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Learning for Life:

A Cross-National Analysis Comparing Education with Other Determinants of Infant Mortality

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A Cross-National Analysis Comparing Education with Other Determinants of Infant Mortality

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Abstract

Notwithstanding extensive improvements over the last decades, infant mortality (IM) still shows huge – and increasing – disparities across the world. This paper compares various paradigms (education, growth, dependency, demographic factors) used to explain this blatant inequality. The paradigm focusing on education emerges as particularly corroborated. A wide series of education indicators are considered and contrasted, vis-à-vis several measures of mortality. The main education indicators seem to have a significant impact on IM, though some of them – in particular, variables taking account of gender – are particularly momentous. The education-IM relation does not change, whatever the indicator used to measure mortality. What is more, the education-IM relation works at both low and high levels of infant mortality, and is limitedly affected by the geographical and cultural-religious context. All in all, with regards to infant/child mortality reduction, education emerges more as a 'stand-alone' paradigm than just as an auxiliary variable.

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THE ROLE OF EDUCATION IN HUMAN DEVELOPMENT

Since the 1960s, studies on the role of ‘human capital’ in economic growth (Schultz 1963; Becker 1964) and of education in the modernization of Western countries (Cipolla 1969) progressively transformed education from an ancillary variable of growth into a key factor of general development. In turn, Sen (1984), Stewart (1985), Streeten (1994), and UNDP (1990) – with its Human Development Index – helped shift the debate focus from growth to *human development* issues, often revolving round access to and advance of education.

This leading role of education is particularly consistent with its expected influence on infant mortality (IM). Now, IM kept over time its character of equivalent of life expectancy at birth: from 1960 to 2005, the average correlation between IM and life expectancy for all the world countries was -0.9396. Life expectancy, in turn, measures the chances of a long and healthy life. Then, if life is the precondition of well-being – goods and opportunities have value if one is alive to enjoy them –, (low) infant mortality must be regarded as the cornerstone of human development.

What has been said about infant mortality (infants who die before reaching one year of age, per thousand live births) applies to childhood mortality (children who die before reaching five years of age) as well. Childhood mortality (CM) is correlated with life expectancy as closely as IM. In the last decades, substantial improvements were registered for infant-childhood mortality. From 1960 to 2005, CM rate over the world decreased from 192‰ to 71‰.; IM rate, which captures most of <5 yrs mortality, decreased from 119‰ to 49‰; from 107‰ to 39‰ if we calculate IM as average for all the countries (Table 1: the difference is due to the fact that some of the most populated countries have high IM rates). These improvements concerned mostly all countries, since there were few exceptions; and in poor countries the IM reduction was particularly remarkable since 1950-60. It looks like a great achievement, given that IM rates of 300 and more were prevalent in premodern times and still remained common in less developed countries in the first half of the 20th century. However, disparity between countries is still huge, with c. ¼ of the countries having an IM rate of 3-5 per 1,000 pop. and another ¼ a rate of over 100 at the beginning of the 21st century. The real gap is probably greater because in developing countries deaths of infants are under-recorded. Moreover, it usually passes unnoticed that this disparity fell in absolute terms but soared in relative terms over time (Table 1). Infant mortality is not an obsolete issue yet; and its trend is only partly heartening.

Table 1. Evolution of Infant Mortality in the World: Average Rates per 1,000 Births for Groups of Countries (Quintiles) and Ratio between Such Rates; Same Countries in 1960 and 2005

Group of countries and ratio	Infant mortality rate					
	1960			2005		
	No. of countries	Min.-Max. rate	Ave. rate & ratio value	No. of countries	Min.-Max. rate	Ave. rate & ratio value
Group 1st quintile	32	13.0-41.0	28.6	33	1.9-6.3	4.1
Group 2nd quintile	32	42.7-83.0	62.4	30	6.7-17.1	11.5
Group 3rd quintile	31	85.0-128.6	108.0	32	17.5-32.1	24.6
Group 4th quintile	31	129.0-164.5	145.3	31	32.7-75.7	55.7
Group 5th quintile	31	169.0-293.0	194.2	31	76.1-156.7	99.0
All the countries	157	13.0-293.0	106.9	157	1.9-156.7	38.6
Ratio 5th/1st			6.8			24.2
Ratio 4th/1st			5.1			13.6
Ratio 3rd/1st			3.8			6.0

Infant Mortality and the Education Paradigm

How then should infant mortality be fought today? According to the education paradigm, economic growth is more a permissive element than a precipitating factor. Knowledge and education, instead, are emphasised as capable of promoting correct nutrition, prevention of diseases, recourse to medical treatments and above all a change in attitude. Educated people are expected to break with tradition and become less fatalistic about health and illness

(Caldwell 1979). Educated parents know what’s good for their children's health and find alternative solutions when medical care is unavailable (Cochrane, O’Hara and Leslie 1980; Haveman and Wolfe 1984; Barrera 1990; UNICEF 2002; Groot and Maassen van den Brink 2003).

If parents' education is momentous for IM, mothers’ is even more so. Women’s education bolsters the quality of activities such as cleaning, cooking, and the care of children and the ill (Caldwell 1979; Cochrane, O’Hara and Leslie 1980; Barrera 1990; Browne and Barrett 1991; Caldwell and Caldwell 1993; World Bank 1993). Mothers’ education encourages children’s immunization (Desai and Alva 1998). Besides, educated mothers are self-confident and abler to make independent decisions on children’s well-being (Jejeebhoy 1995). Women’s education is correlated positively with their age at marriage and negatively with early fertility (Breierova and Duflo 2004), both affecting infant mortality.

In general, female education and gender equality have been highly regarded in IM studies influenced by the human development approach (Boehmer and Williamson 1996; Hanmer, Lensink and White 2003).

Though education achieved a central role in recent studies, other paradigms were and are still used to explain human development and specifically infant mortality rates.

The Economic Growth Paradigm

The growth paradigm was regarded for decades as the most appropriate tool kit for the prediction of development, including its ‘human’ facets, such as education, physical well-being, infant and total mortality. Growth seems to support a vast array of changes both in the organization of society and in people’s quality of life. Growth would promote improvements in nutrition, health care, health services and sanitation. The growth of per capita income – as Kuznets (1973) summarised – changes the entire social organization, bringing about also the shift from a low to a high level of education and from a high to a low level of mortality. The growth paradigm considers economic advance – strictly in the Western countries' footsteps – as the only factor capable of bridging the gap between developing and developed countries. These concepts have found application also in recent studies showing a link between income level (or its growth) and IM (World Bank 1993; Firebaugh and Beck 1994; Pritchett and Summers 1996; Ravallion 1997; Easterly 1999; Cutler, Deaton and Lleras-Muney 2006). However, nowadays this income-IM link is accompanied by a barrage of caveats: about strong deviations and numerous outliers, existence of nonlinear associations, and deferred effects of growth.

The Dependency Paradigm

In spite of their patent contrast – Marxism vs. Liberalism – dependency and growth paradigms share a fundamental feature: confidence in the predominance of material over nonmaterial development aspects (such as education). The dependency paradigm, however, favours – as factors of development/underdevelopment – aspects usually neglected by the growth theory: those regarding international relations. According to dependency theory, *core nations*, by taking advantage of their physical capital and military power, are able to enforce their economic interests at the expense of nations (*peripheral countries*) lacking in the abovementioned characteristics. David Ricardo's idea that trade benefits all participants by increasing international specialization is rejected by the dependency theory. In particular, penetration of physical capital into peripheral countries would negatively affect their whole development (Frank 1967; Wallerstein 1974; London and Williams 1990). All in all, dependency perception of causes of poor development and bad health echoes the accusation of *social murder* leveled by Engels against Capitalism and its "dark Satanic mills". Over the last few years, several studies stated that capitalist world system expansion enfeebled peripheral countries' economies, benefited the happy few, increased income inequality, and undermined health and other basic social services, with serious effects on infant mortality rate (London and Williams 1990; Shen and Williamson 1997; Shandra et al. 2004).

The Demographic Factors Paradigm

Like the growth paradigm, the demographic paradigm shows a selective approach when dealing with variables explaining human development. However, against the growth paradigm and in agreement with that of education, the demographic factors paradigm is cautious about income effects (Preston 1980). Its favoured variables are picked from the set of those regarding population features. Infant, child mortality, and life expectancy rates are predicted by means of variables relating to fertility, birth rate, birth order and birth interval, mothers' age at marriage and at childbirth (Caldwell 1982; Cochrane and Farid 1984; Hobcraft, McDonald and Rutstein 1985; Pitt 1995; Rutstein 2000, Wang 2003). Most of these studies, in particular the recent ones, made recourse to education variables as well. Besides, many emphasised also the role of health and health services: caloric intake, vaccination, physicians and hospital beds per pop., safe water access, flush toilet, to mention those most frequently employed.

