3.16 Toward a broader measure of savings

	Gross savings	Consumption of fixed capital	Net national savings	Education expenditure	Energy depletion	Mineral depletion	Net forest depletion	Carbon dioxide damage	Particulate emission damage	Adjusted net savings
	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI
	2007	2007	2007	2007	2007	2007	2007	2007	2007	2007
Afghanistan	..	..	..	..	..	..	..	..	..	..
Albania	19.2	10.9	8.3	2.8	0.0	0.0	0.0	0.2	0.2	10.7
Algeria	57.9	11.6	46.3	4.5	29.7	0.1	0.1	1.2	0.3	19.4
Angola	31.8	14.3	17.5	2.3	55.6	0.0	0.0	0.2	1.3	–37.3
Argentina	27.2	12.4	14.8	4.0	7.7	0.6	0.0	0.5	1.6	8.3
Armenia	29.7	10.7	18.9	2.2	0.0	1.1	0.0	0.4	1.6	18.1
Australia	22.8	15.3	7.5	4.8	2.9	3.8	0.0	0.3	0.1	5.2
Austria	26.2	15.1	11.1	5.3	0.2	0.0	0.0	0.1	0.3	15.7
Azerbaijan	59.9	13.5	46.4	2.8	52.6	0.0	0.0	2.0	1.2	–6.6
Bangladesh	32.2	7.7	24.5	1.8	2.9	0.0	0.7	0.4	0.5	21.8
Belarus	26.9	11.8	15.1	4.9	0.1	0.0	0.0	1.4	..	18.5[a]
Belgium	24.8	14.6	10.2	5.8	0.0	0.0	0.0	0.2	0.2	15.7
Benin	..	8.8	..	3.6	0.0	0.0	0.9	0.3	0.4	..
Bolivia	30.1	10.1	20.0	6.3	21.6	2.4	0.0	0.5	1.4	0.4
Bosnia and Herzegovina	8.9	11.1	–2.2	..	0.2	0.0	..	0.9	0.1	..
Botswana	57.9	12.8	45.0	6.6	0.2	8.2	0.0	0.3	..	42.9[a,b]
Brazil	17.0	12.6	4.4	4.4	2.3	1.6	0.0	0.2	0.2	4.5
Bulgaria	17.8	11.9	5.9	4.1	0.6	1.1	0.0	1.0	1.5	5.7
Burkina Faso	..	8.4	..	4.3	0.0	0.0	1.1	0.1	1.3	..
Burundi	..	6.6	..	5.1	0.0	0.8	11.5	0.2	0.1	..
Cambodia	15.9	9.1	6.8	1.7	0.0	0.0	0.2	0.1	0.3	7.9
Cameroon	19.7	9.7	10.0	2.6	6.4	0.1	0.0	0.2	0.8	5.3
Canada	23.0	14.9	8.1	4.8	4.1	0.9	0.0	0.4	0.1	7.4[c]
Central African Republic	4.5	8.2	–3.7	1.3	0.0	0.0	0.0	0.1	0.4	–2.9
Chad	26.9	10.2	16.6	1.2	40.7	0.0	0.0	0.0	1.1	–24.0
