Public Disclosure Authorized

Public Disclosure Authorized

30183

THE WORLD BANK

Research Observer

INSIDE

Shaohua Chen and Martin Ravallion on How the World's Poorest Have Fared since the Early 1980s

•

Holger Görg and David Greenaway on Whether Domestic Firms Benefit from Foreign Direct Investment

•

Donald F. Larson, Jock R. Anderson, and Panos Varangis on Managing Risk in Agricultural Markets

•

Sven Wunder and William D. Sunderlin on Oil, Macroeconomics, and Forests

•

Varun Gauri and Ayesha Vawda on Vouchers for Basic Education in Developing Economies

OXFORD UNIVERSITY PRESS

ISSN 0257-3032
www.wbro.oupjournals.org

THE WORLD BANK

Research Observer

EDITOR
Shantayanan Devarajan, World Bank

COEDITORS
Gershon Feder, World Bank
Shahid Yusuf, World Bank

EDITORIAL BOARD
Paul Collier, World Bank
Susan Collins, Georgetown University
Angus Deaton, Princeton University
Barry Eichengreen, University of California–Berkeley
Emmanuel Jimenez, World Bank
Danny M. Leipziger, World Bank
Howard Pack, University of Pennsylvania
Michael Walton, World Bank

The World Bank Research Observer is intended for anyone who has a professional interest in development. *Observer* articles are written to be accessible to nonspecialist readers; contributors examine key issues in development economics, survey the literature and the latest World Bank research, and debate issues of development policy. Articles are reviewed by an editorial board drawn from across the Bank and the international community of economists. Inconsistency with Bank policy is not grounds for rejection.

The journal welcomes editorial comments and responses, which will be considered for publication to the extent that space permits. On occasion the *Observer* considers unsolicited contributions. Any reader interested in preparing such an article is invited to submit a proposal of not more than two pages to the Editor. Please direct all editorial correspondence to the Editor, *The World Bank Research Observer*, 1818 H Street, NW, Washington, DC 20433, USA.

The views and interpretations expressed in this journal are those of the authors and do not necessarily represent the views and policies of the World Bank or of its Executive Directors or the countries they represent. The World Bank does not guarantee the accuracy of data included in this publication and accepts no responsibility whatsoever for any consequences of their use. When maps are used, the boundaries, denominations, and other information do not imply on the part of the World Bank Group any judgment on the legal status of any territory or the endorsement or acceptance of such boundaries.

For more information, please visit the Web sites of the *Research Observer* at www.wbro.oupjournals.org, the World Bank at www.worldbank.org, and Oxford University Press at www.oup.com/us.

THE WORLD BANK

Research Observer

Volume 19 • Number 2 • Fall 2004

How Have the World's Poorest Fared since the Early 1980s? 141
Shaohua Chen and Martin Ravallion

Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment? 171
Holger Görg and David Greenaway

Policies on Managing Risk in Agricultural Markets 199
Donald F. Larson, Jock R. Anderson, and Panos Varangis

Oil, Macroeconomics, and Forests: Assessing the Linkages 231
Sven Wunder and William D. Sunderlin

Vouchers for Basic Education in Developing Economies: An Accountability Perspective 259
Varun Gauri and Ayesha Vawda

Subscriptions
A subscription to *The World Bank Research Observer* (ISSN 0257-3032) comprises 2 issues. Prices include postage; for subscribers outside the Americas, issues are sent air freight.
Annual Subscription Rate (Volume 19, 2 issues, 2004)
Academic libraries
Print edition and site-wide online access: US$98/£67
Print edition only: US$93/£64
Site-wide online access only: US$88/£61
Corporate
Print edition and site-wide online access: US$121/£81
Print edition only: US$115/£77
Site-wide online access only: US$109/£73
Personal
Print edition and individual online access: US$36/£28
Please note: £ Sterling rates apply in Europe. US$ elsewhere.
Readers with mailing addresses in non-OECD countries and in socialist economies in transition are eligible to receive complimentary subscriptions on request by writing to the UK address below.
There may be other subscription rates available; for a complete listing, please visit www.wbro.oupjournals.org/subscriptions.
Full prepayment in the correct currency is required for all orders. Orders are regarded as firm, and payments are not refundable. Subscriptions are accepted and entered on a complete volume basis. Claims cannot be considered more than four months after publication or date of order, whichever is later. All subscriptions in Canada are subject to GST. Subscriptions in the EU may be subject to European VAT. If registered, please supply details to avoid unnecessary charges. For subscriptions that include online versions, a proportion of the subscription price may be subject to UK VAT. Personal rates are applicable only when a subscription is for individual use and are not available if delivery is made to a corporate address.
Back issues: The current year and two previous years' issues are available from Oxford University Press. Previous volumes can be obtained from the Periodicals Service Company, 11 Main Street, Germantown, NY 12526, USA. E-mail: psc@periodicals.com. Tel: (518) 537-4700. Fax: (518) 537-5899.
Contact information: Journals Customer Service Department, Oxford University Press, Great Clarendon Street, Oxford OX2 6DP, UK. E-mail: jnls.cust.serv@oupjournals.org. Tel: +44 (0)1865 353907. Fax: +44 (0)1865 353485.
In the Americas, please contact: Journals Customer Service Department, Oxford University Press, 2001 Evans Road, Cary, NC 27513, USA. E-mail: jnlorders@oupjournals.org. Tel: (800) 852-7323 (toll-free in USA/Canada) or (919) 677-0977. Fax: (919) 677-1714. **In Japan, please contact:** Journals Customer Service Department, Oxford University Press, 1-1-17-5F, Mukogaoka, Bunkyo-ku, Tokyo, 113-0023, Japan. E-mail: okudaoup@po.iijnet.or.jp. Tel: (03) 3813 1461. Fax: (03) 3818 1522.
Postal information: *The World Bank Research Observer* (ISSN 0257-3032) is published by Oxford University Press for the International Bank for Reconstruction and Development/THE WORLD BANK. Send address changes to *The World Bank Research Observer*, Journals Customer Service Department, Oxford University Press, 2001 Evans Road, Cary, NC 27513-2009. Communications regarding original articles and editorial management should be addressed to The Editor, *The World Bank Research Observer*, The World Bank, 1818 H Street, NW, Washington, D.C. 20433, USA.
Permissions: For information on how to request permissions to reproduce articles or information from this journal, please visit www.oupjournals.org/permissions.
Advertising: Inquiries about advertising should be sent to Helen Pearson, Oxford Journals Advertising, PO Box 347, Abingdon OX14 1GJ, UK. E-mail: helen@oxfordads.com. Tel/Fax: +44 (0)1235 201904.
Disclaimer: Statements of fact and opinion in the articles in *The World Bank Research Observer* are those of the respective authors and contributors and not of the International Bank for Reconstruction and Development/THE WORLD BANK or Oxford University Press. Neither Oxford University Press nor the International Bank for Reconstruction and Development/THE WORLD BANK make any representation, express or implied, in respect of the accuracy of the material in this journal and cannot accept any legal responsibility or liability for any errors or omissions that may be made. The reader should make her or his own evaluation as to the appropriateness or otherwise of any experimental technique described.
Paper used: *The World Bank Research Observer* is printed on acid-free paper that meets the minimum requirements of ANSI Standard Z39.48-1984 (Permanence of Paper).
Indexing and abstracting: *The World Bank Research Observer* is indexed and/or abstracted by ABI/INFORM, CAB *Abstracts, Current Contents/Social and Behavioral Sciences, Journal of Economic Literature/EconLit, PAIS International, RePEc (Research in Economic Papers), Social Services Citation Index*, and *Wilson Business Abstracts*.

Copyright © The International Bank for Reconstruction and Development/THE WORLD BANK 2004
All rights reserved; no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without prior written permission of the publisher or a license permitting restricted copying issued in the UK by the Copyright Licensing Agency Ltd, 90 Tottenham Court Road, London W1P 9HE, or in the USA by the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

How Have the World's Poorest Fared since the Early 1980s?

Shaohua Chen • Martin Ravallion

A new assessment is made of the developing world's progress against poverty. By the frugal $1 a day standard there were 1.1 billion poor people in 2001—almost 400 million fewer than 20 years earlier. During that period the number of poor people declined by more than 400 million in China, though half the decline was in the early 1980s and the number outside China rose slightly. At the same time the number of people in the world living on less than $2 a day rose, so that there has been a marked bunching up of people living between $1 and $2 a day. Sub-Saharan Africa has become the region with the highest incidence of extreme poverty and the greatest depth of poverty. If these trends continue, the 1990 aggregate $1 a day poverty rate will be halved by 2015, meeting the Millennium Development Goal, though only East and South Asia will reach this goal.