EMPIRICAL FOUNDATIONS OF THE RELATIONSHIP BETWEEN EDUCATION AND INFANT MORTALITY: SOME OPEN QUESTIONS

Since the 1970s, some studies measured the impact of education on aspects of human development such as infant mortality and life expectancy (Hughes 2001). They were usually based on synchronic macro, cross-national data. However, micro studies produced broadly similar results (e.g. Basu & Stephenson 2005). These studies differed in samples and education variables. Their conclusions, nevertheless, tended to be analogous: for instance, in Shin (1975), on a small number of developing and developed countries, Stockwell and

Hutchinson (1975), Preston (1976), Isenman (1979), Cochrane, O'Hara and Leslie (1980), Loriaux and Remy (1980), education variables show a high significance.

Later studies – as Hicks' (1982) on a sample of developing countries – employed a larger set of determinants, including adult literacy, access to safe water and public consumption. Bicego and Boerma (1991) checked the impact on IM of mothers' education and access to health services, sanitation facilities, and safe water. They found a more robust education impact in urban settings: contra, Mensch, Lentzner and Preston (1985). Some authors tried to check whether the education-IM relation changes according to the geographical region: Hill and King (1991) and McMahon (1999) found no significant difference; contra, Frey and Field (2000).

More recent studies usually employed a wider set of income and health measures, education indicators, gender variables, and lagged measures. Barro and Sala-i-Martin (1995) used income and education attainment indicators, finding primary attainment particularly significant. Subbarao and Raney (1995) found in developing countries an association between IM and female education, family planning, urbanization, physicians per pop., and income. Cornia and Mwabo (1997) used income, female literacy, health services and vaccination to predict IM in sub-Saharan Africa. In Filmer and Pritchett (1997), child mortality in a wide set of countries is explained by income level and distribution, female education, ethno-linguistic differences within the country and Muslim population. The hypothesis of an unfavourable influence of a predominantly Muslim population on IM was supported also by Caldwell (1986). The results obtained by Strauss and Duncan (1995) and McMahons (1999) matched those of Barro and Sala-i-Martin and Filmer and Pritchett.

Shen and Williamson (1997) and Frey and Field (2000) compared some theories used to explain IM differentials in underdeveloped countries. Their results show that IM is associated with economic disarticulation and a gender stratification affecting education.

Finally, other studies (Hobcraft, McDonald and Rutstein 1984; Schultz 1989; World Bank 1993; Desai and Alva 1998; World Bank 1999; Basu and Stephenson 2005) measured infant mortality vis-à-vis educational levels within the same country. Mothers' higher educational levels emerged as associated with lower infant mortality.

Summing up the literature on education and IM, a few problems can be noticed. Several paradigms – some clashing with each other – vie with that of education. It is not clear whether education is only a feature of some interest within other paradigms or something more. Even IM studies interested in education have put together education, growth and health variables rather than expand the analysis of education benefits. Besides, some of the models have employed variables such as caloric intake, or access to safe water and to sanitation facilities, whose correlations with IM are inherent in the nature of these variables. Several aspects of the education-IM relation have received less attention than they deserve. First, education is made up of many facets: literacy, school enrolments, quality of schooling, dailies diffusion and so forth. Do IM differentials vary when we move from one education measure to another? If yes, why? Second, IM is only one out of several measures of mortality in early childhood. Are the education benefits similar when considering mortality rates at a child's various ages? Third, is the education-IM relation working also in high IM level countries and is this relation affected by the countries' socio-economic and cultural contexts? In other words, are education benefits really universal or are they contingent upon favourable national conditions of income, dependency, population, territory or culture?

A QUANTITATIVE, CROSS-NATIONAL EXAMINATION OF INFANT MORTALITY DETERMINANTS

Starting from this state of the art, we checked the impact on IM of education and other socio-economic determinants, by means of macro data for all the world countries drawn from World Bank (2003) and UNESCO (2005) databases.[1] Macro data do not get close to the social actor as micro do; moreover, they summarise, through national averages, regional and social inequalities in IM (for example ‘traditional’ vs. ‘modern’ context). However, IM inequalities within countries are higher where national IM rates are lower and therefore not so worrying (Wang 2003). In any case, macro data offer advantages in terms of cross-national analysis of the social forces affecting IM.

IM measures revolve round the years 2000-2001, the best so far in terms of data availability.

A. The Growth Impact and the Income-IM Link

The decline of infant mortality over the world during the last decades (Table 1) coincided with a widespread rise in income. This seems to be a point in favour of growth. However, substantial improvements in IM were recorded even where there was no growth: therefore the IM-growth relationship is blurred and clearly weaker than the IM relationship with even a partial measure of education development, such as NER2F[2] (Figure 1).

Besides, the synchronic relation between income and IM (or CM) cannot be adequately read through a linear model, especially if we consider the basic GDP per capita (Table 2).

Table 2. Linear Correlations of Infant and Childhood Mortality (Both 1999-2001) with Income and Income Distribution Indicators: World’s Countries

Indicators	IM		CM	
	r	N	r	N
GDP per capita (constant 1995 $) 1995-2000	-.514	181	-.462	178
GDP per capita PPP (current international $) 1995-2000	-.644	168	-.594	165
Sen’s index 1993-2002	-.524	124	-.469	123
Ln GDP per capita (constant 1995 $) 1995-2000	-.793	181	-.760	178
All correlations significant at .01 level (2-tails).				

Note: Variables relating to more than one year (for example IM 1999-2001) supply values that are averages for the period taken into account. This procedure is meant to stabilise data, reduce the incidence of anomalous data, bypass missing values and therefore expand the sample. The length of the period varies with availability of data, use of the variable and so forth.

Figure 1. Scatterplot of Infant Mortality Variations, Female Secondary Education Variations and Average Annual Economic Growth Rate (GDP PC), 1960-1980 and 1980-2000, with Linear Regression Fit Lines; Same Countries for Both the Independent Variables; World's Countries (N = 239 in Two Periods – 5 Outliers Removed (2.1%) = 234)

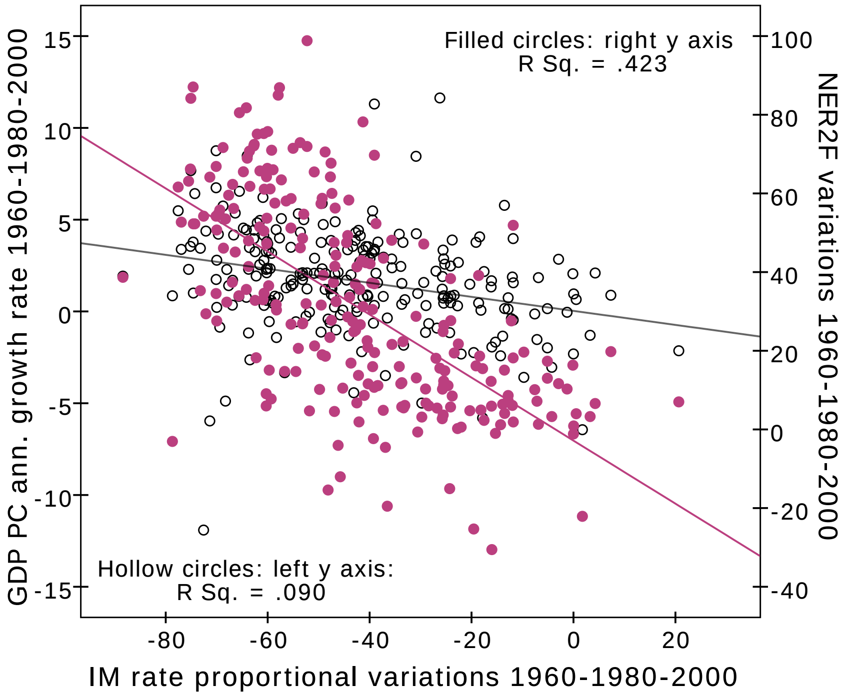
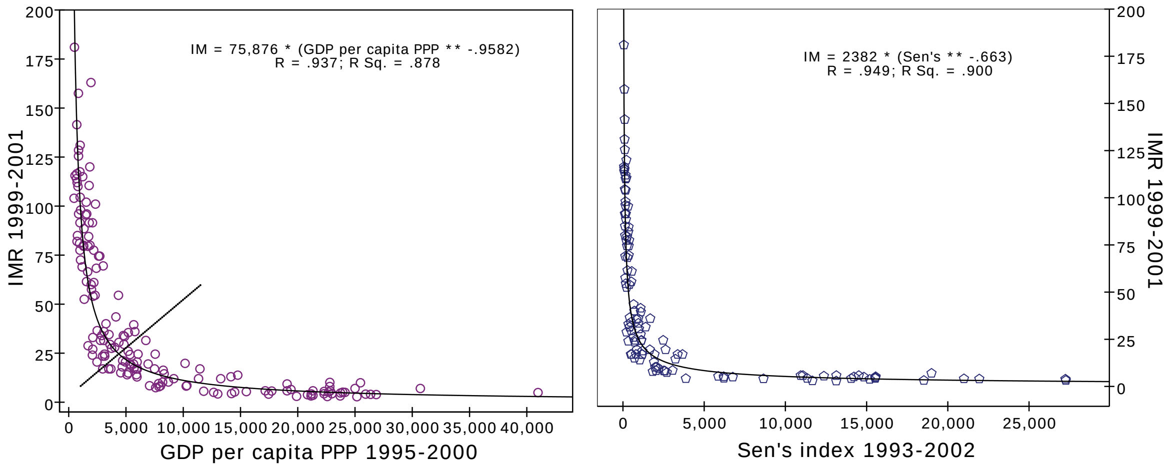