Chile	28.7	14.3	14.4	3.4	0.2	16.7	0.0	0.4	0.6	–0.1
China	54.4	10.7	43.7	1.8	4.5	1.3	0.0	1.4	1.6	36.8
Hong Kong, China	33.8	13.8	20.1	3.0	0.0	0.0	0.0	0.2	..	22.9[a]
Colombia	19.6	12.1	7.5	4.8	6.6	1.7	0.0	0.3	0.1	3.6
Congo, Dem. Rep.	12.1	7.0	5.1	0.9	3.1	2.9	0.0	0.2	0.6	–0.8
Congo, Rep.	45.4	13.4	32.0	2.3	56.5	0.0	0.0	0.4	0.7	–23.4
Costa Rica	19.2	12.4	6.8	4.1	0.0	0.0	0.1	0.2	0.3	10.2
Cote d'Ivoire	9.6	10.0	–0.4	4.7	7.0	0.0	0.0	0.2	0.3	–3.2
Croatia	24.6	13.4	11.3	4.3	0.7	0.0	0.2	0.4	0.5	13.8
Cuba	..	..	..	8.2	..	..	..	..	0.1	..
Czech Republic	27.0	14.4	12.6	4.0	0.4	0.0	0.1	0.6	0.1	15.4
Denmark	24.0	14.9	9.1	7.8	2.3	0.0	0.0	0.1	0.1	14.4
Dominican Republic	21.0	12.0	9.0	3.5	0.0	3.5	0.0	0.6	0.1	8.4
Ecuador	26.9	11.7	15.2	1.4	18.4	0.5	0.0	0.5	0.1	–2.9
Egypt, Arab Rep.	22.4	10.2	12.2	4.4	13.4	0.1	0.2	1.0	1.0	0.9
El Salvador	12.5	11.3	1.2	2.8	0.0	0.0	0.5	0.3	0.2	3.0
Eritrea	..	7.8	..	1.9	0.0	0.0	0.9	0.4	0.4	..
Estonia	21.9	14.5	7.4	4.6	0.8	0.0	0.1	0.9	0.0	10.2
Ethiopia	20.9	7.5	13.4	3.7	0.0	0.4	5.4	0.4	0.3	10.6
Finland	26.5	14.8	11.6	5.9	0.0	0.1	0.0	0.2	0.1	17.1
France	19.2	13.3	5.9	5.1	0.0	0.0	0.0	0.1	0.0	10.9
Gabon	46.3	14.2	32.1	3.1	33.3	0.0	0.0	0.1	..	1.7[a]
Gambia, The	12.6	8.7	3.9	2.0	0.0	0.0	0.6	0.4	0.7	4.2
Georgia	17.0	10.4	6.5	2.8	0.0	0.0	0.0	0.4	1.3	7.7
Germany	24.9	14.6	10.4	4.4	0.2	0.0	0.0	0.2	0.1	14.3
Ghana	23.2	8.9	14.2	4.7	0.0	4.5	2.3	0.4	0.1	11.5
Greece	9.5	14.6	–5.1	2.8	0.2	0.2	0.0	0.3	0.7	–3.7
Guatemala	16.8	10.9	5.9	2.8	0.6	0.0	0.8	0.3	0.5	6.5
Guinea	8.8	8.6	0.2	2.0	0.0	4.9	1.7	0.2	0.3	–4.9
Guinea-Bissau	24.0	7.5	16.5	2.3	0.0	0.0	0.0	0.6	0.9	17.3
Haiti	..	9.8	..	1.5	0.0	0.0	0.6	0.2	0.4	..