A cloud of doubt hangs over our knowledge about the extent of the world's progress against poverty. A widely cited World Bank (2002) estimate is that there were 200 million fewer poor people in the world in 1998 than in 1980. This figure has been contested and for good reasons. Deaton (2002b) contrasts this seemingly optimistic assessment with the estimate in *World Development Report 2000/2001: Attacking Poverty* (World Bank 2000), which appeared to show little or no progress. Deaton argues that the claim in World Bank (2002) was based on methodologically inconsistent estimates from two studies—Bourguignon and Morisson (2002) (up to 1992) and Chen and Ravallion (2000) (beyond that).[1] With reference to the relevant chart in World Bank (2002) Deaton writes:

> The historical data in this chart were assembled by François Bourguignon and Christian Morrisson.... They derive their estimates by applying (sometimes sketchy and outdated) distributional information to the consumption figures from national accounts data, a technique that is almost certainly the

The World Bank Research Observer, vol. 19, no. 2,
© The International Bank for Reconstruction and Development / THE WORLD BANK 2004; all rights reserved.
doi:10.1093/wbro/lkh020 19:141–169

> only methodology that would allow the construction of data for a century and a half.... After 1993, when the Bourguignon and Morrisson data end, *Globalization* [World Bank 2002] uses the poverty estimates that were assembled by Shaohua Chen and Martin Ravallion.... But Chen and Ravallion's data from 1987 to 1993, which is when poverty increased, are dropped from the chart. In consequence, and without any new information, we go from an assessment that the number of poor people in the world was showing little or no decline from 1987 to 1998 in *Attacking Poverty* to an assessment, in *Globalization*, of a continuous and accelerating decline from 1980 to 1998. (see www.imf.org/external/pubs/ft/fandd/2002/06/deaton.htm)

These concerns are too important to ignore. The splicing of these different data sources is questionable. The only solution is to construct a new, internally consistent series over the 1980s and 1990s.

This article offers a new assessment of progress in reducing poverty over 1981–2001 using more consistent data and methods—closely following the methods underlying the *Attacking Poverty* (World Bank 2000) numbers, which had been based on Chen and Ravallion (2000). In common with our past estimates, we draw on nationally representative surveys as much as possible. The article reviews our methods of measuring poverty from those surveys and notes any changes from past estimates, though we refer readers to other sources for further discussion of our methods and alternatives.[2] The new estimates presented here supersede all our previous estimates in that we recalculate everything back in time on a consistent basis incorporating the new data.[3]

We summarize our results in a standard regional tabulation following previous work. However, we have also created a Web-based interactive tool, PovcalNet, that allows users to access the primary distributions and so estimate poverty measures for alternative country groupings or for a selected set of individual countries (http://iresearch.worldbank.org/povcalnet).

A notable feature of these new estimates is that they go back to the early 1980s, allowing an assessment of the validity of the poverty reduction claim in World Bank (2002). We have previously resisted going back this far because of concerns about the coverage and quality of the survey data available for the early 1980s. Our efforts to expand coverage have helped allay our fears about reliability of the data from this time period. However, it is clear that our estimates for the first year in our series, 1981, are not as reliable as those in the rest of the series.

The new estimates suggest that the World Bank (2002) figure of 200 million fewer poor people is probably an underestimate. Indeed, our best estimates suggest that the figure is almost twice that number. That is good news. However, closer inspection of the data leaves little room for complacency about the world's progress

against poverty. Indeed, the picture that emerges is one of highly uneven progress, with serious setbacks in some regions and time periods. The number of people living on less than $2 a day has risen.

It should not be forgotten that there are limitations to our measures. There are continuing concerns about aspects of the underlying data, including the purchasing power parity (PPP) exchange rates, the accuracy and comparability of the surveys used, and intrinsic limitations of the welfare measures based on those surveys. Potentially important examples of the limitations of the welfare measures is that our definition of poverty does not directly reflect inequality within households or access to public goods.

The article first describes the coverage of the survey data. It then discusses the poverty line and exchange rates, followed by the measures of poverty, and then presents the main results.

Coverage of the Household Surveys

This is our first attempt to estimate global poverty measures back to the early 1980s. Our previous estimates started in 1987 (Chen and Ravallion 2000, 2001). In retrospect, starting the series in 1987 was an unfortunate choice, because the late 1980s and early 1990s were a difficult time for the world's poor, given sharply lower growth in both China and India. Going back further in time should give a clearer idea of the long-term trend.

We draw on 454 surveys covering 97 countries representing 93 percent of the population of all low- and middle-income countries (Part 2 member countries of the World Bank). Taking the most recent survey for each country, about 1.1 million households were interviewed. The surveys were mostly done by government statistics offices as part of their routine operations.

The poverty measures are estimated from the survey data. No secondary sources are used for measuring poverty at each survey round (unlike all other compilations of distributional data and global poverty measures that we know of), although other data sources are used for interpolation, given that the surveys of different countries do not coincide in time. Households are ranked by consumption or income per person. The distributions are weighted by household size and sample expansion factors, so that a given fractile (such as the poorest decile) has the same share of the country-specific population across the sample. Thus the poverty counts give the number of people living in households with per capita consumption or income below the poverty line. The data come in various forms, ranging from micro data to specially designed grouped tabulations from the raw data constructed following our guidelines. Datt and Ravallion (1992) and Chen and others (1994) describe our estimation methods for grouped data.

As in previous work we try to eliminate obvious comparability problems, either by reestimating the consumption or income aggregates or by dropping a survey. However, there are problems that we cannot deal with. Differences in survey methods (such as in questionnaire design) can create nonnegligible differences in the estimates for consumption or income. For example, although one-week recall for food consumption is common in surveys, some countries use a longer period, which is likely to give a lower estimate of consumption and hence higher measured poverty. An unusual case is China, in which households are surveyed frequently throughout the year, allowing an estimate of annual income, whereas other countries typically use recall data for a month or less, obtained from one or just a few interviews; there is evidence that China's practice yields lower inequality measures (Gibson and others 2001).

A specific data problem that has received attention in the recent literature concerns the 55th round of India's National Sample Survey (NSS) for 1999/2000, which has created a potentially serious comparability problem with previous NSS rounds (see Datt and Ravallion 2002; Deaton 2002a, 2003). For greater comparability with previous NSS rounds, we use Deaton's (2003) adjusted distributions. The official distributions from the 55th round give a lower poverty rate in 1999/2000 (32.3 percent below $1 a day compared with 34.8 percent using Deaton's corrections). (The distributions are, of course, the same in the previous large sample survey, for which we obtain a $1 a day poverty rate of 41.9 percent.) However, Deaton's correction requires an unchanging probability of being poor conditional on consumption of the goods that appear to have been unaffected by the change in survey design. Changes in relative prices can cast doubt on this assumption (Datt and Ravallion 2002; Sen and Himanshu 2003).

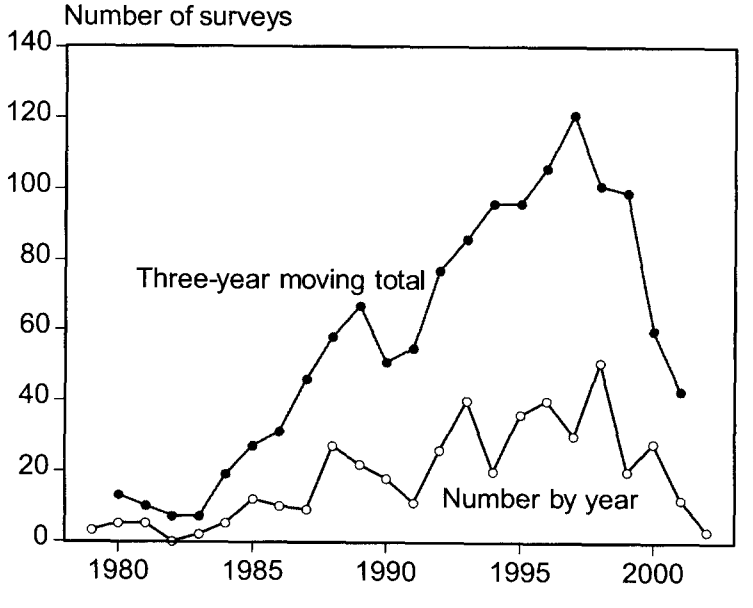
Possibly, Deaton's method overestimates the decline in poverty in India between the 55th and previous rounds. An alternative approach to comparing the surveys for 1999/2000 with the previous large sample survey of 1993 has been proposed by Sundaram and Tendulkar (2003). It entails comparing estimates over time based on a mixed recall period instead of the uniform recall period used by the official data and by Deaton (2003). The comparison is possible only between these two surveys. With the Sundaram and Tendulkar distributions, the $1 a day poverty rate for India falls from 38.7 percent in 1993 to 32.3 percent in 1999/2000—a 6.4-percentage-point drop rather than our 7.1-percentage-point drop estimate using the Deaton-adjusted distributions.