Figure 2. Scatterplot of GDP PC PPP and Infant Mortality, with Power Regression Fit Curve; World's Countries (N = 168 – 8 Outliers Removed (4.7%) = 160). Scatterplot of Sen's Index and Infant Mortality, with Power Regression Fit Curve; World's Countries (N = 124 – 6 Outliers Removed (4.8%) = 118)



Instead, a hyperbolic curve flawlessly fits data, either with GDP or GDP PPP (Figure 2). This curvilinear profile of the income-IM relation has been acknowledged, and somewhat rationalized as a consequence of the fact that IM rates cannot become negative however high the income may be (Ravallion 2007). To this, a growth diehard would probably add that Figure 2 shows how, for poor countries, fractional advances in income can produce huge improvements in IM, whereas further advances beyond a level of welfare produce minimal IM improvements (as the stronger ln income-IM correlation shows, Table 2); and that ultimately really rich countries have low IM, whereas countries with the worst IM rates are poor. However, Figure 2 shows how low incomes can be associated with the most different IM rates, and low IM rates with the most different incomes. The profile of the curve – with its axis crossing the curve at a GDP (PPP) per capita value of c.$4,000 – implies that to a GDP under $3,000 corresponds an IM varying from 17‰ (Sri Lanka) to 181‰ (Sierra Leone). Vice versa, to an IM under 20‰ corresponds a GDP varying from $3,682 (Ukraine) to $40,980 (Luxembourg). With one-third of the US's GDP PC, South Korea boasts a strikingly lower IM. What is more, in particular Third World countries' IM exhibits patterns that differ from what their GDP would imply in linear terms. Over the last few years, several Third World countries (for example Sri Lanka, China, Costa Rica, Jamaica and St Lucia) achieved remarkably low IM vis-à-vis their GDP level. Others (for example Brazil, Gabon, South Africa and Saudi Arabia) retained a relatively high IM in spite of a GDP per capita many times higher than that of some of the previous countries.

The explanation for all this must be found in some factor other than income. Is income distribution such a factor? Income inequality is expected to affect IM (Wilkinson 1996; contra Mellor and Milyo, 2001); therefore we can combine income and income distribution – as measured by Gini's index – into a new variable.[3] However, Sen's index (real GDP PC * (1-Gini's)) does not improve the results of our linear model (Table 2). Income distribution does not rectify the profile of the income-IM link but makes it more similar to a right angle (Figure 2). By restricting the sample to only developing countries, the GDP, GDP PPP and Sen's yield correlations with IM equivalent to those of Table 2.

B. The Association between Education and Infant Mortality

Differently from income, education shows close correlations with IM even when untransformed (linear) variables are used: thus demonstrating that the income-IM curvilinear relation has little to do with the fact that IM rates cannot become negative. Coefficients are already high with literacy rates[4] and they further rise when more accurate indicators are used (Table 3). In particular, net enrolment rates yield higher coefficients. Since gross enrolment rates include overage pupils, they can be higher than 100 per cent and therefore less representative of the educational system performance (compare GER1T and NER1T, Table 3). For tertiary education, however, no net enrolment rate is available.

Table 3. Linear Correlations of Infant, Childhood and 1-4 Years Mortality (All 1999-2001) with Various Education Indicators: World's Countries

Indicators	IM		CM		1-4 Mort.	
	r	N	r	N	r	N
LitM (Literacy Rate, Males % of m. 15 yrs old and over) 2000	-.729	135	-.737	132	-.722	132
LitF (Literacy Rate, Females % of f. 15 yrs old and over) 2000	-.749	135	-.752	132	-.727	132
GER1T (Gross Enrolment Rate, Primary, Total %) 1985-1990	-.647	170	-.671	167	-.683	167
NER1T (Net Enrolment Rate, Primary, Total %) 1985-1990	-.829	91	-.849	91	-.854	91
NER1T (Net Enrolment Rate, Primary, Total %) 1990-1995	-.789	125	-.804	123	-.794	123
NER1F (Net Enrolment Rate, Primary, Females %) 1985-1990	-.837	82	-.856	82	-.858	82
NER2T (Net Enrolment Rate, Secondary, Total %) 1990-2000	-.791	148	-.784	146	-.741	146
NER2M (Net Enrolment Rate, Secondary, Males %) 1990-2000	-.697	136	-.683	134	-.633	134
NER2F (Net Enrolment Rate, Secondary, Females %) 1990-2000	-.827	143	-.820	141	-.776	141
Ln NER2F (Logarithm of NER2F) 1990-2000	-.847	143	-.865	141	-.858	141
GER3T (Gross Enrolment Rate, Tertiary, Total %) 1995-2000	-.662	175	-.638	172	-.582	172
Female/Male, Primary Net Enrolment Ratio 1990-2000	-.652	166	-.662	164	-.653	164
Females, Secondary Enrolment (% of total) 1990-2000	-.672	185	-.679	183	-.664	183
Pupil/Teacher Ratio, Primary 1990-2000	.751	186	.765	184	-.750	184
Schooling Years Total (Both Sexes) 1998-2002	-.782	151	-.772	149	-.726	149
Schooling Years F (Females) 1998-2002	-.791	144	-.779	142	-.726	142
Dailies per 1,000 pop. 1990-2000	-.560	171	-.546	168	-.473	168

All correlations significant at .01 level (2-tails).

Since the effects on IM of primary school enrolment would hardly be immediate, lagged NER1 measures are expected to produce better results. The correlations of IM 1999-2001 with respectively NER1T 1995-2000, 1990-95, 1985-90 indeed show progressively higher coefficients, from -.710 to -.789 and to -.829 (Table 3). The same happens with NER1F. Unfortunately, also missing values rapidly increase: so, NER1 1990-95 could be a compromise between sample size and *r* value optimizations.

Variables revolving around ‘gender equality’ are relevant. The percentage of female pupils is definitely correlated with IM: to a higher inequality corresponds a higher IM. Besides, female education correlation with IM is stronger than that of male education. In particular, NER1F and NER2F show a remarkably high correlation with infant mortality (Table 3). Ln NER2F yields an even higher coefficient, suggesting that there might be some nonlinear element in the education-IM relation. Nothing much, however, when compared to what happens with GDP-IM (contrast Figure 2, and Figure 3).

Quality of schooling is expected to be relevant. There are quality differences in education between countries. These differences might disturb the education variables associations with IM. Recent international surveys on student assessment are available, but cover a limited sample of countries. For want of a more specific indicator, we can use Pupil/Teacher Ratio as a proxy for schooling quality.

The variable ‘Schooling years’ economically summarises the education-IM relation, showing progressive decreases in IM at each ‘Schooling years’ increase (Table 4). Averagely, one additional year of schooling beyond the third one is associated with an IM decrease of 16 per cent, tantamount to sparing c.8 deaths every 1,000 children. The biggest decreases in absolute values are registered around 10-11 years of schooling – which correspond to secondary school level. A comparison with GDP instead shows that only initial increases from GDP lowest level – where having food enough can be a real discriminant between life and death – are paralleled by IM decreases; further increases generate contradictory results, and with GDP higher than $5,000 the income-IM association would be even worse.

