preparedness of 557 households in Phang Nga province in Thailand related to the 2012 Indian Ocean earthquakes finds that formal education—measured at the individual, household and community levels—increased the likelihood of preparedness actions being taken (Muttarak and Pothisiri 2013). Having been affected by the 2004 tsunami increased emergency preparedness, but for the group of persons without such disaster experience, education turned out to be a relevant factor in anticipating and preparing for the risk.

A recent study at the individual level by Frankenberg et al. (2013) examines the extent to which education protects against natural disaster by using longitudinal survey data collected in two provinces on the island of Sumatra, Indonesia, before and after the 2004 Indian Ocean tsunami. It finds that education plays a role in coping with the disaster over the longer term, with the better

educated having greater psychosocial health five years after the tsunami. They are less likely to live under precarious living conditions and appear to be more equipped to compensate for income losses.

Similar evidence on the association between education and vulnerability has been reported at the community level. KC (2013) reports strong effects from education by using comprehensive data from villages in Nepal (a micro-sample of the 2001 Census covering 2.5 million individuals together with disaster data for 2000 to 2009) on damages due to floods and landslides in terms of human lives lost, animals lost and other damage to households. Comparing the effect of education with those of income and wealth, the author concludes that education has a stronger and more consistent impact in reducing damage due to floods and landslides in Nepal.

Similarly, a study by Garbero and Muttarak (2013) investigates the impacts of floods and droughts on community welfare in Thailand. Based on Thai government surveys of living conditions and life quality of 68,695 rural villages for 2009 to 2011, the paper uses difference-in-difference methods to analyse how floods and droughts in 2010 affected the consumption and income of the villages in 2011. It finds that communities with higher educational attainment did not experience reductions in consumption, investment in agriculture or education, or a decline in income. A further analysis demonstrates that communities with high levels of education are more able to secure available government financial aid for areas affected by floods and droughts.

A study by Muttarak et al. (2012) on 286 villages in Phang Nga province in Thailand, chosen for its most severe losses from the 2004 Indian Ocean tsunami, reveals that preparations for extreme climate events and natural disasters are driven by past experiences and anticipation of such events in the future. Villages with a higher proportion of residents with at least a secondary education are more likely to prepare for potential natural disasters.

Pichler and Strießnig (2013) use data from qualitative interviews conducted in Cuba and the Dominican Republic to compare disaster vulnerability in these two island states. Even though they are fairly similar in their exposure to extreme natural events, disaster outcomes vary greatly between them. While effective disaster response is strongly embedded in the entire Cuban population, which is one of the most educated in the developing world, the interviews strongly confirm that lack of education and literacy in the Dominican Republic makes people more vulnerable and prevents them from understanding warnings about upcoming danger.

Using national time series data on disaster fatalities around the world, a recent study by Strießnig et al. (2013) finds significant evidence for the role of education, particularly female education, in reducing disaster fatalities, while there is no evidence for the widely assumed role of per capita income in reducing vulnerability after controlling for other key determinants of socio-economic development as well as exposure to risk. Table 9 shows an update of this multivariate

statistical analysis with newer data for more countries (152) and a larger number of alternative models for 1970 to 2010. The dependent variable is the log of disaster deaths. The sources of data and definitions of variables are explained in detail in Strießnig et al. (ibid.). In addition to controlling for the number of disasters as a proxy for hazard, the estimations presented in table 9 control for exposure by including population size, demographic change by including the rate of population growth, and quality of governance (Polity score). The different models have been defined to assess the relative importance of three factors of human development: economic growth, as measured by gross domestic product or GDP per capita; the development of public health, as best captured by lagged infant mortality to avoid endogeneity; and the proportion of women aged 20 to 39 with at least a secondary education, as a human capital indicator shown to be most sensitive in other contexts.