Toward a broader measure of savings

	Gross savings	Consumption of fixed capital	Net national savings	Education expenditure	Energy depletion	Mineral depletion	Net forest depletion	Carbon dioxide damage	Particulate emission damage	Adjusted net savings
	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI
	2007	2007	2007	2007	2007	2007	2007	2007	2007	2007
Honduras	23.8	10.8	13.0	3.5	0.0	2.0	0.0	0.5	0.4	13.6
Hungary	17.7	14.2	3.5	5.4	0.6	0.0	0.0	0.4	0.1	7.9
India	38.8	9.6	29.2	3.2	2.7	0.7	0.9	1.1	0.7	26.4
Indonesia	27.2	10.8	16.3	1.1	6.9	2.0	0.0	0.8	1.1	6.7
Iran, Islamic Rep.	43.4	11.6	31.8	4.9	26.8	0.6	0.0	1.3	0.7	7.3
Iraq	..	..	..	..	..	..	..	..	..	..
Ireland	25.6	18.1	7.6	5.1	0.0	0.2	0.0	0.2	0.0	12.3[c]
Israel	..	13.9	..	6.0	0.2	0.0	0.0	0.4	0.4	..
Italy	19.8	14.6	5.2	4.2	0.2	0.0	0.0	0.2	0.2	8.9
Jamaica	..	13.2	..	5.4	0.0	1.9	0.0	0.7	0.3	..
Japan	31.0	14.0	17.0	3.2	0.0	0.0	0.0	0.2	0.5	19.5[c]
Jordan	8.2	10.4	–2.2	5.6	0.3	0.5	0.0	0.9	0.6	1.1
Kazakhstan	32.5	13.8	18.7	4.4	28.3	2.4	0.0	2.0	0.3	–9.9
Kenya	17.1	8.8	8.3	6.6	0.0	0.1	1.2	0.3	0.1	13.1
Korea, Dem. Rep.	..	..	..	..	..	..	..	..	..	..
Korea, Rep.	29.9	13.7	16.2	3.9	0.0	0.0	0.0	0.4	0.6	19.1
Kuwait	..	13.3	..	3.0	32.5	0.0	0.0	0.5	1.4	..
Kyrgyz Republic	6.7	9.1	–2.4	5.2	0.1	0.0	0.0	1.2	0.2	1.2
Lao PDR	23.5	9.3	14.2	1.3	0.0	0.0	0.0	0.3	1.2	14.0
Latvia	15.4	13.9	1.6	5.6	0.0	0.0	0.6	0.3	0.0	6.2
Lebanon	0.4	12.1	–11.7	2.5	0.0	0.0	0.0	0.5	0.8	–10.6
Lesotho	32.7	7.3	25.4	10.0	0.0	0.0	1.3	..	0.2	..
Liberia	–19.3	9.4	–28.7	..	0.0	0.0	6.6	0.6	0.4	..
Libya	..	12.4	..	..	45.1	0.0	0.0	0.9	..	..
Lithuania	17.0	13.5	3.5	4.8	0.1	0.0	0.1	0.3	0.2	7.6
Macedonia, FYR	21.1	11.4	9.6	4.9	0.0	0.0	0.2	1.2	0.1	13.1
Madagascar	13.4	8.2	5.2	3.1	0.0	0.0	0.2	0.3	0.2	7.7
Malawi	9.6	7.6	2.0	3.5	0.0	0.0	0.8	0.3	0.2	4.3
Malaysia	38.4	12.5	25.9	5.5	10.3	0.1	0.0	0.8	0.1	20.2
Mali	13.6	9.0	4.6	3.6	0.0	0.0	0.0	0.1	1.6	6.5
Mauritania	28.0	8.9	19.1	2.8	0.0	17.0	0.5	0.8	2.3	1.2
Mauritius	19.7	11.8	7.9	3.4	0.0	0.0	0.0	0.4	..	10.9[a]
Mexico	25.7	12.9	12.8	5.5	6.9	0.4	0.0	0.4	0.4	10.3
Moldova	20.4	8.8	11.6	6.6	0.0	0.0	0.1	1.4	0.6	16.0
Mongolia	42.5	10.3	32.3	4.6	2.5	14.0	0.0	2.2	2.0	16.3
Morocco	32.8	10.9	21.9	5.2	0.0	1.0	0.0	0.5	0.1	25.6
Mozambique	3.1	8.9	–5.8	3.8	7.1	0.0	0.6	0.2	0.2	–10.2
Myanmar	..	..	..	0.8	..	..	..	..	0.6	..
Namibia	40.3	11.3	29.0	7.3	0.0	4.2	0.0	0.3	0.1	31.7
Nepal	28.2	8.0	20.2	2.4	0.0	0.0	4.4	0.2	0.1	17.9
Netherlands	27.6	14.6	12.9	4.8	1.4	0.0	0.0	0.1	0.6	15.6
New Zealand	..	15.5	..	6.7	1.3	0.2	0.0	0.2	0.0	..
Nicaragua	14.6	9.7	4.9	3.0	0.0	0.7	0.0	0.6	0.1	6.5
Niger	..	7.7	..	2.6	0.0	0.0	2.4	0.2	0.9	..
Nigeria	..	10.8	..	0.9	25.2	0.0	0.1	0.7	0.5	..
Norway	38.3	15.7	22.6	6.5	13.4	0.0	0.0	0.2	0.0	15.5
Oman	..	..	..	3.9	..	..	0.0	..	1.4	..
Pakistan	24.5	9.1	15.4	2.1	3.3	0.0	0.9	0.7	1.5	11.0
Panama	24.7	12.9	11.8	4.4	0.0	0.0	0.0	0.3	0.2	15.7
Papua New Guinea	39.2	10.6	28.7	..	18.0	30.0	0.0	0.4	0.0	..
Paraguay	19.6	10.3	9.4	3.9	0.0	0.0	0.0	0.3	0.7	12.3
Peru	25.7	12.4	13.3	2.6	1.5	10.5	0.0	0.3	0.6	3.1
Philippines	31.6	9.3	22.3	2.2	0.4	1.6	0.1	0.5	0.2	21.7
Poland	22.0	13.3	8.7	5.3	0.9	0.5	0.1	0.7	0.4	11.5
Portugal	12.6	14.4	–1.8	5.4	0.0	0.1	0.0	0.2	0.3	3.0
Puerto Rico	..	..	..	..	..	..	..	..	..	..

