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GOOD FOR LIVING? ON THE RELATION BETWEEN GLOBALIZATION AND LIFE EXPECTANCY*

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Summary: This paper analyzes the relation between three dimensions of globalization (economic, social and political) and life expectancy using a panel of 92 countries over the period 1970-2005. Using different estimation techniques and sample groupings we find a very robust positive effect from economic globalization on life expectancy, even when controlling for income, nutritional intake, literacy, number of physicians and several other factors. The result also holds when the sample is restricted to low income countries only. For political and social globalization we find no robust effects.

Keywords: Globalization, health, life expectancy, development
JEL codes: F02, I10, H51

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1. INTRODUCTION

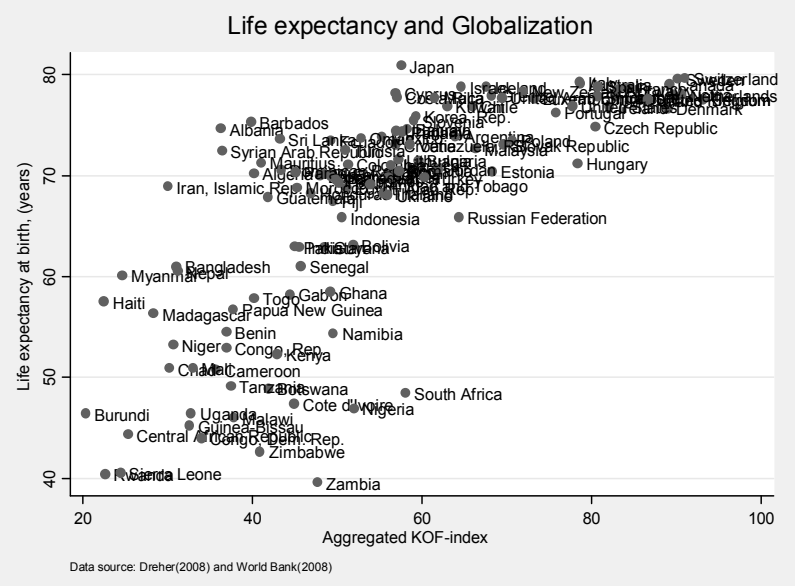
In the wake of increasing worldwide globalization, there has been much research regarding its consequences. A recently published volume by Dreher, Gaston, and Martens (2008) provides a comprehensive summary of the empirical findings on the effects of closer integration between economies for growth, taxation and government spending, within-country inequality, de-unionization, and the natural environment. Additional studies include Nissanke and Thorbecke (2006) and Ravallion (2006) on the relation between globalization and poverty reduction, and Tsai (2007) focusing on the human development index. Little is however known about the effects of globalization on physical health.

Studies on the determinants of population health suggest there are several channels through which globalization may affect health. Many relate to the movement of goods and services such as availability of imported pharmaceuticals and changes in relative prices. Consequently, the limited literature on the relation between globalization and health typically adopts an economic perspective and focus on the health effects from increased trade openness or economic freedom (Bussman 2009, Owen and Wu 2007, Stroup 2007). Globalization could however also affect health through for example life style changes, faster spread of contagious diseases and altered international relations. Analyzing the health effects of increasing internationalization therefore requires a distinction between economic, social and political globalization. Moreover, given the numerous potential channels at work it is essential to control for possible mediating factors in the globalization – health relationship.

This paper analyzes the relation between globalization and an objective and easily quantifiable measure of health: life expectancy at birth. Using the KOF-institute globalization index developed by Dreher (2006), we examine the effects of economic, social and political globalization. We focus especially on how the relation varies between levels of development.

Figure 1 plots the cross-correlation in 2000 between the composite KOF-index, which assigns a value from 0 to 100 indicating the level of globalization to each country, and life expectancy at birth. The scatter plot presents a positive but non-linear relationship. We construct a panel of 92 countries over the period 1970-2005, control for demographic structure and four factors that repeatedly have been found to influence life expectancy: public health, education, nutrition and GDP per capita. We find a strong and robust positive effect from economic globalization on life expectancy. Using a procedure where we gradually exclude high income observations from our sample and re-run the estimation, we examine how the globalization effect varies with income in a way that interaction terms do not pick up. We find a positive effect from economic globalization that is present also in a low-income context.

Figure 1. The cross-country correlation between life expectancy and globalization in 2000



The paper proceeds as follows. In the next section, we review recent research on the determinants of life expectancy and discuss how these might be influenced by globalization. Section three includes a discussion on methodological choices and a data description, and section four presents the empirical analysis including several robustness checks. Section five summarizes our results and concludes.

2. BACKGROUND

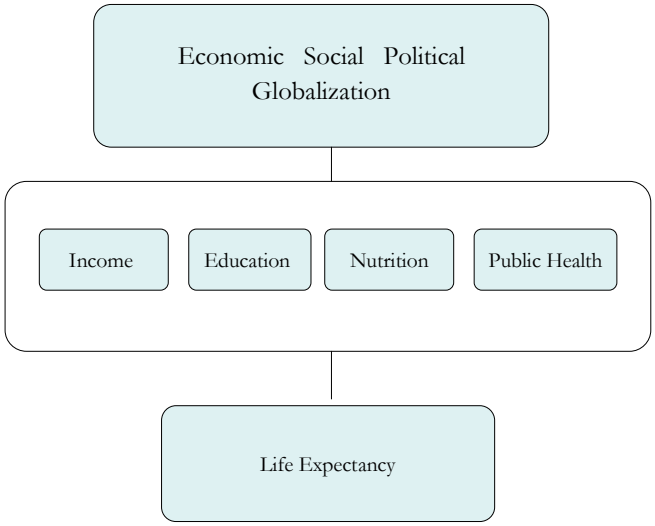
(a) Disentangling the effects of globalization on health

Globalization typically refers to the process of closer integration of economies and societies. This integration is not only a question of openness of countries but also of the development of relations between individuals at a distance. Globalization accordingly refers to both the temporal and the spatial compression of interactions. Moreover, as discussed by Arribas et al. (2009), this course of internationalization presents many facets because of the various types of interactions it involves. In other words, globalization is multidimensional.

Roughly we can disentangle globalization in three different dimensions. By *economic* globalization we mean the increased exchange of goods and services and the enlarged investment flows across countries and regions of the world. *Political* globalization refers to the trend that economies become more integrated at a political level. In addition, globalization entails a *social* dimension in the sense that closer interaction between countries can influence norms and cultural values.