Table 4. Infant Mortality (1999-2001) Variation According to Number of Schooling Years (1998-2002), and to Level of GDP PC (1995-2000): World's Countries (N = 151, 131)

IM	Schooling Years Total (Both Sexes)								
	3	4-5	6-7	8-9	10-11	12-13	14-15	16-17	18-19
IM (average values)	131.0	107.8	95.4	74.7	46.5	25.7	13.5	5.6	4.4
IM Variation (abs.v.)	=	-23.2	-12.4	-20.7	-28.2	-20.8	-12.2	-7.9	-1.2
IM Variation (%)	=	-17.7	-11.5	-21.7	-37.7	-44.8	-47.4	-58.5	-21.5
	Level of GDP PC (US$)								
	0-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000	4001-5000
IM (average values)	92.7	60.3	32.3	40.5	22.5	25.1	20.3	27.4	22.1
IM Variation (abs.v.)	=	-32.4	-28.0	8.2	-18.0	2.6	-4.8	7.1	-5.3
IM Variation (%)	=	-35.0	-46.4	25.4	-44.4	11.6	-19.1	35.0	-19.3

With regards to education and CM, it is worth noticing that CM – spanning a longer period than IM – is expected to be less sensitive to both endogenous causes of death (such as immaturity), which particularly operate over the neonatal period, and 'democratic' benefits from breastfeeding, which evaporate over time. Conversely, CM is expected to be more sensitive to other determinants of survival, such as education. And 1-4 years mortality is expected to be even more sensitive. However, both CM and 1-4 years mortality correlations with education indicators show coefficients alternatively slightly better or worse than those for IM (Table 3). The reason for these close results could be that, since most of CM concentrates in the first year of life, the latter provides room for a wide variance in survival due to education; while deaths independent from education level (such as deaths due to accidents) would be more numerous in the longer period. Also the splitting up of IM into neonatal mortality (that during the first month) and postneonatal (1-11 months) yields results mirroring those obtained with IM. In any case, all these close results boost the reliability of the education-IM link.

Table 5 illustrates some linear regression models. The purpose of Model 00 is to show the relation of IM with each of some basic education indicators, controlling for all the others. The significance of NER1T tells us that even a few years of schooling are accompanied by an IM decline. NER2T, however, is more relevant. In turn, tertiary education contribution is nonsignificant, when controlling for the other variables. The most basic of education indicators, 'Literacy rate' (not shown in Model 00), when used together with NER1T and NER2T to predict IM, makes NER1T contribution nonsignificant, but proves to be less good than NER2T. 'Dailies' – a facet of education ignored by schooling indicators – makes here a more limited and dubious contribution. Finally, the contribution by both 'Gender equality' and 'Staff adequacy' is not taken out by that of the other variables.[5] If we limit the sample only to developing countries, we obtain substantially the same results. An income variable would be nonsignificant in this Model; a transformed income variable would be significant, without altering the education variables contribution (Model 0).

Table 5. Infant Mortality Determinants (Dependent Variable IM 1999-2001; Linear Models 00, 0, 1, 2, 3); World's Countries

Independent Variables	Model 00		Model 0		Model 1		Model 2		Model 3	
	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.
NER1T 1990-95	-.217	.005	-.187	.008	-.159	.025				
Ln NER1T 1990-95							-.147	.024	-.170	.008
NER2T 1990-2000	-.345	.001	-.236	.027						
NER2F 1990-2000					-.458	.000	-.334	.000	-.266	.004
GER3T 1995-2000	.030	.680	.038	.592						
Ln GER3T 1995-2000							-.232	.007	-.294	.001
Dailies 1990-2000	-.105	.065	-.031	.607						
Ln Dailies 1990-2000									-.166	.031
Pupil/Teacher Ratio, Primary 1990-2000	.220	.004	.225	.005	.225	.002	.158	.033		
Fem. Sec. Enrol. (% of total) 1990-2000	-.216	.000	-.142	.012	-.169	.004	-.160	.004	-.134	.015
Ln GDP PC (constant 1995 $) 1995-2000			-.268	.004						
N	108		103		111		111		107	
Multiple R and (Adj. R^2)	.912 (.821)		.920 (.835)		.912 (.825)		.921 (.840)		.924 (.847)	

Model 1 shows that, by choosing only four strictly educational variables, with untransformed values, R is .912, all variables being significant. NER2F, which takes also account of gender, makes the biggest contribution to the model. Model 2 is based on the hypothesis that, when a society has achieved mass education, further increases in education yield decreasing benefits for infant mortality (see also Figure 4), and that it is difficult, in any case, to further reduce IM when its level is low enough to be affected more by endogenous than exogenous factors. This hypothesis might be sound: by using in lieu of NER1T and GER3T their logarithms, a slightly better fit is obtained. If we add the logarithm of 'Dailies', R rises further.

C. The Demographic Variables Influence

The main demographic variables used to predict IM are so correlated with education variables that they seem to overlap one another: the correlation coefficient of NER2F with birth rate (BR) and total fertility (TFR) is -.911 and -.895. Besides, as expected, also women's age at marriage[6] is correlated with the education variables, though less closely (with NER2F .728, whereas with IM -.625). However, the demographic paradigm variables generate interesting results: by using TFR ─ Table 6, Model 4 ─ we obtain coefficients equal to those of Model 3. Equivalent results are reached when birth rate is used.

Table 6. Infant Mortality Determinants (Dependent Variable IM 1999-2001; Linear Models 4, 5, 6, 7, 8); World's Countries

Independent Variables	Model 4		Model 5		Model 6		Model 7		Model 8	
	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.	Beta	Sig.
Ln NER1T 1990-95	-.132	.034	-.119	.031	-.172	.000	-.188	.000	-.155	.005
NER2M 1990-2000									-.119	.047
NER2F 1990-2000	-.235	.018								
Ln GER3T 1995-2000	-.201	.019			-.231	.000	-.186	.004	-.225	.002
Ln Dailies 1990-2000			-.137	.027						
Fem. Sec. Enrol. (% of total) 1990-2000	-.155	.004	-.111	.018	-.179	.000	-.166	.000	-.095	.041
TFR (Total Fertility Rate) 1990-2000	.297	.003								
BR (Birth Rate) 1990-2000					.448	.000	.355	.000	.401	.000
BR (Birth Rate) Squared 1990-2000			.643	.000						
Female Employees Agric. (%) 1990-2000									.133	.010
Grs Foreign Invest. (% of GDP) 1990-2000									.066	.045
Dummy Conflict					.181	.000	.137	.000	.106	.005
Tmax (ave. max. temperat.) sq. 1961-1990					-.144	.001	-.082	.092	-.117	.015
Hospital Beds 1990-2000					.003	.939	.055	.226		
Ln GDP PC (constant 1995 $) 1995-2000							-.192	.000		
N	112		118		110		107		90	
Multiple R and (Adj. R^2)	.924 (.847)		.941 (.881)		.963 (.923)		.967 (.929)		.964 (.922)	

Therefore, an increase in the number of children is associated with higher chances of untimely death for them. Further, we may hypothesise that IM would rise more than proportionally when BR and TFR are high: in other words, an increase of, let's say, 20 per cent in average fertility would be matched by a larger increase in IM when TFR is already 5 children per woman. Model 5 seems to confirm this hypothesis: R rises when squared birth rate is included.

D. Checking the Dependency Variables Impact

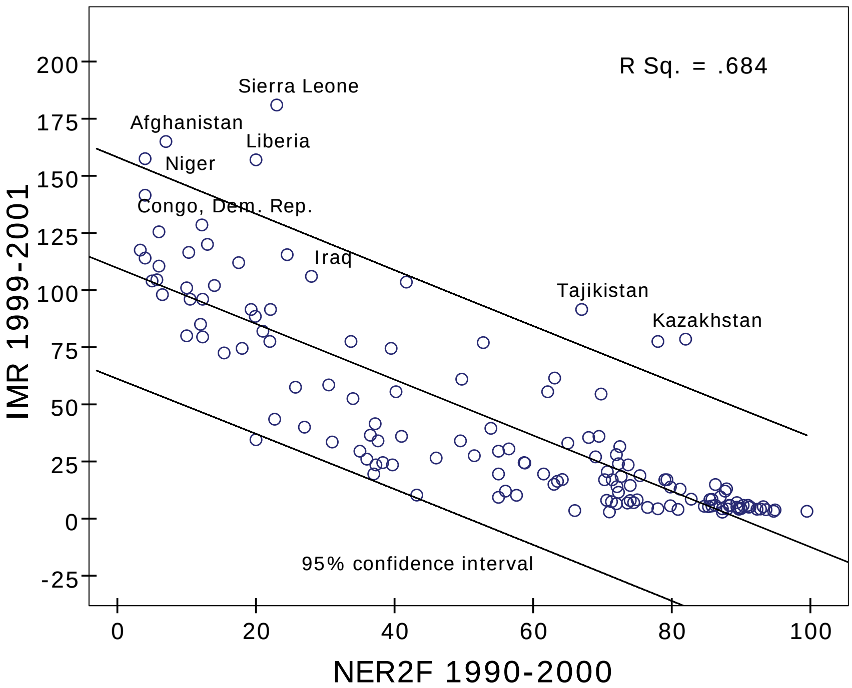
To check the dependency-IM link, we used variables such as the sum of the import and export values (‘Trade in goods as a share of GDP’) and foreign investment (‘Gross foreign direct investment as a share of GDP’). The correlation between ‘Trade in goods’ and IM is negative, though nonsignificant: IM declines when the incidence of ‘Trade’ rises. The correlation between foreign investment and IM is negative and significant: IM declines when investment rises. ‘Foreign investment’ **–** in contrast to dependency theory **–** is also positively and significantly correlated with NER2F. The function and effects of this investment are expected to be different in developed and developing countries: this advocates a breakdown by country groups. However, when the analysis is restricted to developing countries, ‘Trade’ & foreign investment correlations with IM and NER2F yield substantially the same results obtained with the larger sample. We can use ‘Foreign investment’ to obtain better fitting models (see Table 6, Model 8), but one must bear in mind that this variable contribution is opposite to that expected by the dependency theory. Also ‘Aid per capita’ is negatively correlated with IM, though the relation is nonsignificant (Burnside and Dollar, 1998).