Appendix table A.1 lists the surveys used, their dates, and whether consumption or income data are used. Population coverage varies greatly by region, ranging from 74 percent of the population of the Middle East and North Africa to 98 percent of the population of South Asia. Not all available surveys are included. Surveys are excluded if essential data are missing (such as for the PPP exchange rates or consumer price indices used to update poverty lines over time) or if there are serious comparability problems with the rest of the data set.

Naturally, the further back one goes, the fewer the number of surveys. Coverage deteriorates in the last year or two of the series, given the lags in survey processing. A simple but useful guide to the reliability of our estimates is to count the number of surveys by year and to compare the number with the three-year moving total centered on each year—given that having a survey last year or next year can help greatly in estimating poverty this year (figure 1). By this measure, our estimates are the most reliable for the mid- to late 1990s and the least reliable for 1981. We have only 15 surveys up to 1983, though the number rises sharply to 32 surveys for the period up to 1985. By contrast, we have 86 surveys during 1986–90.

Most regions are still quite well covered, from at least the second half of the 1980s (East and South Asia being well covered from 1981 onward). Two exceptions stand out. Unsurprisingly, country coverage in Eastern Europe and Central Asia is weak for the 1980s, when most of these countries did not officially exist. More worrying is the lack of coverage for Sub-Saharan Africa in the 1980s. The estimates for the early 1980s rely heavily on projections based on distributions for the late 1980s, as a list of the average survey year by region for each reference year

Figure 1. Number of National Household Surveys by Year, 1979–2002



Source: National household surveys.

shows (table 1). Although survey coverage for Africa has improved considerably over our previous estimates (Chen and Ravallion 2001), the weakness of the coverage of Africa should be kept in mind when interpreting our results.

Even in regions with seemingly good survey coverage in the 1980s, there are questions about some of the data. The other side of the coin of improved household survey data for developing countries in the 1990s is the much weaker survey data in the 1980s. Consider China, the country with the largest population. The National Bureau of Statistics (NBS) has provided us with income distributions for China from surveys done in 1980 (rural areas) and 1981 (urban). However, the NBS was only beginning to resume doing national household surveys at that time (it had ceased doing surveys during the Cultural Revolution, 1966–76) and it can be conjectured that these early efforts were not as good (Chen and Ravallion 1996). The early NBS surveys (prior to 1985) did not include 30 percent of provinces. However, this does not appear to be a source of bias because the provincial coverage was uncorrelated with poverty; we could convincingly reject the null hypothesis that the first available estimates of all our poverty measures were the same for provinces omitted as for those included (Ravallion and Chen 2004). The sample sizes for these early surveys are also smaller than the other NBS surveys for China that we use, though the sample sizes are still adequate. For the 1980 survey in rural areas, 16,000 randomly sampled households were interviewed, and for the 1981 urban sample, about 9,000. By contrast, from 1985 onward the sample sizes were about 70,000 in rural areas and 30,000 in urban areas.

Table 1. Average Date of the Surveys Used for Each Reference Year, 1981–2001

Region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
East Asia	1981.5	1984.6	1987.4	1990.4	1992.5	1996.1	1999.1	2000.4
Eastern Europe and Central Asia	1988.2	1988.1	1988.3	1989.6	1993.6	1995.7	1998.9	1999.7
Latin America and the Caribbean	1983.2	1984.7	1986.6	1990.4	1992.5	1996.1	1998.1	2000.1
Middle East and North Africa	1987.1	1987.8	1988.1	1990.0	1993.0	1996.0	1998.0	1998.2
South Asia	1980.9	1983.9	1987.2	1989.7	1993.0	1995.9	1999.0	1999.4
Sub-Saharan Africa	1988.6	1988.3	1989.6	1990.2	1993.0	1995.1	1996.6	1997.0
Total	**1982.8**	**1985.3**	**1987.7**	**1990.2**	**1992.8**	**1995.9**	**1998.5**	**1999.4**

Note: Population-weighted mean for all the surveys that were used to estimate the poverty measures for each reference year.

Source: National household surveys.

Exchange Rates and Poverty Lines

We use the same PPP estimates for consumption as Chen and Ravallion (2001), which were produced by the World Bank's Data Group (data sources and methods are described in Ahmad 2003). For 69 of the sample 97 countries, the PPPs are based on price and consumption basket data collected by the 1993 International Comparison Project (ICP). For almost all countries that did not participate in the 1993 ICP, the bank's PPPs are based on interpolations from the cross-country regressions described in Ahmad (2003). Two exceptions are China and India, for which the bank's PPPs are based on other sources—India's on an update of the country's 1985 PPP and China's on a credible independent study of prices levels in 10 cities (Ahmad 2003). As in Chen and Ravallion (2000), the Penn World Tables are used in preference to the World Bank's PPPs for five countries (Ghana, Mauritania, Nicaragua, the Philippines, and Uganda) for which the bank's PPPs give poverty rates that are implausibly low, whereas the PPPs for 1993 from the Penn World Tables (version 5.6) give more believable estimates.[4]

The international poverty line in our work prior to Chen and Ravallion (2001) was set at $1 a day at 1985 PPP (more precisely, at $31 a month or $1.02 a day; see Ravallion and others 1991). The original $1 a day poverty line was chosen as being representative of the poverty lines typical of low-income countries (Ravallion and others 1991). The same principle was applied by Chen and Ravallion (2001) in updating the poverty line using the new PPPs for 1993.

But the 1985 PPPs based on Penn World Tables are not comparable with the World Bank's PPPs at base 1993, either in primary data or method used. So one cannot update the poverty line simply by adjusting for inflation in the United States between 1985 and 1993. Indeed, that gives a poverty line that is well above those typical of low-income countries (Chen and Ravallion 2001).[5] To be consistent with the original aim of using a poverty line that is representative of the lines actually found in poor countries, we recalculate the dollar value of the original set of poverty lines using the new PPPs and compare this with mean consumption, also calculated by the new PPPs. Following Chen and Ravallion (2001), the resulting poverty line is $1.08 a day ($32.74 per month) in 1993 PPP prices. This is the median of the 10 lowest poverty lines in the set of countries used by Ravallion and others (1991). This is the main poverty line focused on here and is referred to as the "$1 a day" line or "extreme poverty."

However, the poverty rate on this basis must be deemed a conservative estimate, because aggregate poverty in the developing world is defined by perceptions of poverty rates in the poorest countries. (Not a new observation, this was argued explicitly in World Bank 1990 and Ravallion and others 1991.) Thus two broader definitions are also considered. In one the poor include all those who would be judged poor by standards more typical of middle-income countries. For this purpose the poverty line is set at twice the $1 a day line.

The second definition allows for "relative poverty." Chen and Ravallion (2001) proposed an operational approach for measuring relative poverty, building on Atkinson and Bourguignon (1999). By this measure of relative poverty people are deemed poor if they do not attain either the $1 a day consumption level (loosely interpretable as "physical needs") or a given proportion of mean consumption ("social needs"). The constant of proportionality was set at one-third, which gave the best fit to the data on poverty lines for developed and developing economies used in setting the $1.08 poverty line (Chen and Ravallion 2001). We fix the real value of the relative poverty line over time for each country. So these poverty lines are relative between countries but absolute over time. (Chen and Ravallion 2001 discuss this choice further.) Making the poverty lines relative over time would mean that for countries with mean consumption of greater than $3.23 a day the poverty measures will be independent of the absolute levels of consumption (and depend solely on the percentile of the population for which the Lorenz curve has a slope of 1/3).

Measuring Poverty from the Surveys

Three poverty measures are computed. The first measure is the *headcount index*, given by the percentage of the population living in households with consumption or income per person below the poverty line. This is the easiest measure to interpret, but it has the well-known deficiency that it says nothing about differences in the depth of poverty below the line. A second measure, the *number of poor people*, is obtained by applying the estimated headcount index to the population of each region (under the assumption that countries without surveys have the same headcount index on average as those with surveys). A third measure, the *poverty gap index*, gives mean distance below the poverty line as a proportion of the poverty line (where the mean is taken over the whole population, counting the nonpoor as having zero poverty gap). PovcalNet also gives estimates of the squared poverty gap, in which individual poverty gaps are weighted by the gaps themselves, to reflect inequality among the poor (Foster and others 1984).

In keeping with our previous work, we aim to measure poverty in terms of household consumption expenditure per capita. Of the 454 surveys used, 247 allow us to estimate the distribution of consumption expenditures; this is true of all the surveys used in the Middle East and North Africa, South Asia, and Sub-Saharan Africa. Whenever there is a choice consumption data are preferred to income data, because consumption is likely to be the better measure of current welfare. About one-quarter of the cases without consumption distributions do have survey-based estimates of mean consumption. For those cases the income mean is replaced by the consumption mean, leaving the Lorenz curve the same (all incomes are scaled up by the ratio of the consumption mean to the income mean). There is, however, no obvious basis

for adjusting the Lorenz curve; one expects higher inequality in an income distribution than in a consumption distribution for the same place and data.