Several studies aim to explain variations in life expectancy across countries. Recent studies and surveys include Kabir (2008), Cutler et al. (2006), Fayissa and Gutema (2005) and Husain (2002). An older study is Grosse and Perry (1982). Four broad factors that repeatedly are found to be significantly and positively related to life expectancy in the literature are nutritional status, education, public health and income. Most studies focus on less developed countries where factors like water sanitation and literacy are crucial determinants (as shown by Grosse and Perry, 1982). In contrast, dietary and nutritional factor often explains variations within developed countries. For example, Shaw et al.(2005) examine 29 OECD countries 1960-1999, and find positive effects of per capita consumption of pharmaceuticals, fruits and vegetables, and butter. Moreover, consumption of alcohol and tobacco has the expected negative sign.

Figure 2. Important determinants of life expectancy according to existing literature



A major point of disagreement in the literature is the relative importance of income in determining life expectancy, with some studies finding no effect and other studies finding small or large positive effects.[1] There are several possible explanations for this. According to standard economic theory there should be no direct effect of income on health: Income is only instrumentally important by enabling purchasing power that can be used for consumption of for example food, safety, health care and vaccination. When more control variables are added to a regression explaining life expectancy, the smaller will be the coefficient on income. Furthermore, the degree to which countries spend their income on health improving consumption is likely to differ, and to some degree income can be spent on areas with likely negative health effects, such as military expenditure or fast food.

Globalization can affect life expectancy through the four factors in Figure 2 and through other mechanisms. First of all, if globalization is positively related to GDP per capita, it will be beneficial for life expectancy. Such an effect may occur through static effects of trade

liberalization or because globalization is good for economic growth, as found by Dreher (2006).[2] Secondly, globalization may affect education levels, including literacy. For example, the possibility of working abroad may increase the education premium and thus strengthen education incentives, as suggested by Stark (2004). Also, social globalization such as tourism and information flows may increase literacy levels.

Thirdly, globalization can affect public health by improving access to new technologies for water sanitation, medical treatments and pharmaceuticals. For example, Papageorgiou et al (2007) argue and find empirical support for the view that R&D in the pharmaceutical industry is highly concentrated to a small group of ten countries which export these goods to the rest of the world. Using a cross-section of 63 technology-importing countries, they show that technology diffusion through medical exports is an important contributor to improved life expectancy.[3]

Fourth, globalization may affect nutritional intakes both directly through increased availability of imports and indirectly because relative prices change when the economy becomes more open. Furthermore, social globalization may lead to changes in lifestyle and dietary habits that have health consequences. Medez and Popkin (2004) note that there is currently a rapid change in the structure of dietary intakes in less developed countries around the world, converging on a "western diet", high in saturated fats and sugar. Yach et al (2007) note that waves of cultural interaction also has extended mass consumption of 'bads', such as tobacco, in turn increasing the spread of non-infectious diseases. On the other hand, Deaton (2004) emphasizes the counter-effect of globalization since closer integration facilitates the transmission of health-related knowledge.

While most of the mechanisms discussed above point towards a positive effect of globalization on life expectancy, there are several complicating factors. One important possible negative link between globalization and health, is the faster and broader spread of infectious diseases such as HIV and the H5N1 avian influenza virus (Kawachi and Wamala, 2007). Another potentially negative health effect of globalization is the stress effect of having more choices and more available information. While economist typically expect more choices to be welfare enhancing, the argument has been put forward by for example Schwartz (2004) that more choices causes stress, regret and makes us less happy.[4] Cutler et al. (2006) note that cumulative distress leads to increased probability of disease, particularly cardiovascular disease.

A third reason why globalization and health may be negatively related is tye effect of globalization on the income distribution. An emerging consensus in empirical studies is that while many aspects of globalization have no significant effect on income inequality, trade liberalization and economic openness probably increase within country income inequality, especially in developed countries – see recent studies by Dreher and Gaston (2008) and Bergh and Nilsson (2008). If there is also a link between income inequality and health, as suggested by e.g. Wilkinson (1996) and Babones (2008) – but disputed by e.g. Gravelle (1998) and Mellor and Milyo (2002) – this is a mechanism through which globalization can negatively affect life expectancy. Furthermore, some aspects of globalization – such as trade – may also affect the environment, and thereby health levels (Owen and Wu, 2007).

To summarize, few of the possible links from globalization to health are theoretically unambiguous, calling for empirical examination.

(b) Related research

There is a limited literature on the relationship between economic globalization and objective or subjective health. The study most similar to ours is that of Owen and Wu (2007) who analyze a panel of 219 countries with observations in five-year intervals from 1960 to 1995. They find that increased economic openness ((exports + imports)/GDP) is associated with lower rates of infant mortality and higher life expectancies, especially in developing countries. Their findings also indicate that some of the positive correlation between trade and health can be attributed to knowledge spillovers.[5] In contrast, using a panel of 134 countries with annual data from 1970 to 2000, Bussman (2009) fails to find evidence that economic integration improves the provision of health care, proxied by female life expectancy, in her study on the effect of trade openness on women's welfare and work life.[6]

Stroup (2007) uses panel data and find evidence of that the economic freedom index (Gwartney, Lawson, and Norton 2008) is positively linked to life expectancy and other welfare outcomes. Moreover, Ovaska and Takashima (2006) examines the effects of economic freedom and trade on self-reported levels of happiness and life satisfaction, using a cross-country sample of 68 countries in the 1990s. Robust positive effects from GDP level, growth and life expectancy were found, and in many cases also economic freedom had big positive impact.

Three of the four related studies include controls for income and education in their estimations. The exception is Stroup (2007) where the only competing explanatory variable to economic freedom is an index of political rights, which to some extent makes it problematic to evaluate the effect of globalization. None of the studies control for nutritional intake and public health such as physicians per capita.

Another closely related study is Tsai (2007) who finds a positive relation between the KOF globalization index and the Human Development Index (HDI), but more so in industrial countries than in developing countries. The data covers 112 countries in three waves (1980, 1990 and 2000) and excludes developing countries with a population less than one million. The interpretation of Tsai's results is made difficult by the fact that the HDI is a composite measure, aggregating life expectancy, adult literacy, combined primary, secondary and tertiary school enrolment, and GDP per capita (PPP US$).[7]

3. METHODS AND DATA

(a) Methods

To examine the relations of interest we specify an equation that relates globalization to population health and a set of control variables

$$health_{it} = \alpha + X_{it-1}\beta_1 + V_{it-1}\beta_2 + Z_{it}\beta_3 + \varepsilon_{it} \quad (1)$$

X is a vector of the types of globalization believed to affect health. Since the impact of closer integration on health is not likely to be instant these variables are lagged: Average globalization 1970-1973 is used to explain average life expectancy 1974-1977. This specification also reduces the bias following from potential reverse causality between globalization and health. V and Z are vectors of additional covariates which can be classified into potential *mediators*, through which globalization influence population health, and *confounders*, which are exogenous factors affecting population health but not themselves influenced by globalization. Importantly, the inclusion of a mediator as a regressor reduces the estimated effect of globalization on population health.