E. The Armed Conflict Role

Unlike past wars, contemporary armed conflicts hit mostly civilians, and children all too easily are among the victims. Many conflicts take place in poor countries, exacerbating people’s already negative conditions (Stewart and Humphreys 1997). Infant mortality causes (dysentery, respiratory infections, measles, cholera, and malaria) have a formidable support in people's wasting away caused by conflict.

Figure 3 shows some evidence of this: most of the outliers with a higher IM are countries in which an armed conflict has recently occurred. Instead, there is no real outlier on the lower IM side: this suggests that factors other than education can limitedly improve IM rates. To further check the conflict impact, we built a *dummy* based on presence/absence (value = 1/0) of an armed conflict over the last few years.[7] By itself, the dummy ‘Conflict’ is definitely significant (for ‘Conflict’ and IM, *t*-test = 9.258). The dummy ‘Conflict’, when used together with other variables, makes a contribution to the models fit (Models 6-7-8). However, part of the ‘Conflict’ contribution is included in other explicative variables such as education indicators, which understandably are negatively affected by a situation of conflict (for ‘Conflict’ and NER2F, *t*-test = -5.817).

Figure 3. Scatterplot of Infant Mortality and Female Secondary Education, with Linear Regression Fit Line, Confidence Interval and Some Outliers; World’s Countries (N = 143)



F. Contributions of Other Structural Variables

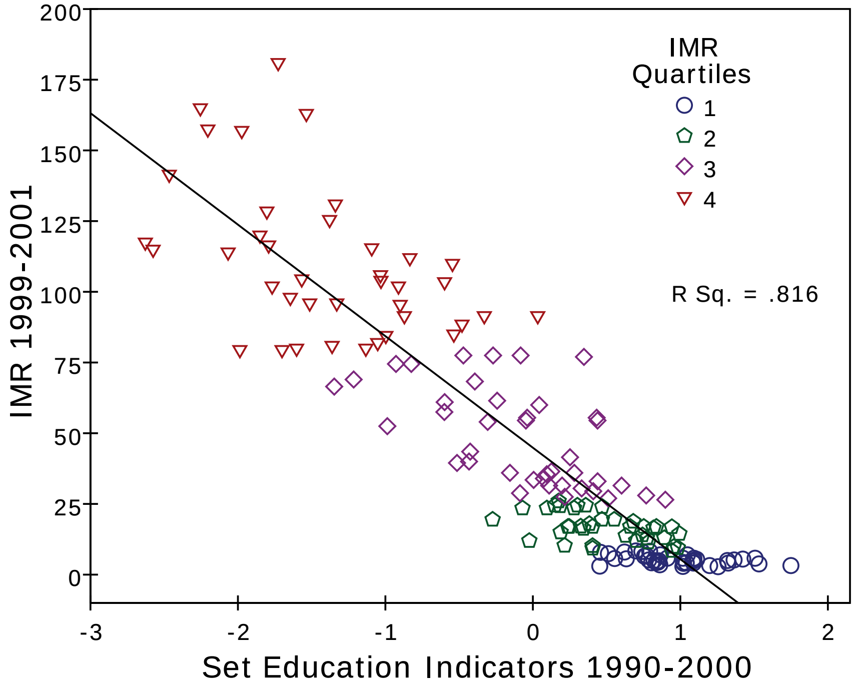
Other aspects seem to be associated with infant mortality. It's worth noticing 'Female Employees in agriculture as a share of female employment'. This indicator measures the propensity to agriculture as well as the rurality level. For structural reasons, rurality implies difficult environmental conditions, limited access to medical facilities, lower education and higher infant mortality. By contrast, the negative image of urban life that was appropriate to 19^{th} century Western countries – when cities were demographic 'sinks' – appears without foundation today. Besides, since it concerns women, 'Female Employees in agriculture' measures work away from home, and in difficult conditions, of those who are so important for children's health. Unsurprisingly, the correlation between 'Female Employees in agriculture' and IM is .787, whereas the variable 'Non-Urban pop.', which captures only some of the aspects underlying 'Female employees in agric.', shows a lower correlation ('Non-Urban pop.' and IM = .614). On the other hand, these two variables, as expected, are similarly correlated with female education: with NER2F, respectively r = -.766 and -.687.

In turn, variables such as 'Public health expenditure as a share of GDP', 'Hospital beds' or 'Physicians', per pop., which are largely depending upon the society's socio-economic structure, are unimpressively correlated with IM (respectively, r = -.489, -.473 and -.581). If we limit the sample only to developing countries, the results would worsen (r = -.287, -.463 and -.576). For instance, a long series of developing countries, from Mongolia to Djibouti, from Armenia to Cameroon, from Papua New Guinea to the Republic of Congo, present IM rates much higher than those expected on the basis of their 'Hospital beds'. When added to any of our models, 'Public health' variables proved to be nonsignificant (Table 6), whatever the sample (all countries or developing countries). Transformed income variables, instead, would slightly improve our Models (see Models 6-7).

G. The Education-IM Relation in Subsets of Countries with Different Infant Mortality Levels

The high coefficients of the education-IM correlations, obtained with all the world countries, suggest that observed values must be close to fit values, whatever the IM level. However, this is too important an issue to leave it unchecked. Therefore, we divided all countries in quartiles according to their IM. We found (Figure 4) that several of the countries with the highest IM (4^{th} quartile) show IM observed values still higher than those expected on the basis of their (low) education. For countries with low IM (2^{nd} and 1^{st} quartile), the situation is the opposite: IM observed values are in many cases lower than the fit ones. Therefore, the fact of belonging to different IM levels constitutes additional information, useful to better predict the trend of the education-IM link.

Figure 4. Scatterplot of Infant Mortality and Set of Education Indicators, Showing IM Quartiles and Linear Regression Fit Line; World's Countries (N = 158)



However, the education-IM relation does not show momentous changes at different IM levels. To check this point, we had recourse to regressions of IM on a set of basic education indicators, for countries within each quartile. This set includes an indicator of enrolment for each education level, and indicators for 'Dailies', 'Gender equality', 'Staff adequacy' and 'Conflict'.[8] The education indicators are based on *gross* enrolment: though less accurate than *net* enrolment indicators, they are the only ones providing enough valid cases for calculations within each quartile. Now, the regressions show that in all IM quartiles there is a significant linear relation between education and IM, and R coefficients are quite similar (Table 7). Coefficients are unimpressive, but this is due to the procedure followed, which erodes a substantial part of the original variance, especially on the IM side. The usual procedure consists in dividing countries in other sub-samples, in particular 'developing/developed countries', that are identified substantially by the income PC level, and not by IM, namely the dependent variable values. However, by dividing countries according to their IM, a more accurate check of the education-IM link can be obtained. In fact, *all* the countries falling into the third and fourth IM quartile are developing countries, with an average GDP PC 2000 of respectively $420 (median 270) and $1,380 (median 955). Therefore, by breaking down countries by IM level we are able to answer both the question 'does the education-IM link work also with high IM countries?' and the question 'does the education-IM link work also with poor countries?'. Instead, if we break down countries by their economic level, we would not answer the first important question, for reasons illustrated by Figure 2.

Table 7. Education Impact on Infant Mortality: Linear Regressions for Each IM Quartile (Dependent Variable IM 1999-2001); World's Countries

Independent variables	IM Quartiles	No. valid cases	Results with adj. quartiles		
			Mult. R	Adj. R^2	Sig.
Set Basic Education Indicators 1990-2000	All	158	.904	.808	.000
Set Basic Education Indicators 1990-2000	1st	40	.712	.417	.000
Set Basic Education Indicators 1990-2000	2nd	39	.712	.395	.001
Set Basic Education Indicators 1990-2000	3rd	40	.703	.383	.001
Set Basic Education Indicators 1990-2000	4th	39	.662	.312	.007

Ultimately, we can state that the education-IM relation detected when all the world countries are considered, is substantially reproduced within subsets of countries belonging to various infant mortality levels. It’s particularly important that the education-IM relation does not change within countries of the third and fourth quartile (namely, countries with high IM). Interestingly, transformed income measures (ln GDP PC) would be significant in the first, second and fourth quartile, and nonsignificant in the critical third one.