Our previous estimates for China (Chen and Ravallion 2001) relied on income Lorenz curves, but we used the survey means for household consumption expenditure per capita supplied by the NBS. For this update we obtained complete consumption distributions from the NBS back to 1990. To maintain consistency with our methods for other countries, we switch to consumption (for both the distribution and the mean) from 1990 onward, though we have no choice but to keep our old method for the 1980s. This raises a concern about comparability between our estimates for China for the 1990s and for the 1980s. To assess whether this is a problem, we also calculate our estimates for the 1990s using the old method. The two sets of estimates for the 1990s match up quite closely (table 2), so the comparisons over time do not appear to be of concern. Ravallion and Chen (2004) discuss this and other issues concerning China's poverty and inequality data in greater detail.

One important difference with Chen and Ravallion (2001) is that when only an income distribution is available, we do not follow our past practice of rescaling mean income by one minus the national savings rate. This practice was questioned by Deaton (2002a), and in Chen and Ravallion (2001) we noted the implications of

Table 2. Poverty Headcount Estimates for China by Old and New Methods, 1990–2001

		Headcount index (%)	
Year	*Poverty line (1993 PPP$)*	*Old method: income distribution with adjustment to the mean (%)*	*New method: consumption distribution with consumption mean (%)*
1981	1.08	63.76	
	2.15	88.12	
1984	1.08	40.99	
	2.15	78.49	
1987	1.08	28.45	
	2.15	67.41	
1990	1.08	31.53	33.01
	2.15	69.93	72.64
1993	1.08	29.46	28.36
	2.15	64.59	68.13
1996	1.08	16.91	17.38
	2.15	50.63	53.36
1999	1.08	16.42	17.77
	2.15	47.19	50.05
2001	1.08	16.51	16.64
	2.15	44.45	46.67

Source: Authors' calculations based on China's national household surveys.

dropping this rescaling. Since then we have assembled surveys for 27 countries for which we have both consumption and income distributions, to test this assumption in our past work by calculating the poverty measures using both consumption and income for the same country. There is only a small and statistically insignificant difference between the two sets of estimates: Consumption has a lower mean but also lower inequality, with the effect that poverty measures are quite close. For the $1 a day line the mean headcount index is 17.8 percent for consumption and 21.2 percent for income; the difference is not statistically significant ($t=0.73$; $n=27$). For the $2 a day line the mean headcount index is slightly higher for consumption (48.2 percent) than for income (44.8 percent) but, again the difference is not statistically significant ($t=0.49$). So we abandon our past practice of rescaling the mean for income surveys. The main implication is that our poverty measures for Latin America (where income surveys are more common than elsewhere) drop a few percentage points.

Having converted the international poverty line at PPP to local currency in 1993, we convert it to the prices prevailing at each survey date using the country-specific official consumer price index (CPI).[6] The weights in this index may or may not accord well with consumer budget shares at the poverty line. In periods of relative price shifts, this will bias our comparisons of the incidence of poverty over time, depending on the extent of utility-compensated substitution possibilities for people at the poverty line.

To estimate regional poverty at a given reference year (say, 1998) we "line up" the surveys in time using the same method as in our past work. We start the series in 1981 and make estimates at three yearly intervals, except for 2002, when there were too few surveys, so we estimate for 2001 instead. We thus make estimates for 1981, 1984, 1987, 1990, 1993, 1996, 1999, and 2001. These are called reference years, as distinct from survey years, which are spread over the interval 1979–2002 (see figure 1).

For the 97 countries, 9 have only one survey, 19 have two surveys, and 69 have three or more surveys over the period. If there is only one survey for a country, measures for each reference year are estimated by applying the growth rate in real private consumption per person from the national accounts to the survey mean—assuming that the Lorenz curve for that country does not change.[7] This seems the best option for dealing with this problem, though there can be no guarantee that the Lorenz curve would not have shifted or that a survey-based measure of consumption would have grown at the same rate as private consumption in the national accounts. For example, growth of private consumption in the national accounts might reflect growth in spending by nonprofit organizations—which are not separated from households in the national accounts for most developing economies—rather than growth in household spending (Ravallion 2003b).

When the reference date (say, 1993) is between two surveys (say, 1989 and 1995), one option is simply to interpolate between the two surveys. However, this could be problematic when there is a long time period between surveys, and it ignores the extra information available from the national accounts data. To bring the national accounts information into the picture, mean consumption is first estimated at the reference year using the national accounts growth rate between the survey year and the reference year. For the example here there are two means at the reference year based on two surveys, M93(89) and M93(95), where M93(t) is the estimated mean for 1993 using the survey for year t. Using the 1989 distribution and M93(89) yields headcount index H93(89). Similarly, using the 1995 distribution and the 1993 mean yields H93(95). Then the poverty headcount for 1993 is estimated as the weighted average of H93(89) and H93(95).[8]

Results

Estimates of the headcount indices for $1.08 at 1993 PPP for 1981–2001 show that the percentage of the population of the developing world living below $1 a day was almost halved over 1981–2001, falling from 40 percent to 21 percent (table 3). Expressed as a proportion of world population, the decline is from 33 percent to 18 percent. This assumes that nobody in developed areas lives below $1 a day.) The number of poor people fell by 390 million, from 1.5 billion in 1981 to 1.1 billion in 2001 (table 4).

There was clearly more progress in some periods than in others. As already noted, the late 1980s and early 1990s were a difficult period for the world's poor, with low growth in both China and India. Once growth was restored, the rate of poverty reduction by the $1 a day standard in the 1990s had returned to its long-term trend. The percentage below $1 a day fell from 28 percent to 21 percent over 1990–2001, about the same trend decline (in percentage points per year) as for 1984–2001 as a whole. The number of poor people fell by about 130 million in 1990s. The poverty measures for $2 a day follow a broadly similar pattern, though with a less dramatic decline in the early 1980s and even stronger signs of stagnation in the period around 1990 (see tables 3 and 4).

The new estimates suggest less progress in getting over the $2 a day line. By this higher standard the poverty rate has fallen from 67 percent in 1981 to 53 percent in 2001 (see table 3). This has not been sufficient to prevent a rise in the number of people living below $2 a day, from 2.4 billion to 2.7 billion (see table 4). Thus the number of people living between $1 and $2 has risen sharply over these two decades, from about 1 billion to 1.6 billion. This marked bunching up of people just above the $1 line suggests that a great many people in the world remain vulnerable to aggregate economic slowdowns.

Table 3. Headcount Indices of Poverty by Region for Two International Poverty Lines, 1981–2001 (%)

Poverty line and region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
$1.08 a day (1993 PPP)								
East Asia	57.7	38.9	28.0	29.6	24.9	16.6	15.7	14.9
China	63.8	41.0	28.5	33.0	28.4	17.4	17.8	16.6
East Asia excluding China	42.0	33.5	27.0	21.1	16.7	14.7	11.0	10.8
Eastern Europe and Central Asia	0.7	0.5	0.4	0.5	3.7	4.3	6.3	3.6
Latin America and Caribbean	9.7	11.8	10.9	11.3	11.3	10.7	10.5	9.5
Middle East and North Africa	5.1	3.8	3.2	2.3	1.6	2.0	2.6	2.4
South Asia	51.5	46.8	45.0	41.3	40.1	36.6	32.2	31.3
India	54.4	49.8	46.3	42.1	42.3	42.2	35.3	34.7
South Asia excluding India	42.2	37.0	41.0	38.7	33.1	19.7	22.9	21.0
Sub-Saharan Africa	41.6	46.3	46.8	44.6	44.1	45.6	45.7	46.4
Total	40.4	32.8	28.4	27.9	26.3	22.8	21.8	21.1
Total excluding China	31.7	29.8	28.4	26.1	25.6	24.6	23.1	22.5
$2.15 a day (1993 PPP)								
East Asia	84.8	76.6	67.7	69.9	64.8	53.3	50.3	47.4
China	88.1	78.5	67.4	72.6	68.1	53.4	50.1	46.7
East Asia excluding China	76.2	72.0	68.4	63.2	56.7	53.2	50.8	49.2
Eastern Europe and Central Asia	4.7	4.1	3.2	4.9	17.3	20.7	23.8	19.7
Latin America and Caribbean	26.9	30.4	27.8	28.4	29.5	24.1	25.1	24.5
Middle East and North Africa	28.9	25.2	24.2	21.4	20.2	22.3	24.3	23.2
South Asia	89.1	87.2	86.7	85.5	84.5	81.7	78.1	77.2
India	89.6	88.2	87.3	86.1	85.7	85.2	80.6	79.9
South Asia excluding India	87.3	84.0	85.0	83.5	81.0	71.3	70.5	69.0
Sub-Saharan Africa	73.3	76.1	76.1	75.0	74.6	75.1	76.0	76.6
Total	66.7	63.7	60.1	60.8	60.2	55.5	54.4	52.9
Total excluding China	58.8	58.4	57.5	56.6	57.4	56.3	55.8	54.9

Source: Authors' calculations based on national household survey data.