Table 9: Determinants of death from natural disaster

*Panel regression for 152 countries over 10-year intervals between 1970 and 2010 using time-fixed effects. The dependent variable is the log of deaths per capita. Numbers in parentheses are standard errors based on the heteroskedasticity-resistant and autocorrelation-resistant covariance matrix. Other independent variables not reported here are dummy variables for 18 world regions. Significance codes: 0.01 = ***; 0.05 = **; 0.1 = *.*

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Constant	-2.252***	-2.983***	-1.227	-3.100***	-1.253	-1.932**	-2.062**
	(0.774)	(0.761)	(0.838)	(0.788)	(0.841)	(0.868)	(0.876)
Log (number of disasters)	1.650***	1.562***	1.569***	1.574***	1.578***	1.535***	1.555***
	(0.119)	(0.118)	(0.118)	(0.120)	(0.120)	(0.118)	(0.119)
Population growth rate	1.401***	1.220***	0.987**	1.076**	0.873*	1.037**	0.745
	(0.517)	(0.449)	(0.455)	(0.512)	(0.527)	(0.452)	(0.525)
Log (lagged population)	0.252***	0.300***	0.266***	0.296***	0.262***	0.288***	0.278***
	(0.082)	(0.081)	(0.081)	(0.082)	(0.082)	(0.081)	(0.081)
Polity score	-0.376***	-0.233*	-0.320**	-0.238*	-0.326**	-0.226*	-0.234*
	(0.132)	(0.134)	(0.130)	(0.134)	(0.131)	(0.133)	(0.134)
GDP per capita (in thousands)	-0.005	0.006	0.005	0.012			
	(0.010)	(0.011)	(0.011)	(0.011)			
Lagged infant mortality rate	0.010***	0.011***	0.008***	0.009***			
	(0.003)	(0.003)	(0.003)	(0.003)			
Female 20-39	-1.472***	-1.523***	-1.076**	-1.173***			
Proportion of females 20-39 with at least secondary education	(0.414)	(0.431)	(0.434)	(0.443)			
Deviance	1135.210	1100.223	1104.476	1099.509	1104.081	1087.360	1084.830
AIC	2010.264	1993.109	1995.223	1994.753	1997.027	1988.664	1989.388
BIC	2130.839	2113.685	2115.799	2119.635	2121.909	2113.546	2118.576
N	548	548	548	548	548	548	548

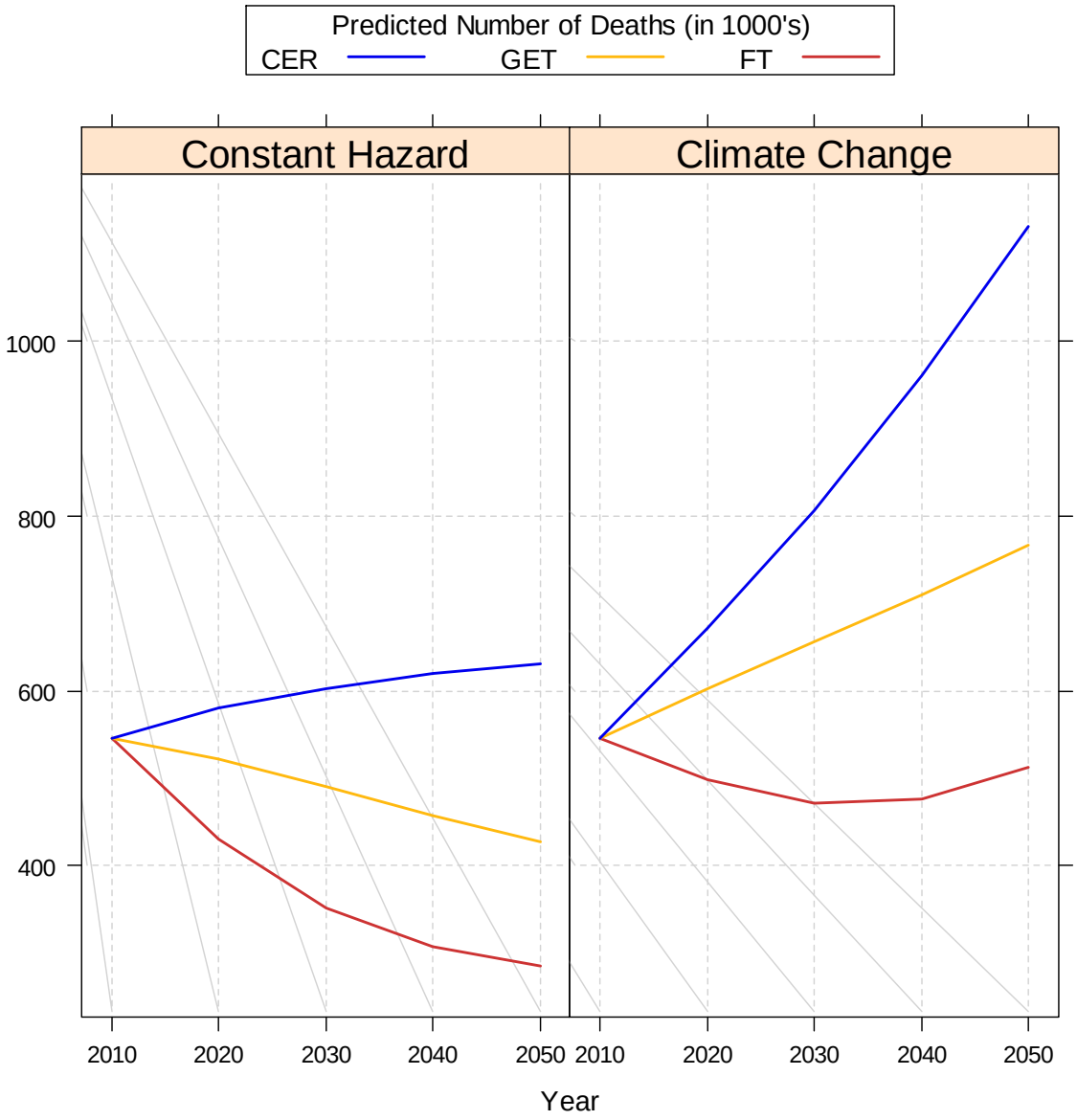
Source: Strießnig et al. 2013..