H. Education, Infant Mortality, and the Impact of the Geographical-Cultural Context

The geographical setting is associated with strong IM differentials (see Table 8, Figure 5). Besides, for Africa and especially sub-Saharan countries, IM rates are higher than those expected on the basis of the education indicator of choice (NER2F); for Latin American countries, lower. Therefore, the fact of belonging to different regions constitutes useful additional information. By adding to education variables the Africa, sub-Saharan Africa and Latin America dummies, we obtain fit values closer to those observed.

Table 8. Infant Mortality and Impact of the Geographical-Cultural Context: Linear Regressions of IM (1999-2001) on NER2F (1990-2000) for Subsets of Countries Belonging to Specific Geographical Regions or Cultural Contexts; Average Rates and t-Tests for IM and NER1F, NER2F, NER2M, BR (All 1990-2000), GDP PC (1995-2000) in Each Region or Context vs. All the Others

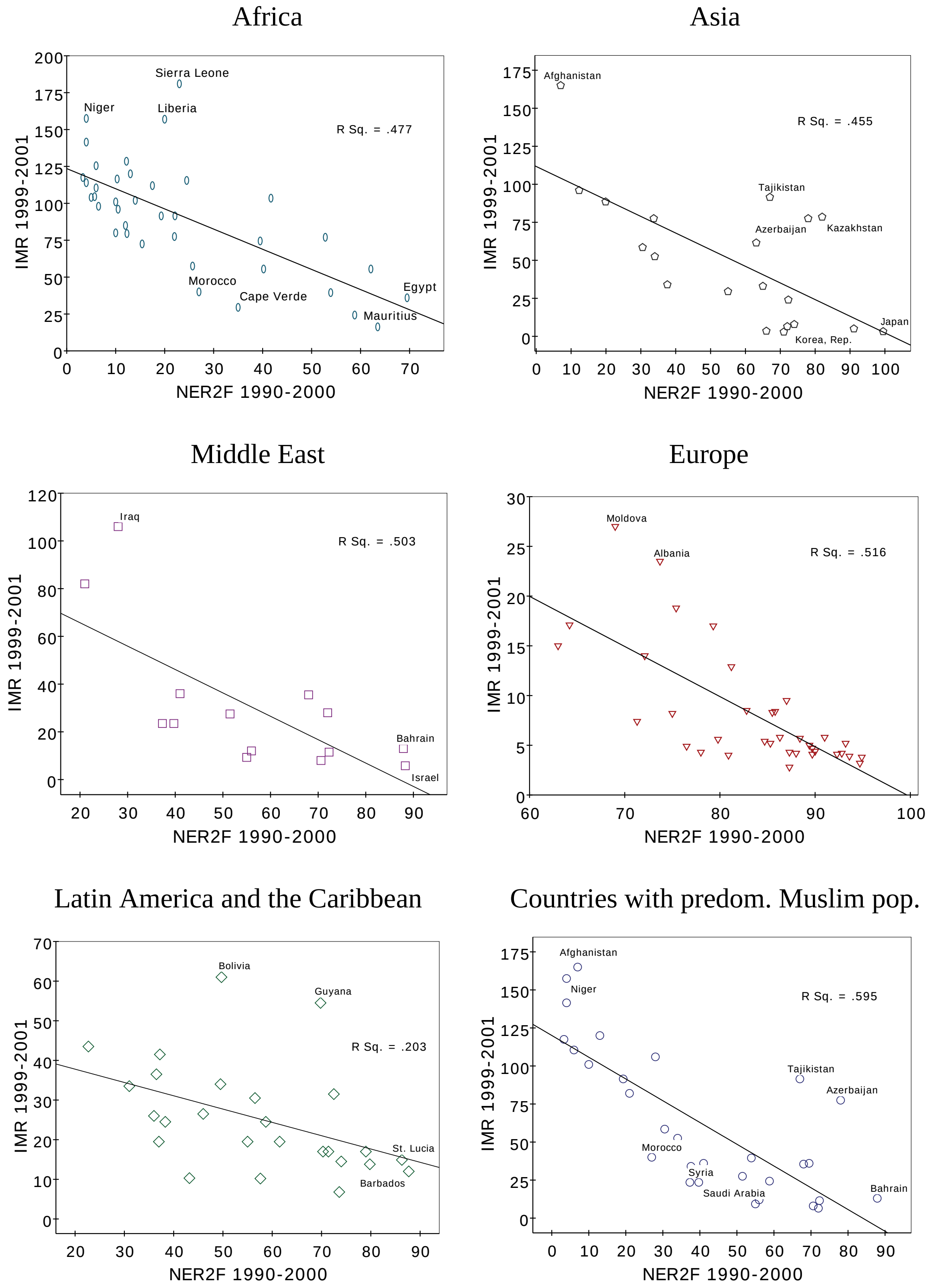
Geographical region or cultural context	Regr. IM on NER2F				IM		NER1F		NER2F		NER2M		GDP PC		BR	
	R	Adj. R^2	Sig.	N	Ave.	t	Ave.	t	Ave.	t	Ave.	t	Ave.	t	Ave.	t
Africa	-.691	.463	.000	38	90.0	11.0	61.8	-7.2	23.2	-10.7	33.2	-7.9	957	-7.6	39.4	12.5
Africa sub-Saharan	-.598	.338	.000	34	96.1	12.5	58.8	-7.8	19.8	-13.2	29.7	-8.6	905	-7.6	40.7	15.2
Asia	-.674	.424	.001	20	48.7	.8	84.8	.8	56.6	.2	58.6	.08	5,314	-.6	24.9	-1.1
Middle East	-.709	.461	.005	14	29.5	-1.8	78.3	-.6	56.3	.1	72.2	1.8	6,647	.1	28.9	1.1
Europe	-.718	.502	.000	36	8.5	-12.6	92.9	6.1	83.3	12.3	77.6	6.6	15,259	4.8	12.1	-20.0
Lat. Am. & Caribb.	-.452	.170	.021	26	25.1	-4.9	90.7	3.8	58.7	.8	56.9	-.4	3,808	-2.9	24.4	-1.8
North America				2	6.0	-11.9	95.5	8.3	90.4	13.6	92.2	13.7	25,403	4.4	14.0	-8.5
Pred. Muslim pop.	-.772	.581	.000	30	62.3	3.3	68.2	-3.8	40.8	-3.2	49.9	-1.9	2,841	-3.6	33.1	4.1

However, this does not mean that the relation between education and IM is different in the various regions. The regressions of IM on NER2F (Table 8, Figure 5) show that, in all the world main geographical regions, there’s always a negative and significant linear relation between female education and IM; besides, coefficients – with the partial exception of that for

Latin America – are similar. Summing up these results, we can state that the education-IM relation is limitedly affected by either the country's geographical context or its IM quartile. After all, countries belonging to the same geographical group tend to coincide – at least for some continents – with some of the abovementioned quartiles: for example Africa = fourth quartile, Europe = first.

The scatterplots for the geographical contexts show, together with the worst outliers already identified in Figure 3, some further significant cases. For Africa, one can notice the good position of Egypt (in spite of both its modest income and substantial birth rate) and Mauritius, and the positive deviations from the trend of Morocco and Cape Verde. For Asia, the remarkable success of Japan and Korea. For the Middle East, the unsurprising plight of Iraq, and the positions of Bahrain and Israel, very close in spite of their differences in so many other aspects. For Europe, the negative situation of former Communist countries such as Albania and Moldova. For Latin America, the achievements of Barbados and St. Lucia, but also the strong deviations of Bolivia and Guyana, two countries characterised by turbulent politics and social unrest: these two deviations markedly affect the regression results.[9] The geographical-cultural set of countries with predominantly Muslim population shows, together with the leading position of Bahrain, the positive deviations of Morocco, Syria and Saudi Arabia; the latter's IM, however, is higher than that expected from its income.

Figure 5. Scatterplots of Infant Mortality and Female Secondary Education for Various Geographical Contexts, with Linear Regression Fit Line; World's Countries (N: See Table 8)



The geographical setting is worth further thought. One may notice the strong deviation from average IM registered in sub-Saharan Africa (Table 8). Sub-Saharan Africa presents the worst record in terms of IM, and also by far the worst records in terms of education indicators, GDP and BR. Differences between its average IM, education level and so forth, and those of all the other countries, are significant, as shown by their *t*. Its ‘Gender equality’ record is the worst, as shown by the gap between its NER2F and NER2M. Sub-Saharan Africa's IM rates, however, are averagely even worse than those expected on the basis of its (low) level of education, as mentioned above. In other words, in sub-Saharan Africa, education seems to be less momentous than it is for example in Latin America. An explanation could be poor government and its correlate, ‘conflict’. Conflict in sub-Saharan Africa is significantly more frequent than elsewhere (for the two dummies ‘Conflict’ and ‘Sub-Saharan Africa’, Phi = .408, sig. .000). The same happens with HIV incidence. A further factor could be temperature. Sub-Saharan Africa has the highest Tmax (average maximum temperatures): 30.1° C. (Mitchell, Hulme and New, 2002). Its Tmax is significantly different from that of all the other regions: *t*-test = 9.253. High temperatures facilitate diseases such as gastro-enteritis and malaria, which are responsible for high IM. Now, the Tmax-IM correlation for all the world countries shows a significant but unimpressive r = .412: a coefficient by far lower than those obtained with education variables. When used together with education variables, Tmax makes a contribution to the models fit (Table 6). Therefore, the plight of the world’s worst region in terms of IM, namely sub-Saharan Africa, is associated with its very poor level of education but also with recurrent ‘conflict’ and ‘high temperatures’. However, ecological factors (Tmax) seem to be marginal in comparison with educational aspects. And, as we have already emphasised, ‘conflict’ and education are highly and negatively correlated; as are education and HIV.