Regional Differences

Performance in poverty reduction has been far from uniform across regions. Indeed, there have been notable changes in regional poverty rankings over this period. In 1981 East Asia had the highest incidence of extreme poverty in the world, with 58 percent of the population living below $1 a day. Next was South Asia, followed by Sub-Saharan Africa, Latin America, Middle East and North Africa, and Eastern Europe and Central Asia. Twenty years later, Sub-Saharan Africa had swapped places with East Asia, where the headcount index had fallen to 15 percent. South Asia remained in second place, but Eastern Europe and Central Asia had overtaken the Middle East and North Africa. The ordering of regions is not, however, robust to the choice of poverty line. At the $2 a day poverty line South Asia edges out East

Table 4. Number of Poor People by Region for Two International Poverty Lines, 1981–2001 (millions)

Poverty line and region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
$1.08 a day (1993 PPP)								
East Asia	795.6	562.2	425.6	472.2	415.4	286.7	281.7	271.3
China	633.7	425.0	308.4	374.8	334.2	211.6	222.8	211.6
Eastern Europe and Central Asia	3.1	2.4	1.7	2.3	17.5	20.1	30.1	17.0
Latin America and Caribbean	35.6	46.0	45.1	49.3	52.0	52.2	53.6	49.8
Middle East and North Africa	9.1	7.6	6.9	5.5	4.0	5.5	7.7	7.1
South Asia	474.8	460.3	473.3	462.3	476.2	461.3	428.5	431.1
India	382.4	373.5	369.8	357.4	380.0	399.5	352.4	358.6
Sub-Saharan Africa	163.6	198.3	218.6	226.8	242.3	271.4	294.3	312.7
Total	1,481.8	1,276.8	1,171.2	1,218.5	1,207.5	1,097.2	1,095.7	1,089.0
$2.15 a day (1993 PPP)								
East Asia	1169.8	1108.6	1028.3	1116.3	1079.3	922.2	899.6	864.3
China	875.8	813.8	730.8	824.6	802.9	649.6	627.5	593.6
Eastern Europe and Central Asia	20.2	18.3	14.7	22.9	81.3	97.8	113.0	93.3
Latin America and Caribbean	98.9	118.9	115.4	124.6	136.1	117.2	127.4	128.2
Middle East and North Africa	51.9	49.8	52.5	50.9	51.8	60.9	70.4	69.8
South Asia	821.1	858.6	911.4	957.5	1004.8	1029.1	1039.0	1063.7
India	630.0	661.4	697.1	731.4	769.5	805.7	804.4	826.0
Sub-Saharan Africa	287.9	326.0	355.2	381.6	410.4	446.8	489.3	516.0
Total	2,450.0	2,480.1	2,477.5	2,653.8	2,763.6	2,674.1	2,738.8	2,735.4

Source: Authors' calculations based on national household survey data.

Asia for the highest headcount index in 1981, and it edges out Africa for the highest headcount index in 2001.

The dramatic progress in East Asia has meant that by 2001 the region had already reached the Millennium Development Goal of halving the 1990 $1 a day poverty rate by 2015. China's progress against absolute poverty was a key factor (given the country's population weight), though the rest of East Asia had the same proportionate decline in poverty over 1981–2001 as did China (see table 3). In 1981 China's incidence of poverty at the $1 a day measure was roughly twice that for the rest of the developing world; by the mid-1990s China's poverty rate had

fallen well below the average. There were 400 million fewer people living under $1 a day in China in 2001 than 20 years earlier, though a staggering half of this decline was in the period 1981–84 (see table 4). This was enormous progress for China's (and the world's) poor people. The most plausible explanation would appear to be China's reforms, starting in the late 1970s, which decollectivized agriculture and, in the "household responsibility system," gave farmers considerably greater control over their land and output choices (Ravallion and Chen 2004 discuss this and other explanations for China's success against absolute poverty). This was a one-off reform, however, suggesting that the sharp drop in global poverty by the $1 a day standard in the early 1980s was also unusual. China experienced a further drop in the poverty count of 120 million between 1993 and 1996, which is generally attributed to the substantial but short-lived increases in 1994 and 1995 in the procurement prices for food grains paid by the government, which greatly reduced the burden on farmers of this form of taxation (World Bank 1997; Ravallion and Chen 2004).

The long-run trend decline in the global $1 a day poverty rate over 1981–2001 is 0.86 percentage point a year (table 5). For 1984–2001, which is more indicative of the overall trend given the unusual large decline in extreme poverty between 1981 and 1984 resulting from China's agrarian transition, the trend is 0.66 percentage point a year.[9] Focusing on the 1990s could also be deceptive, because the early 1990s had relatively high poverty as a result of the stalled growth in China and India.

For the developing world outside China, the headcount index for the $1 a day poverty line fell from 32 percent to 23 percent over 1981–2001. This was not sufficient to prevent an increase in the total number of poor people, which rose from 850 million to 880 million. The decline in the headcount index over time in the developing world excluding China was close to linear (figure 2), with a trend decline of 0.42 percentage point a year (with a standard error of 0.029).

The number of poor people has also fallen in South Asia, from 475 million in 1981 to about 430 million in 2001 (figure 3), and the poverty rate fell from 52 percent to 31 percent. The South Asia series suggests a remarkably robust trend rate of decline in the $1 a day headcount index of 1 percentage point a year (see table 5). (For South Asia a linear trend clearly fits better than an exponential trend.) If maintained, this will be sufficient to reach the Millennium Development Goal for poverty reduction. The critical value needed to reach the goal is −0.83 percentage point a year, which is outside the 95 percent confidence interval (−0.87, −1.09) for the estimate of South Asia's trend rate of poverty reduction.

The extent of bunching up that has occurred between the $1 and $2 a day poverty lines is particularly striking in East and South Asia, where the total number is 1.2 billion, roughly equally split between the two regions. Although this points again to the vulnerability of the poor, it also suggests that substantial further

Table 5. Trend Rates of Change by Region in the Headcount Index for the $1 a Day Poverty Line, 1981–2001 and 1984–2001 (percentage points per year)

Region	*1981–2001*	*1984–2001*	*Critical rate for halving the 1990 headcount index*
East Asia	−1.87*	−1.36*	−0.59
	(0.32)	(0.19)	
China	−1.99*	−1.37*	−0.66
	(0.40)	(0.26)	
Latin America and Caribbean	−0.03	−0.10	−0.23
	(0.04)	(0.03)	
South Asia	−0.98*	−0.95*	−0.83
	(0.05)	(0.05)	
India	−0.91*	−0.83*	−0.84
	(0.10)	(0.12)	
Sub-Saharan Africa	0.12	0.00	−0.89
	(0.09)	(0.08)	
Total	−0.86*	−0.66*	−0.56
	(0.12)	(0.06)	

*Significant at the 1 percent level.

Note: The numbers in parentheses are standard errors. Eastern Europe and Central Asia and the Middle East and North Africa regions are dropped from this table because there were so few people living below the $1 a day poverty line in 1990. Trends were estimated by linear regression on time. All regressions were tested for first-order serial correlation in the errors using the Lagrange multiplier tests. The null hypothesis of serial independence could not be rejected in any case.

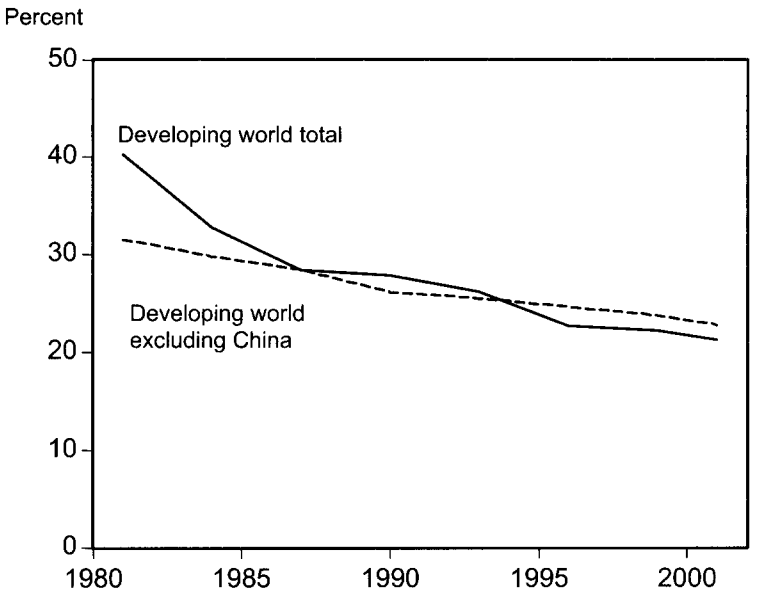
Source: Authors' calculations based on national household survey data.

impacts on poverty can be expected from economic growth, provided that it does not come with higher inequality.