ε in equation (1) is an error term. Ordinary least squares (OLS) assume error processes to have the same variance and being independent of each other. In presence of non spherical errors the estimated coefficients are still consistent, but standard errors are not efficient and likely biased in turn affecting statistical inference. By correction, robust standard errors of the fixed effect OLS estimator can be estimated in case of heteroscedasticity and autocorrelation within panels.[8] However, because globalization means larger integration between economies, increasing inter-country linkages imply that errors may be contemporaneously correlated across countries. We therefore estimate the relationship using

a *panel-corrected standard errors procedure* (PCSE), allowing for disturbances that are heteroskedastic and contemporaneously correlated across countries (Beck and Katz, 1995).[9] Estimations correct for first-order autocorrelation, treating the AR(1) process as specific for each country. From Monte Carlo experimentation, Reed et al. (2009) recommend this estimator when the discussed non-spherical errors are present; the number of units is larger than the number of time periods and primary concern is accurate inference. To control for potential unobserved heterogeneity specifications include country dummies, capturing stable differences between countries in population health status, and period dummies, capturing the influence of health shocks in multiple countries at the same time.

Following Wiggins (2001) we also estimate the relationship by *OLS fixed effects* using a variant of the White estimator of robust standard errors that adjusts for clustering over country. This estimator yields consistent estimation of the covariance matrix under general conditions of heteroscedasticity and autocorrelation within panels.[10] All fixed effects estimations include period dummies.

(b) Data

Using several data sources we create a panel data set for the period 1970-2005. The dependent variable and indicator of population health refers to *Life expectancy at birth*. This is the average numbers of years that a newborn infant would live, assuming that current levels and patterns of mortality remain constant over his or her lifetime. The measure refers to the whole population in each country and comes from the World Development Indicators (World Bank, 2008). Information on life expectancy at birth is also available for men and women separately, which we make use of in the sensitivity analysis.

Our globalization indicator is the *KOF index* (Dreher et al., 2008), which measures *economic globalization* (using e.g. trade flows and trade restrictions), *social globalization* (using e.g. tourism and outgoing telephone calls), and *political globalization* (using e.g. number of embassies and membership in international organizations).[11] We use the index both as a composite measure where the three dimensions of globalization are equally weighted together, and in a disaggregated format. In either case the index takes values between 0 and 100, where a higher value represents more globalization. To capture the non-linearity between globalization and life expectancy we log these indices.

The selection of additional control variables is mainly informed by the discussion in section 2(a). As an indication of the level of economic development specifications include country *real GDP per capita* (PPP adjusted) from the Penn World Table (2008). Although the data sample is large, implying skewness is less of a concern, we log GDP per capita. A histogram indicates that the empirical variation still is large after this operation. Furthermore, we use data on the log average years of *education* in the population above 15 years old (Barro and Lee, 2000), *nutritional status*, measured by log national average calorie intake per day per capita (FAO, 2009), and the log number of *physicians per 1000 people* (World Bank, 2008). These controls are all conservatively assumed to relate positively to life expectancy. To capture economic and demographic structure we correct for the *urban share of the population* and national *dependency ratio* in our specifications (World Bank, 2008). The latter variable refers to the share of young (age <15) and old (age >64) relative to the working-age population.

To test the robustness of the results, we include several control variables. *Government consumption* as a share of GDP (World Bank, 2008) is included to check if globalization

affects government size in a way that changes its effect on life expectancy. We also test if results are sensitive to the inclusion of *Gini* coefficients for net income (taken from Solt, 2008), and to alternative data on the level of *human capital* – log average educational level in the population above 15 years old and in the population above 25 years old. The latter two variables comes from Lutz et al. (2007) who derive them by backward-simulation using detailed recent sources on education levels and demographic information. Finally, as a proxy for *instability* and rapid change, we include the growth rate of the urban population.

Table 1. Summary statistics

Variable	Mean	Std. Dev.	Min	Max	n	N	Source
Life expectancy at birth (years)	65.84	10.47	27.72	81.86	92	608	World Bank, 2008
Life expectancy at birth (years, female)	68.23	11.13	29.63	85.44	92	608	World Bank, 2008
Globalization - Kof*	3.77	0.43	2.54	4.53	92	608	Dreher, 2008
Economic globalization - Kof1*	3.81	0.46	2.05	4.56	88	583	Dreher, 2008
Social globalization - Kof2*	3.57	0.58	1.90	4.56	91	604	Dreher, 2008
Political globalization - Kof3*	3.85	0.54	0.76	4.59	92	608	Dreher, 2008
GDP per capita (PPP)*	8.28	1.19	5.46	10.53	92	608	Penn World Table, 2008
Years in education (population 15+)*	1.59	0.65	-1.34	2.49	92	608	Barro and Lee, 2000
Years in education (population 15+, female)*	1.44	0.81	-2.32	2.49	92	608	Barro and Lee, 2000
Years in education (population 15+, male)*	1.71	0.56	-1.34	2.50	92	608	Barro and Lee, 2000
Years in education (population 15+, simulated)*	1.72	0.61	-1.61	2.55	75	445	Lutz et al., 2007
Years in education (population 25+, simulated)*	1.59	0.75	-2.30	2.56	75	445	Lutz et al., 2007
Number of physicians (per 1000 people)*	-0.55	1.43	-4.17	1.61	92	608	World Bank, 2008
Nutritional status (average calorie intake per capita)*	7.88	0.19	7.38	8.23	92	608	FAO, 2009
Dependency ratio	0.71	0.19	0.35	1.14	92	608	World Bank, 2008
Urban population	52.40	23.82	4.07	98.27	92	608	World Bank, 2008
Government consumption	20.18	8.06	2.47	67.54	92	608	Penn World Table, 2008
Net income Gini coefficient	37.80	9.59	20.95	63.11	79	448	Solt, 2008
Urban population growth	0.05	0.06	-0.08	0.45	92	608	World Bank, 2008
Low income country	0.23	0.42	0.00	1.00	92	608	World Bank, 2008
Middle income country	0.46	0.50	0.00	1.00	92	608	World Bank, 2008
High income country	0.31	0.46	0.00	1.00	92	608	World Bank, 2008

* indicates that the variable is logged

The initial sample is an unbalanced panel consisting of 121 countries for which the composite KOF-index is available and 9 time periods: 1970-1973, 1974-1977, 1978-1981, 1982-1985, 1986-1989, 1990-1993, 1994-1997, 1998-2001, and 2002-2005. Observations are period averages, with the exception of average years of education, which is only available for particular years.[12] Due to missing data, the effective sample is smaller than the apparent

population of 1089 possible observations (121 countries times 9 time periods). Moreover, to ease interpretation of how additional covariates affect the results, we do not allow the sample size to vary across tested specifications. The final sample refers to 92 countries (28 high-income, 41 middle income and 23 low-income) and more than 600 observations. Table A2 in the appendix presents a complete list of countries included in the panel. Table 1 presents summary statistics on the variables of interest.