3.16 Toward a broader measure of savings

	Gross savings	Consumption of fixed capital	Net national savings	Education expenditure	Energy depletion	Mineral depletion	Net forest depletion	Carbon dioxide damage	Particulate emission damage	Adjusted net savings
	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI	% of GNI
	2007	2007	2007	2007	2007	2007	2007	2007	2007	2007
Romania	21.1	12.4	8.7	3.4	2.1	0.1	0.0	0.5	0.0	9.3
Russian Federation	31.3	12.9	18.4	3.5	17.9	1.3	0.0	1.1	0.2	1.4
Rwanda	16.2	8.0	8.2	4.6	0.0	0.0	3.6	0.2	0.1	9.0
Saudi Arabia	..	13.4	..	7.2	42.1	0.0	0.0	0.7	1.4	..
Senegal	21.8	9.4	12.4	4.5	0.0	0.1	0.0	0.3	1.2	15.2
Serbia	..	..	..	..	..	..	..	..	..	..
Sierra Leone	9.8	7.9	2.0	3.9	0.0	0.9	1.6	0.4	0.9	2.1
Singapore	..	15.1	..	2.7	0.0	0.0	0.0	0.3	0.9	..
Slovak Republic	24.0	13.8	10.2	3.8	0.1	0.0	0.4	0.5	0.0	13.1
Slovenia	28.0	14.2	13.7	5.5	0.1	0.0	0.2	0.3	0.2	18.4
Somalia	..	..	..	..	..	..	..	..	..	..
South Africa	14.5	12.4	2.1	5.3	3.1	2.2	0.2	1.3	0.1	0.4
Spain	21.9	14.8	7.1	3.9	0.0	0.0	0.0	0.2	0.4	10.4
Sri Lanka	23.3	10.3	13.0	2.6	0.0	0.0	0.6	0.3	0.3	14.3
Sudan	13.2	10.8	2.4	0.9	15.7	0.1	0.0	0.2	0.4	–13.2
Swaziland	19.8	10.6	9.2	6.4	0.0	0.0	0.0	0.3	0.1	15.2
Sweden	27.5	14.7	12.8	7.2	0.0	0.3	0.0	0.1	..	19.6[a]
Switzerland	..	13.9	..	4.8	0.0	0.0	0.0	0.1	0.2	..
Syrian Arab Republic	19.7	10.6	9.1	2.6	19.2	0.0	0.0	1.3	0.9	–9.7
Tajikistan	13.9	8.9	5.0	3.2	0.3	0.0	0.0	1.3	0.4	6.3
Tanzania	..	8.2	..	2.4	0.5	5.6	0.0	0.2	0.1	..
Thailand	34.0	11.8	22.2	4.8	4.1	0.0	0.2	0.9	0.4	21.4
Timor-Leste	..	1.9	..	..	..	0.0	..	0.1	..	..
Togo	..	8.3	..	2.5	0.0	0.6	2.6	0.6	0.2	..
Trinidad and Tobago	31.0	14.0	16.9	4.0	41.9	0.0	0.0	1.6	0.3	–22.8
Tunisia	23.9	11.8	12.0	6.7	4.6	0.6	0.1	0.6	0.2	12.5
Turkey	16.0	12.7	3.2	3.7	0.2	0.1	0.0	0.3	1.1	5.3
Turkmenistan	..	11.1	..	..	92.6	0.0	..	2.5	1.0	..
Uganda	14.0	8.3	5.7	4.0	0.0	0.0	4.6	0.1	..	4.9[a]
Ukraine	23.1	11.2	11.9	4.4	3.0	0.0	0.0	2.2	0.3	10.7
United Arab Emirates	..	..	..	..	..	..	..	..	..	..
United Kingdom	15.7	14.7	1.0	5.0	1.5	0.0	0.0	0.2	0.0	4.3[c]
United States	14.0	14.8	–0.8	4.8	1.2	0.1	0.0	0.3	0.3	2.0[c]
Uruguay	13.4	12.5	1.0	2.6	0.0	0.0	0.3	0.2	1.9	1.2
Uzbekistan	38.6	9.2	29.4	9.4	38.5	0.0	0.0	5.8	0.7	–6.2
Venezuela, RB	34.8	12.3	22.5	3.4	18.7	0.7	0.0	0.7	0.0	5.9
Vietnam	35.5	9.4	26.1	2.8	11.6	0.1	0.4	1.2	0.5	15.2
West Bank and Gaza	..	..	..	..	..	..	..	..	..	..
Yemen, Rep.	..	10.1	..	..	22.5	0.0	0.0	0.8	..	..
Zambia	26.2	10.7	15.5	2.1	0.1	19.8	0.0	0.2	0.6	–3.0
Zimbabwe	..	..	..	6.9	..	..	..	..	0.1	..
World	**22.7 w**	**13.7 w**	**8.9 w**	**4.3 w**	**3.0 w**	**0.4 w**	**0.0 w**	**0.4 w**	**0.4 w**	**8.8 w**
Low income	25.4	9.3	16.2	2.6	9.8	0.9	0.8	0.7	0.7	5.8
Middle income	32.3	11.7	20.6	3.5	7.1	1.2	0.1	0.9	0.8	14.0
Lower middle income	41.7	10.7	31.0	2.6	6.6	1.2	0.2	1.2	1.1	23.5
Upper middle income	23.2	12.8	10.5	4.4	7.6	1.3	0.0	0.6	0.4	4.9
Low & middle income	32.0	11.6	20.4	3.4	7.2	1.2	0.1	0.9	0.8	13.6
East Asia & Pacific	48.0	10.7	37.3	2.1	4.9	1.3	0.0	1.3	1.3	30.6
Europe & Central Asia	24.0	12.8	11.2	4.0	9.8	0.7	0.0	1.0	0.5	3.2
Latin America & Carib.	22.9	12.6	10.3	4.5	5.4	1.9	0.0	0.3	0.4	6.7
Middle East & N. Africa	33.3	11.3	22.0	4.7	21.3	0.4	0.0	1.0	0.6	3.4
South Asia	36.2	9.5	26.8	3.0	2.7	0.6	0.9	1.0	0.8	23.9
Sub-Saharan Africa	17.4	11.1	6.3	3.6	11.7	1.5	0.5	0.7	0.4	–5.0
High income	20.6	14.5	6.1	4.6	1.5	0.2	0.0	0.3	0.3	8.5
Euro area	22.3	14.4	7.8	4.6	0.2	0.0	0.0	0.2	0.2	11.9