The results support earlier findings that human development is positively associated with reduced disaster vulnerability at the national level. The three dimensions of human development turn out to be of very different relative importance, however. GDP per capita is insignificant in all models, while infant mortality and female education turn out to be highly significant in all models. Higher infant mortality as an indicator of weaker public health is associated with relatively more disaster fatalities; higher levels of female education are shown to be a dominant determinant in reducing disaster vulnerability. These results clearly indicate that at least at the aggregate level of national time series, the ubiquitous assumption that GDP is a key determinant of disaster vulnerability has no empirical support, while the importance of female education is strongly confirmed.

The rest of this section converts these findings into alternative scenarios for possible future disaster vulnerability in sub-Saharan Africa depending on the three different scenarios for future education trends as defined earlier in this paper (results for 19 other world regions are available on request). Figure 4 posits two alternative assumptions about future trends in disaster hazards by combining results from Model 7, which was chosen based on model selection criteria, with the population and education projections according to the three education scenarios. On the left of the figure, the assumption is that over the coming decades, sub-Saharan Africa will be exposed to 'constant hazard'; that is, the number of registered disasters as experienced from 2000 to 2010 will remain stable. Already in this depiction, the future of education makes a huge difference, not only in the population at risk, but also in the projected decadal number of deaths due to disasters, which by the end of the prediction horizon in the CER scenario is more than twice the number in the FT scenario.

The potential to save lives through education becomes even more obvious under a hypothetical climate change scenario, on the right of the figure. It is operationalized by assuming a constant 10 percent increase per decade in the frequency of natural disasters in sub-Saharan Africa. While in the FT scenario increased educational attainment is still able to offset the effect of the assumed increase in hazards on future disaster fatalities, the assumption of a world evolving according to the CER scenario predicts an exponential increase in fatalities from extreme events. By 2050, the predicted decadal number of casualties in the CER scenario reaches over 1.13 million, a 50 percent increase over the figure predicted by the GET scenario, and more than twice that of the FT scenario.

Figure 4: Predicted deaths from natural extreme events in sub-Saharan Africa



These are of course highly stylized scenario calculations. Since assessments of the future frequency of natural disasters around the world depend on myriad factors such as geography, type of disaster or societies' capacities to prevent them from happening in the first place, to name just a few, the Intergovernmental Panel on Climate Change (IPCC) is still careful in quantifying the effect of climate change on the number of natural extreme events. There seems to be a consensus, however, on an upward trend in frequency of almost any type of disaster due to sea level rise or higher mean temperature (IPCC 2012). The assumption of constant hazards is thus unlikely to hold. Many climate change researchers may think that the assumed increase of 10 percent per decade in the climate

change scenario in figure 4 is far too conservative for the more distant future when the negative effects of climate change may accelerate. In such a case, the calculated effects contingent on the assumed future hazard levels will be proportionately higher than those shown here. Even an increase of 10 percent per decade results in a dramatic rise in fatalities, highlighting the potential for near term investments in education to reduce risks.