4. RESULTS

Prior to running estimations, we perform various diagnostic testing. First, using the Hadi method we do not detect any precense of outliers. Second, examination of pair-wise correlations between variables indicates a close relationship between some of the indicators which might inflate standard errors. However, an examination of the variance inflation factor (VIF) suggests that there is no incidence of multicollinearity. Individual figures range from 3.6 (urban) to 6.5 (GDP per capita) which is below the critical value of 7.

(a) Baseline estimations

Table 2 presents estimation results for the relationship between globalization and life expectancy controlling for level of development and demographic structure. Regressions using panel corrected standard errors (PCSE) suggest that the composite KOF-index is posetively related to life expectancy. Testing the components of the index spearately (column 2-4), it appears that this result is driven by economic globalization. In baseline estimations, we find no significant relation between social or political globalization and life expectancy. As expected, the effect of GDP per capita is positive while a high dependency ratio is negatively related to life expectancy. R-squared statistics are obliterated for the PCSE

regressions as they include the influences of country dummies which serve only to control for influences of unobserved variables.

Table 2. Globalization and life expectancy

	PCSE	PCSE	PCSE	PCSE	FE	FE	FE	FE
KOF (t-1)	1.661**				3.266			
	[0.732]				[3.475]			
KOF1 (t-1)		2.702***				4.473**		
		[0.756]				[2.098]		
KOF2 (t-1)			0.572				1.804	
			[0.300]				[1.968]	
KOF3 (t-1)				-1.181				-2.094*
				[0.800]				[1.119]
GDP per capita (t-1)	0.867**	0.834	0.832*	1.248**	0.884	0.196	0.753	1.082
	[0.449]	[0.616]	[0.445]	[0.622]	[1.623]	[1.723]	[1.737]	[1.465]
Dependency	-4.388**	-2.944	-5.102**	-4.809*	-2.332	-1.874	-2.884	-5.365
	[2.189]	[2.474]	[2.344]	[2.483]	[5.117]	[5.168]	[5.593]	[4.562]
Observations	608	583	604	608	608	583	604	608
Number of countries	92	88	91	92	92	88	91	92
R-squared (within)					0.448	0.452	0.433	0.448

*, ** and *** denote statistical significance at the 10 %, 5% and 1% levels respectively

PCSE: Estimations include country dummies and period dummies. Panel-corrected standard errors in brackets.

FE: Estimations with country- and period fixed effects. Robust standard errors in brackets

Fixed effect (FE) estimations support the findings of a positive health effect from economic globalization. However, there is also evidence of a negative from political globalization. We will return to this result in the sensitivity analysis.

A Hausman specification test suggests that a fixed effect model matches the data better than a random effects model. Moreover, period dummies are jointly significant in the specifications and consequantly should be included. In this stage we also assess the presence of serial correlation. Using a test derived by Wooldridge (2002) the null hypothesis of no serial correlation is strongly rejected which supports the clustering at the panel level and the AR correction.

Table 3 displays how results change when including additional control variables. The positive association between economic globalization and life expectancy remains significant across specifications. The magnitude of the effect is rather stable, with a coefficient estimate of approximately 3 in PCSE estimations, suggesting that a 10 percent increase in economic globalization increases life expectancy by 0.3 years. This result confirms the findings of Owen and Wu (2007) and Stroup (2007) where more openness and economic freedom associate with higher life expectancies. Regarding the social dimension of globalization none of the models indicate that this type of integration is a significant determinant of life expectancy.

Regardless of estimation technique we identify a strong and robust positive effect on life expectancy from the number of physicians per capita and a larger per capita calorie intake, confirming previous findings in the literature. On the other hand neither the average level of education in the population, nor the share of people living in urban areas is significantly associated with longevity. Moreover, relating to the discussion on the relative importance of income on population health, it appears that the coefficient estimates of GDP per capita become insignificant when adding more covariates to the model. Also the indicator of demographic structure loses significance when including additional control variables.

Table 3. Including additional control variables

	PCSE	PCSE	PCSE	PCSE	PCSE	PCSE	PCSE	PCSE	FE	FE	FE	FE	FE	FE	FE	FE
KOF (t-1)	1.406	1.950**							3.290	3.577						
	[0.923]	[0.902]							[3.618]	[3.003]						
KOF1 (t-1)			2.771***	3.372***							4.448**	4.126**				
			[0.774]	[0.752]							[1.963]	[1.731]				
KOF2 (t-1)					-0.240	0.685							1.825	1.584		
					[0.569]	[0.621]							[1.931]	[1.675]		
KOF3 (t-1)							-1.454*	-1.543*							-2.253*	-1.612*
							[0.776]	[0.804]							[1.210]	[0.878]
GDP per capita (t-1)	1.073**	-0.182	0.805	-0.705	0.931*	-0.098	1.289**	-0.143	0.895	-1.146	0.214	-1.591	0.852	-1.095	1.139	-0.714
	[0.518]	[0.635]	[0.589]	[0.555]	[0.521]	[0.636]	[0.609]	[0.610]	[1.528]	[1.401]	[1.535]	[1.434]	[1.521]	[1.413]	[1.276]	[1.288]
Dependency	-4.469**	-1.561	-2.821	-0.626	-5.156**	-2.136	-4.569**	-3.116	-2.749	0.586	-1.792	1.212	-3.178	-0.259	-4.924	-1.764
	[2.070]	[2.534]	[2.486]	[2.736]	[2.281]	[2.659]	[2.325]	[2.286]	[4.525]	[4.288]	[4.763]	[4.500]	[4.861]	[4.467]	[3.992]	[3.806]
Urban share of population	0.008	0.042	0.024	0.050	0.046*	0.048	0.019	0.050	-0.017	-0.025	0.0006	-0.009	-0.028	-0.037	-0.022	-0.031
	[0.025]	[0.035]	[0.029]	[0.033]	[0.026]	[0.035]	[0.028]	[0.034]	[0.103]	[0.087]	[0.104]	[0.089]	[0.110]	[0.094]	[0.120]	[0.104]
Average year of education	-0.206	-0.701	-0.477	-0.855	1.257	-0.470	1.292	0.615	0.656	-0.564	0.751	-0.308	1.078	-0.170	2.647	1.165
	[1.091]	[1.164]	[1.142]	[1.184]	[0.803]	[1.225]	[0.808]	[0.897]	[2.188]	[1.724]	[2.124]	[1.631]	[2.203]	[1.692]	[1.878]	[1.563]
Physicians		1.000**		0.978**		0.983**		0.803**		1.711***		1.658**		1.736***		1.389***
		[0.395]		[0.408]		[0.382]		[0.341]		[0.632]		[0.648]		[0.630]		[0.527]
Nutrition		11.34***		11.02***		11.43***		11.25***		15.93***		15.29***		15.83***		15.52***
		[3.192]		[3.121]		[3.279]		[3.161]		[4.198]		[4.380]		[4.163]		[4.063]
Observations	608	608	583	583	604	604	608	608	608	608	583	583	604	604	608	608
Number of countries	92	92	88	88	91	91	92	92	92	92	88	88	91	91	92	92
R-squared (within)									0.438	0.521	0.453	0.529	0.434	0.516	0.454	0.524