a. Excludes particulate emissions damage. b. Likely to be overestimated because mineral depletion excludes diamonds. c. World Bank staff estimate.

Toward a broader measure of savings

About the data

Adjusted net savings measure the change in value of a specified set of assets, excluding capital gains. If a country's net savings are positive and the accounting includes a sufficiently broad range of assets, economic theory suggests that the present value of social welfare is increasing. Conversely, persistently negative adjusted net savings indicate that an economy is on an unsustainable path.

The table provides a check on the extent to which today's rents from a number of natural resources and changes in human capital are balanced by net savings, or this generation's bequest to future generations.

Adjusted net savings are derived from standard national accounting measures of gross savings by making four adjustments. First, estimates of capital consumption of produced assets are deducted to obtain net savings. Second, current public expenditures on education are added to net savings (in standard national accounting these expenditures are treated as consumption). Third, estimates of the depletion of a variety of natural resources are deducted to reflect the decline in asset values associated with their extraction and harvest. And fourth, deductions are made for damages from carbon dioxide and particulate emissions.

The exercise treats public education expenditures as an addition to savings. However, because of the wide variability in the effectiveness of public education expenditures, these figures cannot be construed as the value of investments in human capital. A current expenditure of $1 on education does not necessarily yield $1 of human capital. The calculation should also consider private education expenditure, but data are not available for a large number of countries.