New insights about the important role of education for adaptive capacity presented in this section are already reflected in the new shared socio-economic pathways (SSP) scenarios produced by the international integrated assessment community to serve as a common reference point for IPCC-related modelling (O'Neill et al. forthcoming). Much more context-specific analysis of differential vulnerabilities and the role of demographic factors, including education, is needed to arrive at robust country-specific forecasts and policy recommendations.

In general, however, there can be no doubt that universal basic education of the entire population, including basic literacy and numeracy, is a key factor in enhancing adaptive capacity and reducing the vulnerability of individuals, communities and entire nations. When it comes to priorities for investments in adaptation, the benefits of currently favoured engineering solutions should be critically compared to the long-term benefits of investing in human capital formation, and general empowerment to flexibly and effectively react to still uncertain climate change effects.

In conclusion, this paper has shown that over the entire life cycle of individuals, changes in behaviour that tend to be associated with more education—of mothers or individuals themselves—can be viewed as potent factors in reducing child mortality, unemployment risks at a young age, vulnerability to natural disasters and the risk of falling into disability. These general long-term benefits of near-term investments in education hold for individuals and entire societies.

Appendix

Table A.1: World Health Survey countries used in the analysis

Africa	Asia	Western Europe	Eastern Europe	Latin America
Burkina Faso	Bangladesh	Austria	Georgia	Brazil
Chad	China	Belgium	Bosnia and Herzegovina	Dominican Republic
Comoros	India	Denmark	Croatia	Ecuador
Congo	Israel	Finland	Czech Republic	Guatemala
Ivory Coast	Kazakhstan	France	Estonia	Mexico
Ethiopia	Laos	Germany	Hungary	Paraguay
Mali	Pakistan	Luxembourg	Slovenia	
Mauritania	Philippines	Netherlands	Ukraine	
Mauritius	Sri Lanka	Norway		
Morocco	Turkey	Portugal		
Namibia	United Arab Emirates	Spain		
Senegal	Viet Nam	Sweden		
South Africa		United Kingdom		
Swaziland		Australia		
Tunisia				
Zambia				
Zimbabwe				

Source: WHO 2000.

Table A.2: Age, sex and education structure in the World Health Survey's sample population

Table A.2 shows regional distributions. Europe has by far the oldest population, with about one-fifth in the 30 to 39 age group and a little less than two-fifths at 65 and older. Africa has the youngest adult population, with about two-fifths in the 30 to 39 age group and 20 percent aged 60 and beyond. The educational disparities are striking, with the proportions of those with no education ranging from 46 percent in Africa to 27 percent in Asia, 7 percent in Latin America and 2 percent in Europe. Each region had more women than men in the sample.

	Sample (proportion)				
	Africa	Asia	Western Europe	Latin America	Eastern Europe
Age (years)					
30-39	19,083 (38%)	23,561 (36%)	4,574 (22%)	15,902 (34%)	2,980 (20%)
40-49	12,685 (26%)	18,225 (28%)	4,548 (22%)	11,539 (25%)	3,388 (23%)
50-59	7,997 (16%)	11,025 (17%)	4,047 (19%)	8,006 (17%)	2,958 (20%)
60-69	5,490 (11%)	7,233 (11%)	3,783 (18%)	5,860 (13%)	2,710 (18%)
70+	4,389 (9%)	4,557 (7%)	4,042 (19%)	4,825 (10%)	2,912 (19%)
Sex					
Female	26,618 (54%)	34,882 (54%)	12,308 (59%)	26,015 (56%)	9,407 (63%)
Male	23,026 (46%)	29,719 (46%)	8,686 (41%)	20,117 (44%)	5,541 (37%)
Education					
None	23,012 (46%)	17,694 (27%)	610 (3%)	3,012 (7%)	191 (1%)
Primary	17,541 (35%)	22,989 (36%)	5,371 (26%)	15,765 (34%)	2,095 (14%)
Secondary	6,895 (14%)	17,569 (27%)	10,939 (52%)	25,559 (55%)	8,563 (57%)
Tertiary	2,196 (4%)	6,349 (10%)	4,074 (19%)	1,796 (4%)	4,099 (27%)
Total	49,644 (100%)	64,601 (100%)	20,994 (100%)	46,132 (100%)	14,948 (100%)

Source: WHO 2000.

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