There is less sign of progress against poverty outside Asia. The number of poor people increased in Latin America, where the poverty rate has been roughly constant over time (10 percent for $1 a day and 25 percent for $2 a day, which is closer to the national poverty lines in that region). The Middle East and North Africa region experienced a marked downward trend in the poverty rate during the 1980s, but the rate stabilized in the 1990s at around 2 percent for the $1 a day poverty line and at a little more than 20 percent for the $2 a day line.

Both the incidence of poverty and the number of poor people rose in Eastern Europe and Central Asia in the 1990s compared with the 1980s. Although very few people live below $1 a day in this region, the poverty rate by the $2 a day standard rose from almost 2 percent in 1981 to 20 percent in 2001. However, the paucity of survey data for this region in the 1980s should not be forgotten. Thus the estimates are based heavily on interpolations, which do not allow for any changes in distribution. Distribution was probably better from the point of view of the poor in the

Figure 2. Headcount Indices of Poverty Incidence in the Developing World for the $1 a Day International Poverty Line, with and without China, 1981–2001



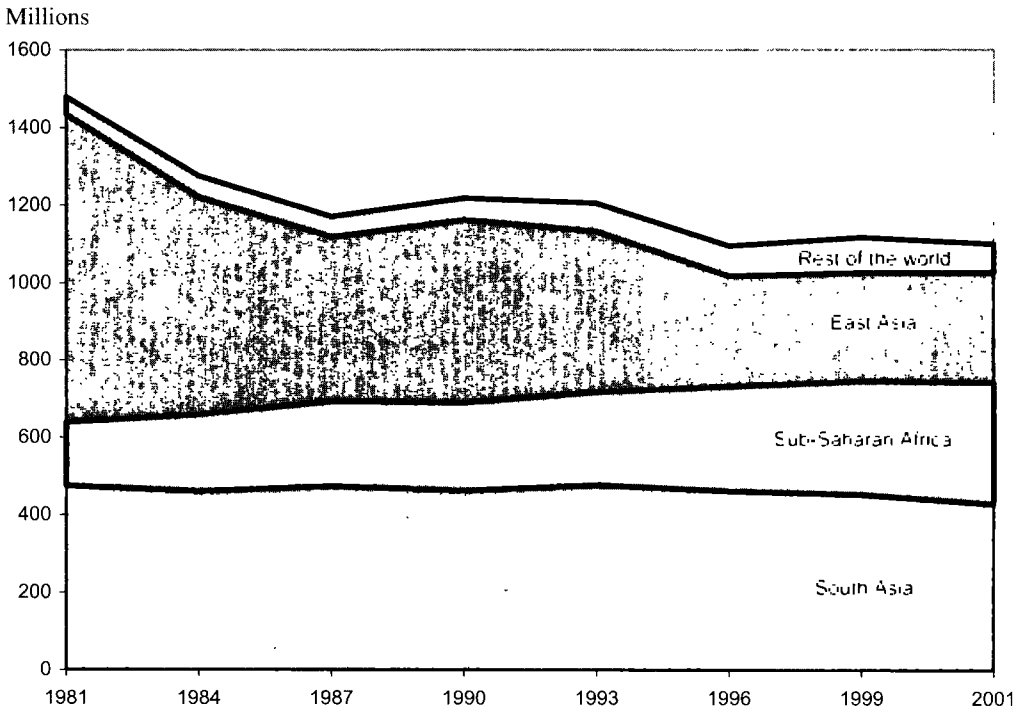
Note: The actual $1 a day poverty line is $1.08 (1993 PPP).
Source: Authors' calculations based on national household survey data.

1980s, in which case poverty would have been even lower than estimated here. There are also some signs of recent progress for the poorest in the region, though it is too early to say if this represents a change in trend.

The incidence of poverty in Sub-Saharan Africa has fluctuated around a mean of 45 percent for the $1 a day line (75 percent for the $2 a day line), with no significant trend in either direction (see table 5). The number of poor people almost doubled over 1981–2001, from 164 million to 316 million. By the $1 a day measure the share of the world's poor living in Africa has risen from 11 percent in 1981 to 29 percent in 2001.

The critical rates of decline in poverty needed to achieve the Millennium Development Goal by 2015 are given in table 5. The actual trend rates of decline in the aggregate $1 a day poverty rate will be sufficient to achieve the Millennium Development Goal if progress is maintained until 2015. However, the variations found over time point to a need for caution. For the full time period studied, the critical trend needed to reach the Millennium Development Goal is just outside the 95 percent confidence interval for the estimated trend, so it can be claimed with

Figure 3. Number of Poor People by Region for the $1 a Day International Poverty Line, 1981–2001



Note: The actual $1 a day poverty line is $1.08 (1993 PPP).
Source: Authors' calculations based on national household survey data.

95 percent confidence that the trend over 1981–2001 exceeds that needed to halve the 1990 headcount index for $1 a day. However, 1981–84 was an unusual subperiod, as we have noted. For the period 1984–2001 the critical trend for the Millennium Development Goal is within the 95 percent confidence interval. For the series starting in 1984, it can only be said with about 90 percent confidence that the aggregate trend exceeds the critical value needed to halve the 1990 poverty rate.

Poverty Gap Indices

The poverty gap index, PG, is related to the headcount index, H, as $PG=(1 - MP)H$, where MP is the ratio of the mean income of the poor to the poverty line. Regional rankings for the poverty gap index (table 6) are the same as those for the headcount index (see table 3), and they follow the same change in patterns over time.

Table 6. Poverty Gap Indices by Region for Two International Poverty Lines, 1981–2001 (%)

Poverty line and region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
$1.08 a day (1993 PPP)								
East Asia	20.58	11.11	7.69	7.65	6.13	3.52	3.57	3.35
China	23.41	11.82	8.17	8.87	7.34	3.82	4.18	3.94
Eastern Europe and Central Asia	0.18	0.14	0.11	0.11	0.84	1.25	1.86	0.75
Latin America and Caribbean	2.75	3.45	3.36	3.57	3.52	2.36	4.03	3.36
Middle East and North Africa	1.00	0.76	0.61	0.49	0.27	0.39	0.53	0.45
South Asia	16.06	13.86	12.35	11.00	10.21	8.97	6.63	6.37
India	17.27	14.99	12.68	11.09	10.86	10.55	7.22	7.08
Sub-Saharan Africa	17.03	19.65	20.10	19.07	19.24	19.80	20.10	20.53
Total	13.92	10.20	8.64	8.23	7.62	6.44	6.20	5.99
$2.15 a day (1993 PPP)								
East Asia	47.20	36.45	29.36	30.55	27.22	19.95	18.94	17.78
China	50.82	37.92	29.67	32.94	29.85	20.33	19.79	18.44
Eastern Europe and Central Asia	1.43	1.16	0.87	1.35	5.49	7.06	8.25	5.87
Latin America and Caribbean	10.66	12.44	11.48	11.81	12.04	9.25	10.97	10.20
Middle East and North Africa	8.81	7.36	6.80	5.69	5.05	5.74	6.54	6.14
South Asia	45.78	43.02	41.86	39.92	38.84	36.52	32.98	32.35
India	47.22	44.68	42.52	40.43	40.10	39.93	34.89	34.43
Sub-Saharan Africa	38.54	41.77	42.14	40.77	40.53	41.24	41.79	41.42
Total	35.02	30.79	27.86	27.80	26.82	23.76	23.05	22.20

Source: Authors' calculations based on national household survey data.

The most striking finding for the regional poverty gap indices is the depth of poverty in Africa, which has a $1 a day poverty gap index of 20 percent compared with 6 percent for the developing world as a whole. Furthermore, the mean income of Africa's poor has been falling over time, dropping from $0.64 per person per day in 1981 to $0.60 in 2001 for the $1 a day poverty line, though remaining roughly constant for the $2 a day line (table 7). In the rest of the world poverty became shallower. The mean income of the poor in the developing world as a whole rose for the $1 a day poverty line from about $0.70 in 1981 to $0.77 in 2001 and even more markedly for the $2 a day line, from $1.02 to $1.25.