While extensive, the accounting of natural resource depletion and pollution costs still has some gaps. Key estimates missing on the resource side include the value of fossil water extracted from aquifers, net depletion of fish stocks, and depletion and degradation of soils. Important pollutants affecting human health and economic assets are excluded because no internationally comparable data are widely available on damage from ground-level ozone or sulfur oxides.

Estimates of resource depletion are based on the "change in real wealth" method described in Hamilton and Ruta (2008), which estimates depletion as the ratio between the total value of the resource and the remaining reserve lifetime. The total value of the resource is the present value of current and future rents from resource extractions. An economic rent represents an excess return to a given factor of production. Natural resources give rise to rents because they are not produced; in contrast, for produced goods and services competitive forces will expand supply until economic profits are driven to zero. For each type of resource and each country, unit resource rents are derived by taking the difference between world prices (to reflect the social opportunity cost of resource extraction) and the average unit extraction or harvest costs (including a "normal" return on capital). Unit rents are then multiplied by the physical quantity extracted or harvested to arrive at total rent. To estimate the value of the resource, rents are assumed to be constant over the life of the resource (the El Serafy approach), and the present value of the rent flow is calculated using a 4 percent social discount rate. For details on the estimation of natural wealth see World Bank (2006a).

A positive net depletion figure for forest resources implies that the harvest rate exceeds the rate of natural growth; this is not the same as deforestation, which represents a change in land use (see *Definitions* for table 3.4). In principle, there should be an addition to savings in countries where growth exceeds harvest, but empirical estimates suggest that most of this net growth is in forested areas that cannot currently be exploited economically. Because the depletion estimates reflect only timber values, they ignore all the external and nontimber benefits associated with standing forests.

Pollution damage from emissions of carbon dioxide is calculated as the marginal social cost per unit multiplied by the increase in the stock of carbon dioxide. The unit damage figure represents the present value of global damage to economic assets and to human welfare over the time the unit of pollution remains in the atmosphere.

Pollution damage from particulate emissions is estimated by valuing the human health effects from exposure to particulate matter pollution in urban areas. The estimates are calculated as willingness to pay to avoid illness and death from cardiopulmonary disease and lung cancer in adults and acute respiratory infections in children that is attributable to particulate emissions.

For a detailed note on methodology, see www.worldbank.org/data.

Definitions

• **Gross savings** are the difference between gross national income and public and private consumption, plus net current transfers. • **Consumption of fixed capital** is the replacement value of capital used up in production. • **Net national savings** are gross savings minus consumption of fixed capital. • **Education expenditure** is public current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment. • **Energy depletion** is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. • **Mineral depletion** is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. • **Net forest depletion** is unit resource rents times the excess of roundwood harvest over natural growth. • **Carbon dioxide damage** is estimated at $20 per ton of carbon (the unit damage in 1995 U.S. dollars) times tons of carbon emitted. • **Particulate emission damage** is the willingness to pay to avoid illness and death attributable to particulate emissions.• **Adjusted net savings** are net savings plus education expenditure minus energy depletion, mineral depletion, net forest depletion, and carbon dioxide and particulate emissions damage.

Data sources

Data on gross savings are from World Bank national accounts data files (see table 4.8). Data on consumption of fixed capital are from the United Nations Statistics Division's *National Accounts Statistics: Main Aggregates and Detailed Tables, 1997,* extrapolated to 2007. Data on education expenditure are from the United Nations Statistics Division's *Statistical Yearbook 1997* and from the United Nations Educational, Scientific, and Cultural Organization Institute for Statistics online database. Missing data are estimated by World Bank staff. Data on energy, mineral, and forest depletion are estimates based on sources and methods in Arundhati Kunte and others' "Estimating National Wealth: Methodology and Results" (1998). Data on carbon dioxide damage are from Samuel Fankhauser's *Valuing Climate Change: The Economics of the Greenhouse* (1995). Data on particulate emission damage are from Kiran D. Pandey and others' "The Human Costs of Air Pollution: New Estimates for Developing Countries" (2006). The conceptual underpinnings of the savings measure appear in Kirk Hamilton and Michael Clemens' "Genuine Savings Rates in Developing Countries" (1999).