*, ** and *** denotes statistical significance at the 10 %, 5% and 1% levels respectively

PCSE: Estimations include country dummies and period dummies. Panel-corrected standard errors in brackets. FE: Estimations with country- and period fixed effects. Robust standard errors in brackets

(b) Sensitivity Analysis

Table 4a and 4b list the PCSE regression coefficient estimates of the indices of globalization for variations of sensitivity analyses using the preferred specification with the complete set of control variables. The first type of robustness assessment involves *adding of covariates*. Following Tsai (2007), we control for the influence of instability and rapid change on health by including urban population growth. The urbanization rate is not significantly associated with life expectancy and the inclusion of the covariate does not alter our previous findings on economic and political globalization. This is also true when controlling for within-country net income Gini coefficients, an exercise that significantly reduce the number of observations examined. With this specification there is moreover evidence of a positive effect on life expectancy from the social dimension of globalization. In contrast to a number of studies on the relationship between income inequality and population health (e.g. Babones 2008) we find that higher income inequality correlates with good health status.[13]

When including all sub-components of the globalization index simultaneously in one specification economic globalization remains positive and significant while there is still a negative effect of more political integration. The same is true when testing baseline results with respect to sample coverage allowing the sample size to vary across specifications. Including maximum 117 countries and 725 observations in the analysis does not alter the baseline findings.

A second type of robustness tests addresses the *timing of effects*. Using current rather than lagged GDP per capita does not change our initial conclusions, neither with respect to the effect of globalization nor with respect to the role played by income. More income does not

directly contribute to better health. Furthermore we also test the assumption that the impact from globalization on health is contemporaneous. Interestingly increasing political collaboration between economies has no immediate deteriorating consequence on health status. However, there is a significant simultaneous relationship between economic globalization and life expectancy. Notably, the magnitude of the coefficient indicates that the health benefit from economic globalization is larger when the process is allowed to work some years.

The third set of sensitivity tests involves *replacement of variables*. Substituting information on average education level with corresponding information from an alternative data source (Lutz et al, 2007) generates a smaller sample to analyze. In this setting the negative effect on life expectancy from political globalization disappears while economic integration still is beneficial for longevity. We also replace the dependent variable and run separate regressions focusing on female and male life expectancy respectively. In contrast to Bussman (2009) who does not find any significant relationship between economic openness and female life expectancy our baseline results are not altered neither when modeling female nor male longevity. In fact, our findings indicate that globalization is more beneficial to women than men: the positive association with economic globalization is larger whereas the negative impact from political globalization is smaller. We have also verified that our results hold when not using any logged variable values.

A fourth type of sensitivity assessment examines whether baseline outcomes change when *excluding various groups* of countries. Excluding East Asian countries in the sample has little effect and keeps economic globalization significant and positive and political globalization

significant and negative. Excluding Latin American economies however renders a situation where political globalization does not reduce life expectancy. The negative influence of the political dimension of globalization also disappears when excluding sub-Saharan countries in the analysis. This also reveals a positive relation between social globalization and population health. Apparently, closer social integration and more personal cross border contacts generally improve population health, but not in sub-Saharan Africa.

Finally we exclude the five economies in our sample with the highest prevalence of HIV where life expectancy has decreased during the period 1990-2005. Also this exercise renders the effect from political globalization insignificant while the effect from economic globalization remains positive and significant.

To summarize, the positive effect from economic globalization on life expectancy is very robust. Conversely, the initially stated negative relationship between political globalization and population health is sensitive to the selection of countries. A closer examination of data reveals that many countries in Latin America have experienced decreasing political globalization, increasing economic globalization and increasing life expectancy – possibly an effect of what Biglaiser (2002) calls the internationalization of Chicago's Economics in Latin America. In any case, the negative effect of political globalization found in our main specification is not robust and seems to be driven specific circumstances in certain countries, not picked up by the country fixed effects.

Table 4a. Sensitivity Analysis

Variation	Composite KOF- index		Significant components			Comments
Baseline model	1.950**	[0.902]	KOF1 (t-1) KOF2 (t-1) KOF3 (t-1)	3.372*** 0.685 -1.543*	[0.752] [0.621] [0.804]	Baseline estimates Corresponds to the PCSE results in Table 3
Controling for income inequality	2.628**	[1.028]	KOF1 (t-1) KOF2 (t-1) KOF3 (t-1)	3.195*** 1.178** -1.278**	[0.909] [0.514] [0.544]	Income inequality positive and significant except when controlling for social globalization Reduced sample: 79 countries, 448 observations
Controlling for Government consumption	2.075**	[1.050]	KOF1 (t-1) KOF3 (t-1)	3.377*** -1.466**	[0.715] [0.744]	Government consumption negative and insignificant
Controlling for urban population growth	2.321**	[1.054]	KOF1 (t-1) KOF3 (t-1)	3.279*** -1.518**	[0.713] [0.725]	Urbanization rate positive and insignificant
All sub-indices of globalization together in the same specification			KOF1 (t-1) KOF3 (t-1)	3.141*** -1.119**	[0.946] [0.542]	
Controling for non-lagged GDP per capita	1.895*	[1.072]	KOF1 (t-1) KOF3 (t-1)	3.539*** -1.530**	[0.718] [0.724]	GDP per capita insignificant
Controling for non-lagged globalization and non-laggedGDP per capita	0.765	[1.164]	KOF1	2.757***	[0.696]	GDP per capita insignificant
Alternative data on education (+15 years)	1.113	[1.069]	KOF1 (t-1)	3.756***	[0.732]	Education insignificant Reduced sample: 75 countries. 445 observations.
Alternative data on education (+25 years)	0.996	[1.085]	KOF1 (t-1)	3.694***	[0.732]	Education negative and significant

*, ** and *** denotes statistical significance at the 10 %, 5% and 1% levels respectively

Panel-corrected standard errors in brackets. Country and period dummies included in all estimations.