The fact that the mean income of the poor is lowest in Africa implies that unless inequality falls sufficiently, it will take more growth in Africa than in other regions

Table 7. Mean Daily Income of the Poor by Region for Two International Poverty Lines, 1981–2001 (1993 PPP$)

Poverty line and region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
$1.08 a day (1993 PPP)								
East Asia	0.69	0.77	0.78	0.80	0.81	0.85	0.83	0.83
China	0.68	0.77	0.77	0.79	0.80	0.84	0.82	0.82
Eastern Europe and Central Asia	0.81	0.80	0.76	0.85	0.83	0.76	0.76	0.91
Latin America and Caribbean	0.77	0.76	0.74	0.73	0.74	0.84	0.66	0.70
Middle East and North Africa	0.86	0.86	0.87	0.85	0.89	0.87	0.86	0.87
South Asia	0.74	0.76	0.78	0.79	0.80	0.81	0.85	0.86
India	0.73	0.75	0.78	0.79	0.80	0.81	0.86	0.86
Sub-Saharan Africa	0.64	0.62	0.61	0.62	0.61	0.61	0.60	0.60
Total	0.70	0.74	0.75	0.76	0.76	0.77	0.77	0.77
$2.15 a day (1993 PPP)								
East Asia	0.95	1.13	1.22	1.21	1.25	1.35	1.34	1.35
China	0.91	1.11	1.21	1.18	1.21	1.33	1.30	1.30
Eastern Europe and Central Asia	1.50	1.55	1.57	1.56	1.47	1.42	1.41	1.51
Latin America and Caribbean	1.30	1.27	1.26	1.26	1.27	1.33	1.21	1.26
Middle East and North Africa	1.50	1.52	1.55	1.58	1.61	1.60	1.57	1.58
South Asia	1.05	1.09	1.11	1.15	1.16	1.19	1.24	1.25
India	1.02	1.06	1.10	1.14	1.15	1.14	1.22	1.23
Sub-Saharan Africa	1.02	0.97	0.96	0.98	0.98	0.97	0.97	0.99
Total	1.02	1.11	1.15	1.17	1.19	1.23	1.24	1.25

Source: Authors' calculations based on national household survey data.

to have the same proportionate impact on the poverty gap. This is borne out by calculations of the elasticities of the poverty gap index to growth in the mean, holding inequality constant (so that all levels of income grow at the same rate). The higher the mean income of the poor, the higher is the absolute elasticity of the poverty gap index to the overall mean. (It is readily verified that when all levels of income grow at the same rate, the elasticity of the poverty gap index to the overall mean is $-MP/[1 - MP]$.) Thus although this elasticity for the $1 a day poverty line in 2001 is −1.3 for Sub-Saharan Africa, it is −1.8 for Latin America and the Caribbean, −3.3 for East Asia (−3.2 for China), −3.7 for Eastern Europe and Central Asia, −3.9 in South Asia, and −4.3 for the Middle East and North Africa (though this is deceptive, because proportionately fewer people live below the $1 a day line; elasticity falls to −2.8 for the $2 a day line). The elasticity is −2.5 for the developing world overall. The elasticity has fallen (in absolute value) over time in Africa, though only slightly (from −1.4 in 1981), while rising in the developing world as a whole (from −1.9 in 1981).

Relative Poverty

The absolute poverty measures examined so far aim to treat the same consumption level the same way no matter what country a person lives in. To see how the results might be affected by making an allowance for relative deprivation, poverty is estimated based on the relative poverty lines described above (table 8 and figure 4).

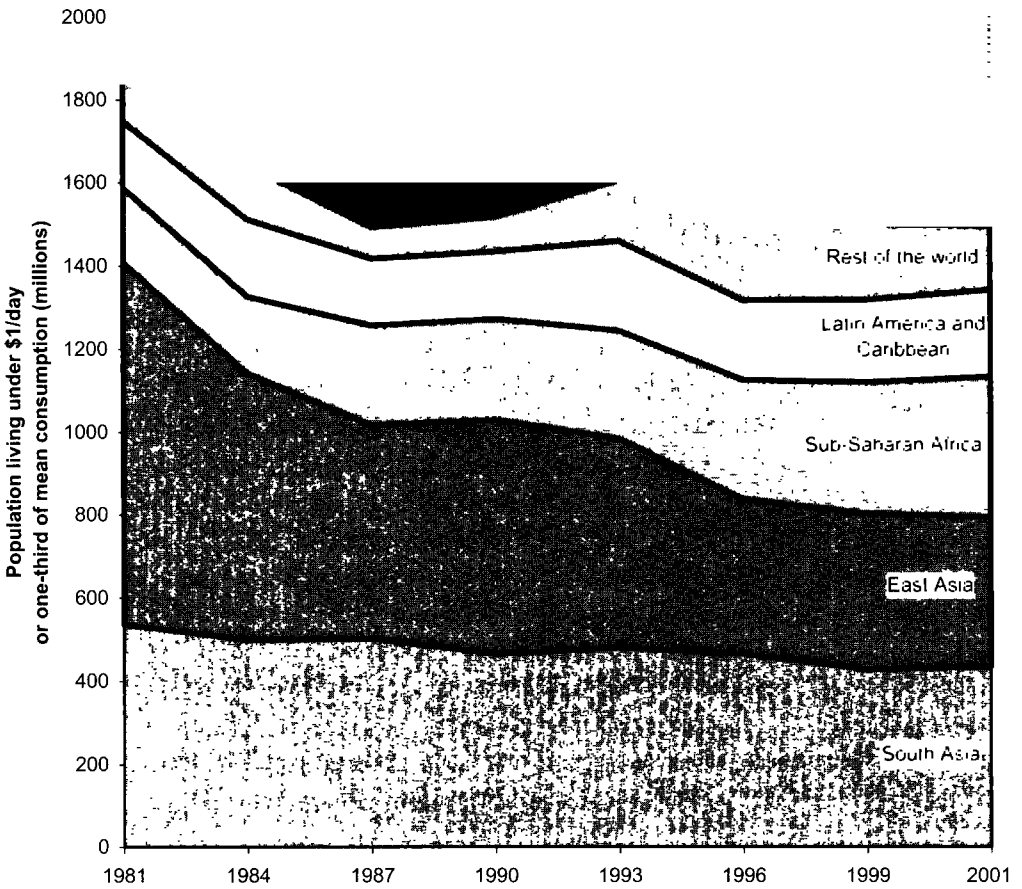
As expected, the incidence of relative poverty is noticeably higher for Eastern Europe and Central Asia, Latin America, and the Middle East and North Africa. By this measure Latin America overtakes South Asia in the early 1990s, making it the second poorest region. And Eastern Europe and Central Asia overtakes East Asia by

Table 8. Relative Poverty Measures by Region, 1981–2001

Region	*1981*	*1984*	*1987*	*1990*	*1993*	*1996*	*1999*	*2001*
Headcount index (%)								
East Asia	63.15	44.45	33.92	35.31	30.17	21.48	20.86	19.69
China	63.76	41.01	28.45	33.01	28.36	17.38	17.77	16.64
Eastern Europe and Central Asia	8.11	7.53	6.41	7.77	22.65	23.17	27.17	21.49
Latin America and Caribbean	40.55	45.37	42.34	43.28	44.97	39.39	38.98	39.77
Middle East and North Africa	37.36	33.40	21.80	19.29	17.58	17.16	18.26	16.91
South Asia	58.17	50.65	47.72	41.45	40.33	36.87	32.09	31.41
India	62.55	54.50	49.43	42.07	42.31	42.25	35.33	34.70
Sub-Saharan Africa	45.93	50.48	51.27	47.61	47.56	48.71	49.66	50.18
Total	50.1	42.0	36.6	35.3	34.9	30.6	29.8	28.8
Number of poor (millions)								
East Asia	871.3	642.9	515.2	563.7	502.6	371.4	373.1	358.8
China	633.7	425.2	308.4	374.8	334.2	211.6	222.8	211.6
Eastern Europe and Central Asia	34.9	33.3	29.2	36.2	106.8	109.6	128.9	102.0
Latin America and Caribbean	149.1	177.6	175.6	189.8	207.8	191.3	198.1	208.3
Middle East and North Africa	67.1	66.1	47.3	45.8	45.0	46.8	52.8	50.8
South Asia	536.2	498.6	501.4	464.5	479.4	464.1	426.9	432.8
India	439.6	408.6	394.8	357.4	380.0	399.5	352.4	358.6
Sub-Saharan Africa	180.5	216.4	239.3	242.2	261.6	290.0	319.5	338.2
Total	1839.2	1634.9	1508.0	1542.1	1603.2	1473.2	1499.4	1490.8

Note: The relative poverty line is $1.08 or one-third of mean consumption, whichever is larger.
Source: Authors' calculations based on national household survey data.