Latin America’s low IM is accounted for by neither its income nor its birth rate. Its income would predict a much higher IM. Its GDP, for example, is c. half of that of the Middle East, whereas its IM is lower. Its BR, in turn, is the same of Asia, where IM is twice that of Latin America (Table 8). Latin America’s IM is lower than that expected also on the basis of its NER2F. However, this fact is accounted for by other education variables. Latin America's NER1F is closer to that of Europe than to that of any other area. Besides, Latin America, with Europe, is the only area where NER2F is higher than NER2M (Table 8): a fact implying an active social role for women.

Finally, one may wonder whether some cultural-religious characteristic has any significant effect on IM and its relation with education. To better investigate this, we distinguished between countries with predominantly Muslim population (>50%) and other countries.[10] The association between NER2F and IM in Muslim countries is quite strong – even stronger than that registered in all the abovementioned geographical regions (Table 8). This confirms the hypothesis of universal benefits of education. At the same time, Muslim countries show an average IM significantly different from other countries (Table 8). However, when we use the dummy ‘Predominantly Muslim pop.’ together with education indicators (for example NER2F) to predict IM, its contribution is no longer significant. The contribution made by Muslim/non-Muslim, in other words, is dwarfed by the contribution made by education. Muslim countries, in fact, deviate from average NER2F as much as they deviate from average IM (Table 8). Their deviance from the mean is more limited with regards to male education (NER2M). In some Muslim regions, such as the Middle East, male education rates are indeed high and they are associated with IM rates better than those expected on the basis of only female education or of the high BR and the just average income.

The general rule of the greater effectiveness of female education is confirmed by Europe, where very low IM is matched by definitely high female education rates, whereas male rates are less impressive.

DISCUSSION

This paper has tried to achieve a better evaluation of the education–IM relation. Differently from other studies, it has considered and contrasted a wide series of education variables and mortality measures. It has emerged, first, that the various education variables show dissimilar associations with IM. A few years of education (those of primary school) are paralleled by a longer/healthier life. This is probably due to a change in attitude, since a few years of school is not expected to considerably improve knowledge of health matters. Even literacy is closely correlated with IM: literacy rates, however, measure the condition of all adult population, whereas school enrolment that of a limited age group. Secondary education, anyway, is more momentous when controlling for the other variables. This probably happens because people's knowledge and, above all, attitudes are less affected by literacy and primary education. Tertiary education influence, in turn, seems to be inhibited by the fact that it usually concerns a small portion of the total population. Whereas education variables not distinguishing genders miss the special contribution of mothers to children's health. Some satellite parameters of education (for example 'Dailies') show a lower association with IM. School staff numerical adequacy (a proxy for quality of schooling) is definitely relevant for IM, even when controlling for other education variables: something planners should think about.

So, differences between the various education facets do matter. Instead, the breaking down of mortality in infant, child, 1-4 years, and postneonatal mortality, has shown that the education variables associations with all these measures are similar. This seems to support the relevance of education.

The present study shows that the education-IM relation is robust when we consider all the world countries, but also when we deal with subsets of countries and in particular with the high infant mortality subsets. Therefore, it seems there is hope in the benefits of education also for countries with the worst IM levels. All these countries belong to the developing countries category. This suggests that education benefits do not stop at the threshold of developing countries. The education-IM relation stands also the test represented by the geographical context effects: they don't alter the substantially universal character of the education-IM relation. Combined features of education provide a reasonable explanation for the peculiar IM of regions such as sub-Saharan Africa and Latin America. Ecological factors – such as high temperatures – seems to play marginal roles, when compared to education.

The introduction of a cultural-religious parameter – 'Predominantly Muslim population' – yields interesting results, but it does not change the picture. The present results suggest – in contrast with other studies – that this cultural-religious variable does not play any autonomous role because its significant association with IM is absorbed by the stronger relation between (female) education and IM.

Conflict, instead, is associated with the worst outliers and the highest recorded levels of IM and it seems particularly relevant for Africa's plight. 'Conflict', nevertheless, is associated with low levels of education. Other variables often regarded as momentous for IM trends, such as 'Public health expenditure', 'Hospital beds' or 'Physicians', in turn, proved to be irrelevant within our models. This suggests that education makes the best of available health services, whereas health resources are not a surrogate for education.

The education paradigm emerges from the present study as more convincing than the growth paradigm. Clearly, poverty can hardly advance children's health, save in Horatio Alger's novels. When compared to education, however, untransformed income measures are disappointing predictors of IM. They are not much help when one tries to predict IM for lower-middle income developing countries, the very group containing the most dissimilar IM rates. They do not account for Latin America's and the Middle East's IM rates. The growth paradigm is also challenged by the scarce impact on IM of variables such as 'Public health expenditure' and 'Hospital beds', largely dependent upon income level. Moreover, it is not just a problem of 'variations around the line'. The fact is that the income-IM relation presents a hyperbolic curve outline, shaped almost as a right angle. Transformed income measures fit much better IM rates and give a contribution to the models, but even logarithmised GDP is a nonsignificant predictor of IM for countries belonging to the critical third IM quartile (that between the worst quartile and the median). Besides, diachronic analyses confirm this picture. IM variations occurred since 1960 are better predicted by education development than by economic growth. All this is hardly surprising if one remembers that, in the West too, rise in income and decline in mortality did not coincide. In the mid-1800s, mortality decline in France, England and the US was still rather negligible, and remained so for decades, in spite of their rapidly rising income. The decline in mortality occurred later, in concomitance with mass education and the large-scale adoption of prevention measures. As Parsons and Smelser (1956) noticed, growth produces social development only in proportion to its integration in the other subsystems, that of culture and education included.

On the other hand, income and education are not in opposition: income is correlated – though not closely – with the education indicators (for GDP PC 2000 and LitM, NER1F, NER2F 2000, r is respectively .402, .368, and .567; and lagged GDP measures would produce worse results). It is not sound, anyway, to infer that income determines the educational level and indirectly, at the end of the day, IM as well. This interpretation would clash not only with the peculiarity of the income-IM link but also with past and present (Jamison, Jamison and Hanushek 2007) human capital studies showing the importance of education in income growth. Besides, relevant historical cases turn down the possibility of regarding income as a reliable predictor of education. Suffice to say that France, around 1850, had by far more illiterates than Sweden, then a much less developed country. England, the most developed country, presented, over those same years, an illiteracy rate much higher than that of Switzerland. Japan had in 1900 an income per capita distinctly lower than that of Italy and Spain, whereas its illiteracy rate was only 20 per cent, namely half of that of the other two countries. South Korea had, around 1950, an income PC equivalent to 1/3 of that of Mexico, but a literacy record markedly higher. If no Malthusian shackles bind infant mortality to income, the relationship between income and education is even looser. The fact is that education is a labour-intensive, not a capital-intensive service. Education can be relatively inexpensive – as Adam Smith already realised – and poor countries can achieve with little money what would cost much more to richer countries. China's remarkable decrease in IM was obtained *before* the recent economic boom. Something similar occurred in India.

The growth paradigm receives only a partial support from the present study, but in turn the dependency paradigm emerges here as rejected. Variables relating to dependency – such as 'Foreign investment' and 'Trade in goods' – seem to influence IM in a way opposite to that anticipated by this paradigm, no matter the sample (developed & developing or only developing countries). 'Aid' (Western countries' underhand way for further extending their grasp of dependent countries?) follows the same trend. The positive correlation between 'Foreign investment' and NER2F weakens the argument that women's education mediates the negative effect of dependency on IM.

Conversely, the demographic factors paradigm ends up being corroborated by the present results, though it fails to explain the differences in IM between Asia, the Middle East and Latin America. However, the contribution made by some variables relating to this paradigm seem to have a tautological character (higher number of children averagely implies less care for each of them) and, on the other hand, it seems to be intertwined with the education contributions. The abovementioned high correlations existing – on a synchronic level – between education and both birth and fertility rates, would make it arduous to distinguish between their respective effects on IM. We can notice, however, that the female education role in the reduction of fertility – which in turn affects IM – has long been known. With regards to all this, we found that lagged female education variables ($GER2F_{t-20}$, or $LitF_{t-20}$) predict BR and TFR more accurately than lagged BR or TFR predict female education.