Table 4b. Sensitivity Analysis (cont.)

Variation	Composite KOF- index	Significant components		Comments
Replacing life expectancy with Female life expectancy	2.497** [1.136]	KOF1 (t-1) KOF3 (t-1)	3.473*** [0.769] -1.472* [0.771]	Average years of education refers in this case to average years of education in female population
Replacing life expectancy with Male life expectancy	1.321 [0.987]	KOF1 (t-1) KOF3 (t-1)	3.203*** [0.689] -1.586** [0.675]	Average years of education refers in this case to average years of education in male population
Excluding countries with high prevalence of HIV (5 countries)	2.266*** [0.651]	KOF1 (t-1)	1.718*** [0.625]	Botswana, Namibia, South Africa, Zambia and Zimbabwe all have an estimated prevalence of HIV of +15 per cent in the adult population Dependency negative and significant. Education positive and significant.
Excluding sub-Saharan African coutries (23 countries)	1.713*** [0.532]	KOF1 (t-1) KOF2 (t-1)	1.568*** [0.479] 0.639** [0.325]	Estimations exclude countries with very high and high adult prevalence of HIV
Excluding Latin American countries (23 countries)	2.380* [1.296]	KOF1 (t-1)	2.727*** [0.913]	
Excluding East Asian countries (10 countries)	1.999 [1.221]	KOF1 (t-1) KOF3 (t-1)	3.535*** [0.761] -1.903** [0.839]	

*, ** and *** denotes statistical significance at the 10 %, 5% and 1% levels respectively

Panel-corrected standard errors in brackets. Country and period dummies included in all estimations.

(c) Distinguishing between levels of development

The relation between globalization and life expectancy may well differ between rich and poor countries. For one thing, Cutler et al. (2006) note that the mortality pattern is very different: In low income countries, 30 percent of all deaths occur before age 4. The same number in high income countries is 0.9 percent. For another, high income countries have more deaths caused by cancer and cardiovascular disease, and low income countries have more deaths from respiratory infections and HIV/AIDS. This suggests that even small improvements in knowledge, nutrition and access to pharmaceuticals may have large health effects in low income countries. Finally, the sensitivity analysis indicated a negative relationship between political integration to health in (some) low and middle-income countries.

We first examine the relationship between globalization and population health for countries with low GDP per capita in 1970. These 47 countries are kept in the sample regardless of whether they remained poor throughout the period or if they moved up the income per capita ladder. As shown in table 5, both economic and social globalization seem to increase ilife expectancy under these circumstances. The size of the effect of economic globalization is about the same as in the full sample. Notably, there is in this case no negative relationship between political globalization and life expectancy.

Table 5. Globalization and life expectancy – low-income countries in 1970

	PCSE	PCSE	PCSE	PCSE
KOF (t-1)	2.621*			
	[1.467]			
KOF1 (t-1)		2.601***		
		[0.852]		
KOF2 (t-1)			1.525**	
			[0.763]	
KOF3 (t-1)				-0.948
				[0.851]
GDP per capita (t-1)	1.211	0.851	1.066	1.131
	[0.825]	[0.875]	[0.697]	[0.813]
Dependency	0.813	3.657	0.599	1.519
	[4.280]	[4.949]	[4.242]	[4.095]
Urban share of population	0.0188	0.0408	0.0239	-0.0643
	[0.0620]	[0.0564]	[0.0644]	[0.0659]
Average years of education	-0.785	-1.394	-0.614	-0.783
	[1.287]	[1.328]	[1.405]	[0.942]
Physicians	1.500***	1.544***	1.460***	1.149**
	[0.501]	[0.551]	[0.487]	[0.536]
Nutrition	15.54***	15.07***	15.90***	16.70***
	[4.222]	[4.324]	[4.192]	[4.655]
Observations	307	282	303	307
Number of countries	47	43	46	47

*, ** and *** denotes statistical significance at the 10 %, 5% and 1% levels respectively.
Estimations include country dummies and period dummies. Panel-corrected standard errors in brackets.

A standard approach when examining if coefficients vary with income levels is to include interaction terms. For example, Owen and Wu (2007) find a negative multiplicative effect, suggesting that trade openness has a bigger effect in low income countries, using this technique.

As noted by Braumoeller (2004), multiplicative interaction terms make it harder to interpret other coefficients in the model, and the use of interaction terms assumes a simple linear relation between (in our case) the effect of globalization and income. When we include interaction terms between dimensions of globalization and income, both globalization coefficients and interactions terms are insignificant, suggesting that there is no simple linear relation between the size of the globalization coefficient and income.[14]

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To get a more thorough and meaningful interpretation of how the globalization – health relationship varies with income levels, we estimate the globalization coefficients repeatedly when we one-by-one exclude observations with the highest income and re-estimate the equation.

Figure 3, 4 and 5 demonstrate how the coefficient estimates and panel-corrected standard errors (for a 95% confidence interval) of economic, social and political globalization vary as we gradually move from full sample to focusing only on the observations with the lowest income.[16] The graph shows that little happens with the estimate as we gradually restrict the full sample to excluding all observations with income higher than approximately 4000 PPP-dollars. For lower GDP levels the relationship is insignificant, but when we focus on the lowest incomes only in our sample, the effect is actually positive and significant. A similar pattern holds for social globalization, with the exception that the effect in most regressions not significantly different from 0.

Political globalization, on the other hand is negative and sometimes significant until we have excluded incomes higher than approximately 3000 PPP-dollars. Below this level, the effect is actually some times positive and significant. However, we know from the sensitivity analysis that the effect of political globalization is likely to be driven by a few countries, explaining the sudden jumps in the curve occurring when observations from these countries are excluded.

In general, the shape of the coefficient curves in figure 3-5 reveal that the globalization-health relation varies with income levels in a way too complex to be captured by interaction effects or sample divisions only.

Figure 3. Coefficients relating economic globalization to life expectancy at different levels of GDP per capita

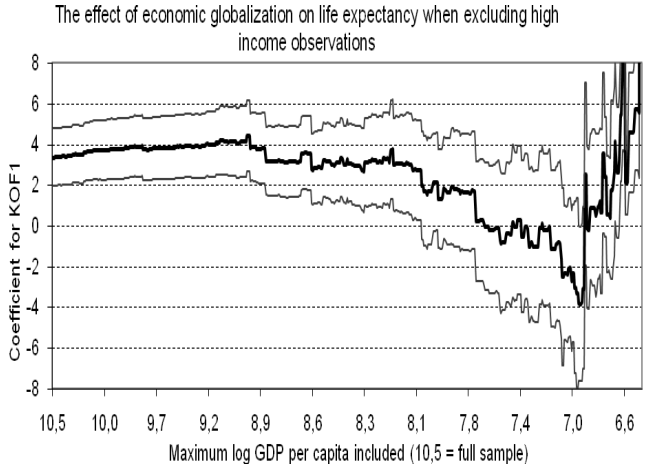


Figure 4. Coefficients relating social globalization to life expectancy at different levels of GDP per capita

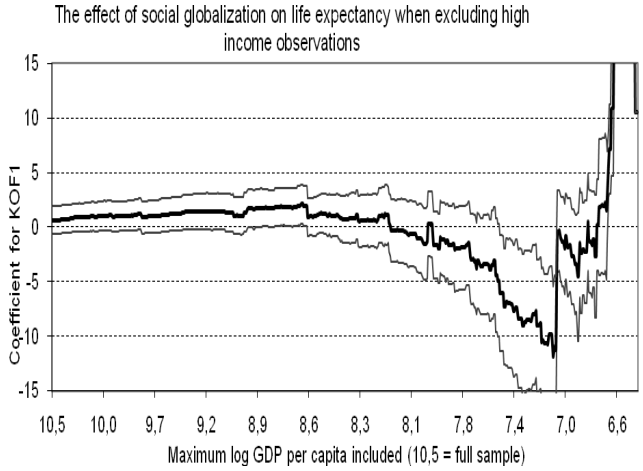
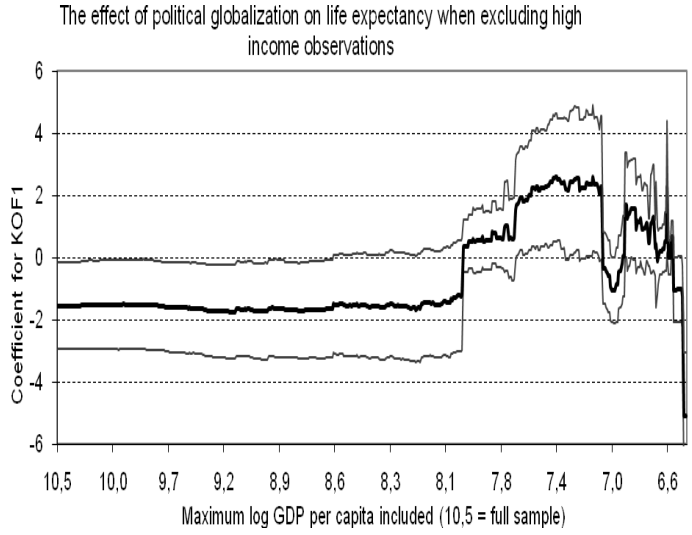


Figure 5. Coefficients relating political globalization to life expectancy at different levels of GDP per capita



5. CONCLUSION

We have examined the relation between globalization and life expectancy. Our choice of dependent variable is means that we differ from the mainstream debate concerning the effects of globalization, where the effect on GDP levels and growth have attracted much attention – for obvious reasons. But especially when it comes to the effect of globalization in low income countries, we should acknowledge that there are substantial measurement problems in GDP-data, and that results should be interpreted with care. We do not claim that life expectancy data are free from measurement errors, but we do claim that our attempt to analyze the relation between globalization and health is an important complement to existing studies with other dependent variables.

Among our results, the most robust finding is the positive relation between economic globalization and life expectancy. While the effect of the KOF-index on life-expectancy has not been systematically analyzed before, our finding is in line with previous findings such as Owen and Wu (2007) who find a positive effect of trade/GDP on life expectancy. We find no evidence that the positive effect is driven by rich countries: In fact, excluding the observations with the highest income will increase the estimated effect until all observations with income higher than 7300 PPP-dollars are excluded. After that, the effect decreases and is sometimes insignificant – but in the poorest part of our sample, the effect is again positive, and both economically and statistically significant. In any case, our analysis illustrates that only including interaction terms will not give a full picture of how the effect of globalization depend on income levels.

To put the size of our estimated effect into perspective, note that for example Uganda has increased its KOF value for economic globalization from 22 to 46 (almost two standard

deviations) during the period 1970 to 2005, thereby increasing life expectancy by two to three years according to our estimates. This effect is about as big as a one standard deviation increase in nutritional intake, which increases life expectancy by roughly two years.[17] Needless to say such calculations are only for illustrational purposes, but they do show that the sizes of the effects are economically and politically relevant.

As for social and political globalization, there is a tendency towards a positive relation for social globalization and towards a negative relation for political globalization, but these effects are not robust to the various sensitivity tests we perform. In particular, the effect of political globalization seems to be very dependent on country specific circumstances.

Finally, it should be stressed that the globalization effects we find hold when controlling for the four factors that other studies have found to be important for life expectancy: Nutrition, literacy, income and public health (proxied by physicians per capita). This suggest that parts of the effect from globalization work through other mechanisms that might be hard to measure, such as knowledge transfer or changes in relative prices. Further research is needed to know more about the relevant mechanisms at work in the relation between globalization and health.