In short, IM seems to discount almost everything, but not in the same degree. And most of the contributions to the explanation of IM differentials made by significant non-educational variables, from ‘Conflict’ to ‘Sub-Saharan Africa’ and HIV, from ‘Predominantly Muslim pop.’ to birth rate, are already included in the educational variables. The present paper shows that, by focusing mainly on a set of education indicators, it is possible to obtain excellent IM predictions, even without resorting to growth and health variables. Education emerges more as a ‘stand-alone’ paradigm than just as an auxiliary variable in other paradigms explaining infant/child mortality.

The present results suggest that mass education and equality of opportunity help achieve the goal of a longer/healthier life. Conclusions, however, are not inevitably optimistic. First, the ongoing presence of conflict and its consequences warn us that education benefits can be cancelled. Second, the human development theory conveys the image of education as an autonomous factor of development and IM reduction. This study shows that IM is also associated with high rates of ‘Female employees in agriculture’, non-urban population, birth and total fertility, and with women’s low age at marriage. All these variables are correlated with each other and – negatively, except for age at marriage – with education as well. The picture emerges of a traditional context in which education – and particularly women’s education – is restrained by a socio-economic framework emphasizing *reproduction of producers* rather than education of the latter. The education-IM link, therefore, seems to confirm a basic notion by Vilfredo Pareto: behind any social phenomenon there is not a single cause but a network of interacting factors. An intervention only on education would yield results inferior to those expected as long as it clashes with other socio-economic pressures. This might explain why IM reduction was accompanied over the last decades by a marked increase in disparity between developed and developing countries.

There are good reasons for having confidence in education, but no room for arrogant optimism.

Endnotes

[1] Most socio-economic data are from the World Bank. Some education variables (such as schooling years) are from UNESCO. As regards the dependent variables, IM and CM are World Bank estimates, based on data from United Nations and UNICEF, State of the World's Children. One to four years mortality is calculated on CM and IM rates. The plurality of the sources should ensure the reliability of the data.

[2] Acronyms: see Table 3. NER2F variations were calculated as reduction of the distance from the goal represented by NER2F=100%. Let X be NER2F, i the country and t time (year): $(X_{it} – X_{i,t\text{-}20}) / (100 – X_{i,t\text{-}20}) * 100$; in the few cases where $X_{i,t\text{-}20} > X_{it}$, then $(X_{it} – X_{i,t\text{-}20}) / (X_{i,t\text{-}20}) * 100$. Because NER2F data are available only since the late 1970's, before this date they were calculated on the basis of later GER2F/NER2F ratios.

[3] Variables used for Sen's: GDP per capita constant 2000 US$ 1993-2002 and Gini's 1993-2002 (World Bank data).

[4] Literacy rate is the share of literate people (of a certain age group) in the population of that age group.

[5] Since Model 00 is meant to identify the most important education variables in terms of their effects on IM, collinearity could be a problem. A high collinearity would make it difficult to distinguish between determinants contributions. However, collinearity is not worrying here: even for the worst determinant, 25% of its variance cannot be predicted from other independent variables. In other models (1-8), the problem of collinearity does not seem as relevant as for Model 00. What we want to show is the total amount of variance of the dependent variable associated with the set of independent variables. The collinearity level remains in any case acceptable.

[6] Singulate mean age at marriage, women, is relative to various years, in most cases between 1995 and 2000, and is from United Nations (2003).

[7] Sources: UNICEF (www.unicef.org); OnWar (www.onwar.com); Amnesty International (www.amnesty.org); Central Intelligence Agency (www.odci.gov/cia/publications/factbook).

[8] More precisely, GER1T 1990-2000, GER2T 1990-2000, GER3T 1990-2000, Dailies 1990-2000, Females/males ratio GER2 1990-2000, Pupil/teacher ratio GER1T 1990-2000, 'Conflict'. There are missing values in the education variables used; and these missing cases are not evenly distributed in the four quartiles. Consequently, the number of valid cases in the quartiles is not the same. Therefore, we calculated also adjusted quartiles (Table 7): they are based on only valid cases for both IM and the independent variables.

[9] Without Bolivia and Guyana, the regression results for Latin America would be $R^2 = .445$, Adj. $R^2 = .420$, therefore close to those for the other geographical contexts.

[10] Countries with predominantly Muslim population were identified according to information drawn from Statistical, Economic and Social Research and Training Centre for Islamic Countries (http://www.sesrtcic.org/act_inforep.php); Central Intelligence Agency (www.odci.gov/cia/publications/factbook); Intl Religious Freedom Report (www.state.gov/g/drl/rls/irf).

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Appendix: Descriptive statistics

Variables	Obs	Mean	Std. dev.	Min	Max
IM (Infant Mortality Rate) 1999-2001	198	43.1	41.72	2.8	181.0
CM (Child Mortality Rate) 1999-2001	194	63.7	68.11	3.7	316.0
1-4 Years Mortality Rate 1999-2001	194	19.7	27.38	0.47	135.0
LitM (Literacy Rate, Males % of m. 15 years old and over) 2000	156	85.9	16.66	18.5	99.8
LitF (Literacy Rate, Females % of f. 15 years old and over) 2000	156	78.3	24.05	8.1	99.8
GER1T (Gross Enrolment Rate, Primary, Total %) 1985-1990	170	89.6	26.46	8.0	135.0
NER1T (Net Enrolment Rate, Primary, Total %) 1985-1990	91	78.6	23.36	9.8	100.0
NER1T (Net Enrolment Rate, Primary, Total %) 1990-1995	125	81.0	21.32	22.0	100.0
Ln NER1T (Net Enrolment Rate, Primary, Total %) 1990-1995	125	4.3	0.36	3.1	4.6
NER1F (Net Enrolment Rate, Primary, Females %) 1985-1990	82	76.4	26.41	6.9	100.0
NER2T (Net Enrolment Rate, Secondary, Total %) 1990-2000	150	55.1	27.43	5.0	100.0
NER2M (Net Enrolment Rate, Secondary, Males %) 1990-2000	139	58.2	26.40	6.5	98.9
NER2F (Net Enrolment Rate, Secondary, Females %) 1990-2000	145	55.6	28.97	3.3	99.5
Ln NER2F (Net Enrolment Rate, Secondary, Females %) 1990-2000	145	3.8	0.85	1.2	4.6
GER3T (Gross Enrolment Rate, Tertiary, Total %) 1995-2000	177	20.7	18.86	0.30	77.1
Ln GER3T (Gross Enrolment Rate, Tertiary, Total %) 1995-2000	177	2.4	1.4	-1.2	4.3
Female/Male, Primary Net Enrolment Ratio 1990-2000	168	0.95	0.11	0.36	1.19
Females, Secondary Enrolment (% of total) 1990-2000	190	46.7	6.79	20.0	64.5
Pupil/Teacher Ratio, Primary 1990-2000	191	27.5	12.96	5.4	75.3
Schooling Years Total (Both Sexes) 1998-2002	154	11.5	3.57	3.0	20.0
Schooling Years F (Females) 1998-2002	146	11.6	3.91	2.0	21.0
Dailies per 1,000 pop. 1990-2000	173	106.2	135.8	0.10	758
Ln Dailies per 1,000 pop. 1990-2000	173	3.6	1.8	-2.3	6.6
TFR (Total Fertility Rate) 1990-2000	190	3.5	1.71	1.2	7.4
BR (Birth Rate) per 1,000 pop. 1990-2000	191	26.5	11.88	9.4	53.5
BR (Birth Rate) Squared 1990-2000	191	844.1	679.89	88.5	2,860
Female Employees in Agric. (%) 1990-2000	155	31.9	34.61	0.0	98.0
Gross Foreign Invest. (% of GDP) 1990-2000	164	4.6	5.95	0.0	45.5
Tmax (ave. max. temperat.) Squared 1961-1990	205	649.3	352.12	0.0	1,267
Hospital Beds per 1,000 pop. 1990-2000	171	4.3	3.88	0.0	19.0
GDP per capita (constant 1995 $) 1995-2000	181	6,315	9,945	110	49,599
Ln GDP per capita (constant 1995 $) 1995-2000	181	7.6	1.59	4.7	10.8
GDP per capita PPP (current international $) 1995-2000	168	8,100	8,238	468	40,980
Sen’s index 1993-2002	124	3,863	6,447	64.2	26,687
GDP per cap. Ann. Growth Rate (two periods: 1960-1980; 1980-2000)	244	1.7	2.90	-14.6	12.0
NER2F Variations (two periods: 1960-1980; 1980-2000)	260	30.6	25.47	-35.1	100.0