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APPENDIX

Table A1. The KOF Index of Globalization

A. Economic Globalization

i) Actual Flows
- Trade (percent of GDP)
- Foreign Direct Investment, flows (percent of GDP)
- Foreign Direct Investment, stocks (percent of GDP)
- Portfolio Investment (percent of GDP)
- Income Payments to Foreign Nationals (percent of GDP)

ii) Restrictions
- Hidden Import Barriers
- Mean Tariff Rate
- Taxes on International Trade (percent of current revenue)
- Capital Account Restrictions

B. Social Globalization

i) Data on Personal Contact
- Outgoing Telephone Traffic
- Transfers (percent of GDP)
- International Tourism
- Foreign Population (percent of total population)
- International letters (per capita)

ii) Data on Information Flows
- Internet Hosts (per 1000 people)
- Internet Users (per 1000 people)
- Cable Television (per 1000 people)
- Trade in Newspapers (percent of GDP)
- Radios (per 1000 people)

iii) Data on Cultural Proximity
- Number of McDonald's Restaurants (per capita)
- Number of Ikea (per capita)
- Trade in books (percent of GDP)

C. Political Globalization

Embassies in Country
Membership in International Organizations
Participation in U.N. Security Council Missions

Table A2. Sample coverage

Low income countries
Bangladesh, Benin, Burundi, Central African Republic, *Chad*, Congo, Dem. Rep., *Cote d'Ivoire*, Ghana, Guinea-Bissau, Haiti, India, Kenya, *Madagascar*, Malawi, Mali, *Myanmar* Nepal, Niger, Nigeria, Pakistan, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda, Zambia, Zimbabwe
Middle income countries
Albania, Algeria, Argentina, *Belize*, Bolivia, Botswana, Brazil, *Bulgaria*, Cameroon, Chile, China, Colombia, Congo, Rep., Costa Rica, *Croatia*, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, *Gabon*, Guatemala, Guyana, Honduras, Hungary, Indonesia, Iran, Islamic Rep., Jamaica, Jordan, *Latvia, Lithuania*, Malaysia, Mauritius, Mexico, *Morocco*, *Namibia* Nicaragua, Panama, Paraguay, Peru, Philippines, Poland, *Romania*, *Russian Federation, Slovak Republic*, South Africa, Sri Lanka, Syrian Arab Republic, Thailand, Tunisia, Turkey, *Ukraine* Uruguay, Venezuela RB
High income countries
Australia, Austria, *Bahamas*, Barbados, Belgium, Canada, Cyprus, *Czech Republic*, Denmark, *Estonia*, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Japan, Korea, Rep., Kuwait, *Luxembourg*, *Malta*, Netherlands, New Zealand, Norway, Portugal, *Slovenia*, Spain, Sweden, Switzerland, Trinidad and Tobago, *United Arab Emirate*s, United Kingdom, United States

Countries in italics are only included in the regressions in the sensitivity analysis where we allow the sample size to vary across specifications.

Table A3. Correlation matrix

	KOF1	KOF2	KOF3	GDP per capita	Dependency	Urban population	Average years of education	Physicians	Nutrition	Income inequality	Government consumption	Urbanization rate	Alt. education (+15 years)	Alt. education (+25 years)
KOF1	1													
KOF2	0.840	1												
KOF3	0.245	0.374	1											
GDP per capita	0.764	0.840	0.394	1										
Dependecy	-0.608	-0.651	-0.415	-0.767	1									
Urban population	0.652	0.699	0.424	0.774	-0.655	1								
Average years of education	0.683	0.786	0.527	0.840	-0.790	0.718	1							
Physicians	0.655	0.694	0.447	0.789	-0.762	0.733	0.806	1						
Nutrition	0.654	0.640	0.481	0.757	-0.708	0.657	0.755	0.747	1					
Income inequality	-0.291	-0.395	-0.428	-0.481	0.628	-0.350	-0.588	-0.593	-0.572	1				
Government consumption	0.065	0.007	-0.162	-0.083	0.196	-0.179	-0.142	-0.040	-0.159	-0.124	1			
Urbanization rate	-0.450	-0.440	-0.281	-0.495	0.442	-0.422	-0.480	-0.554	-0.410	0.316	-0.023	1		
Alt. education (+15 years)	0.689	0.786	0.383	0.816	-0.750	0.716	0.926	0.816	0.678	-0.560	-0.041	-0.546	1	
Alt. education (+25 years)	0.684	0.784	0.380	0.808	-0.755	0.703	0.921	0.810	0.672	-0.571	-0.035	-0.544	0.995	1

END NOTES

[1] For example Soares (2007) argues that increases in life expectancy between 1960 and 2000 were largely independent of improvements in income.

[2] Note however that the empirical link between globalization and growth is debated and depends on how globalization is measured – c.f. Rodriguez and Rodrik (2000) and Lee Ha Yan (2004).

[3] The relevance of medical technologies, specifically new drugs, is supported by Lichtenberg (2003). In a sample of 50 upper-middle-income developing and developed countries, he shows that the launch of new drugs between 1986 and 2000 had a strong positive impact on the probability of survival. He claims that these new drugs were responsible for 40 percent of the gains in life expectancy observed in the sample during the period.

[4] Reviewing Schwartz's book, Veenhoven (2005) claims it to be "persuasive at first sight" but adding that "a closer look shows the evidence to be flimsy" (p. 94).

[5] Their results imply that a one-standard-deviation increase in the log of openness for a country that is in the lowest quintile of real GDP is associated with a drop of approximately seven infant deaths per 1000 (a reduction in the average rate of infant mortality of about 8%). The increase in female (male) life expectancy from a one-standard-deviation increase in log openness is 1.39 years (0.84).

[6] This result might be explained by Bussman's use of annual data for trade/GDP with the dependent variable being interpolated for missing years. While economic openness (trade/GDP) fluctuates from year to year, changes in health outcomes likely evolve over a number of years.

[7] An obvious problem in Tsai's study is that per capita income is used both as an explanatory variable and as part of HDI. This is addressed by the authors in a footnote, where it is also reported that "economic globalization generated significantly favorable impacts on life expectancy, and all but political globalization measures produced positive impact on infant mortality." (p. 124).

[8] Using the Stata command xtreg, fe, SE estimates are robust to disturbances being heteroscedastic if using the robust option. In case of heteroscedasticity and autocorrelation within panels one should use the cluster( ) option (Wiggins 2001, Hoechle 2008).

[9] We use the Stata command xtpcse.

[10] With the fixed effect estimator can not correct for contemporaneous correlation. Moreover, the FE and the PCSE estimators differ in that the former is asymptotic in the number of panels while the latter is asymptotic in the number of time periods.

[11] For details of the KOF-index and its different dimensions, see table A1 in Appendix.

[12] Data on average years of schooling is reported on a five-year basis 1960-2000. In this study we linearly interpolate for intervening years. The average years of education in the final time period refers to average years of schooling in period t-1. Regression results are robust to the exclusion of the final time period.

[13] The reason that we test the effect of income inequality in the sensitivity analysis, rather than in our main scenario, is that we lose a high number of observations when including standardized Gini coefficients.

[14] In our case, adding an interaction term turns the coefficients of the lower order terms into conditional effects, measuring the effect of types of globalization when GDP per capita equals zero.

[16] Figure 3, 4 and 5 do not include coefficient estimates based on the 40 observations with the lowest GDP per capita.

[17] Assuming a coefficient on economic globalization around 3 to 4, and a nutrition coefficient at 11 (taken from Table 3 and 4).