Figure 4. Number of Poor People by Region for a Relative Poverty Line, 1981–2001



Note: The relative poverty line is $1.08 a day or one-third of mean consumption, whichever is larger.
Source: Authors' calculations based on national household survey data.

the mid-1990s. Although there are marked changes in regional rankings, the aggregate trends over time are quite similar. (This is at least in part a consequence of the fact that the relative poverty lines are absolute over time.) The incidence of relative poverty in the developing world as a whole is 29 percent in 2001, down from 50 percent in 1981. By this measure the total number of poor people is 1.5 billion in 2001. The total number of poor people by the relative poverty measure has shown no trend decline since the mid-1980s. Excluding China, the number of relatively poor people has remained at around 1.2 billion, though showing a slight upward trend in the 1990s.

Conclusions

In providing new estimates of the extent of poverty in the developing world over 1981–2001, we have followed previous practice in focusing primarily on an international poverty line that accords with poverty lines typical of the poorest countries. We used a poverty line of about $1 a day, though we also considered a line set at twice this value, as well as a relative poverty line that rises with average consumption when it exceeds about $3 a day. The estimates drew on newly available household surveys, and all past estimates have been revised in the light of the new data. Our estimates appear to be more internally consistent and comparable over time than past estimates, including those of World Bank (2002), which argued that there were 200 million fewer poor at the end of twentieth century than 20 years earlier.

We find that the 200 million figure is an underestimate and that the reduction in the number of poor people in the world was almost twice that size, entailing a near halving of the 1981 poverty rate of 40 percent by 2001.

The precise time period covered is crucial, however. Progress against extreme poverty has been uneven over time. The most dramatic reduction in poverty was in the early 1980s; about half of the 390 million drop in the $1 a day poverty count between 1981 and 2001 occurred in the first three years of that period. This coincided with the sharp drop in extreme poverty in China in the aftermath of the reforms that abandoned the socialist mode of agricultural production in favor of household-based farming. In contrast, during 1987–93 the number of people living on less than $1 a day stayed roughly constant, at around 1.2 billion. There was more progress in the 1990s, once growth had been restored in the most populous countries, China and India. There were 100 million fewer poor people by the $1 a day standard at the end of the 1990s than at the beginning. For assessing overall trends, we argue that the focus should be on the period 1984–2001.

Although the overall picture is good news, it is no cause for complacency. The 390 million fewer poor people by the $1 a day poverty line over 1981–2001 are still poor by the standards of middle-income developing economies and certainly very poor by the standards of what poverty means in rich countries. Our estimates indicate that the number of people living on less than $2 a day has risen. Clearly, a great many people remain poor and vulnerable to aggregate economic slowdowns.

Nor has this aggregate progress for the poorest over the 1980s and 1990s been shared by all regions. The dramatic progress against poverty in the early 1980s owes much to China. If one focuses on the developing world outside China, the number of poor people by the $1 a day standard has changed little—indeed, it has risen slightly.

The composition of world poverty has changed dramatically. The number of poor people has fallen in Asia but risen elsewhere. The share of the world's poor people living in Africa has risen appreciably. Not only has Africa emerged in the 1990s as

the region with the highest incidence of poverty, but the depth of poverty is also markedly higher than in other regions—suggesting that future economic growth will have a harder time reducing poverty in Africa than elsewhere unless inequality falls.

If the trend rate of decline in the incidence of poverty by the $1 a day standard over 1984–2001 is maintained over 2001–15, it will be sufficient to halve the 1990 aggregate headcount index by 2015, consistent with the Millennium Development Goal. However, only one part of the world—East and South Asia—will have reached the goal.

Appendix: Survey Data Sets by Country, Date, and Welfare Indicator

Table A.1. Survey Data Set

Region	*Share of 2001 population represented (%)*	*Country*	*Survey dates*	*Welfare indicator*
East Asia	96.11	Cambodia	1997	Expenditure
		China	1980, 1981, 1984, 1985, 1987, 1990	Income
			1990, 1992, 1993, 1996, 1999, 2001	Expenditure
		Indonesia	1981, 1984, 1987, 1990, 1993, 1996, 1999, 2002	Expenditure
		Lao PDR	1992, 1997	Expenditure
		Malaysia	1984, 1987, 1989, 1992, 1995, 1997	Income
		Mongolia	1995,1998	Expenditure
		Philippines	1985, 1988, 1991, 1994, 1997, 2000	Expenditure
		Thailand	1981, 1988	Income
			1988, 1992, 1996, 1998, 1999, 2000, 2002	Expenditure
		Vietnam	1992/93, 1998	Expenditure
Eastern Europe and Central Asia	97.32	Albania	1997, 2002	Expenditure
		Armenia	1988, 1996	Income
			1996, 1998	Expenditure
		Azerbaijan	1988	Income
			1995, 2001	Expenditure
		Belarus	1988, 1993, 1995, 1998, 1999	Income
			1996–2000	Expenditure

(Continued)

Table A.1. (Continued)

Region	*Share of 2001 population represented (%)*	*Country*	*Survey dates*	*Welfare indicator*
		Bulgaria	1989, 1992, 1994, 1995, 1997, 2001	Expenditure
			1993, 1996	Income
		Croatia	1998, 1999, 2000, 2001	Expenditure
			1988, 1998	Income
		Czech Republic	1988, 1993, 1996	Income
		Estonia	1988, 1993, 1995, 1998	Income
		Georgia	1989, 1996, 1997	Income
			1996, 1998–2001	Expenditure
		Hungary	1989, 1993–1996, 1998	Income
		Kazakhstan	1988, 1993	Income
			1993, 1996, 2000	Expenditure
		Kyrgyz Republic	1988, 1993, 1996, 1998	Income
			1993, 1997–2001	Expenditure
		Latvia	1988, 1993, 1995, 1998	Income
		Lithuania	1988, 1993, 1994, 1996, 2000	Income
			1996, 1998, 2000	Expenditure
		Macedonia	1988	Income
			1998	Expenditure
		Moldova	1988, 1992, 1997	Income
			1997–2001	Expenditure
		Poland	1985, 1987, 1989, 1993,1998	Income
			1990, 1992, 1993–96	Expenditure
		Romania	1989, 1992, 1994	Income
			1998, 2000	Expenditure
		Russian Federation	1988, 1993	Income
			1993, 1996, 1998, 2000	Expenditure
		Slovak Republic	1988, 1992, 1996	Income
		Slovenia	1987, 1993, 1996, 1998	Income
		Tajikistan	1998	Expenditure
		Turkey	1987, 1994, 2000	Expenditure
		Turkmenistan	1988, 1993, 1998	Income
		Ukraine	1988, 1992, 1997	Income
			1995, 1996, 1999	Expenditure
		Uzbekistan	1988, 1993	Income
			1998, 2000	Expenditure
Latin America and the Caribbean	95.31	Argentina	1980, 1982, 1989, 1992, 1996, 1998, 2001	Income
		Bolivia	1986, 1990, 1997, 1999	Income

Table A.1. (Continued)

Region	*Share of 2001 population represented (%)*	*Country*	*Survey dates*	*Welfare indicator*
		Brazil	1981, 1984, 1985, 1987, 1988–89, 1990, 1993, 1995–98, 2001	Income
		Chile	1987, 1990, 1992, 1994, 1996, 1998, 2001	Income
		Colombia	1980, 1988, 1989, 1991, 1995–96, 1998–1999	Income
		Costa Rica	1981, 1986, 1989, 1990, 1993, 1996–1998, 2001	Income
		Dominican Republic	1986, 1989, 1992,1996, 1998	Income
		Ecuador	1988, 1994–95, 1998	Income
			1994–95	Expenditure
		El Salvador	1989, 1995–98, 2000	Income
		Guatemala	1986, 1989, 1998, 2000	Income
		Guyana	1993, 1998	Expenditure
		Honduras	1986, 1989–90, 1992, 1994, 1996–1999	Income
		Jamaica	1988–94, 1996–2000	Expenditure
		Mexico	1984, 1992, 2000	Expenditure
			1989, 1995, 1996, 1998	Income
		Nicaragua	1993, 1998	Expenditure
		Panama	1979, 1989, 1991, 1995–98, 2000	Income
		Paraguay	1990, 1995, 1997–1999	Income
		Peru	1985, 1994, 1996	Expenditure
			1994, 1996, 2000	Income
		St. Lucia	1995	Income
		Trinidad and Tobago	1988, 1992	Income
		Uruguay	1981, 1989, 1996–1998, 2000	Income
		Venezuela	1981, 1987, 1989, 1991, 1993, 1995–98	Income
Middle East and North Africa	74.05	Algeria	1988, 1995	Expenditure
		Egypt, Arab Rep.	1991, 1995, 2000	Expenditure
		Iran	1986, 1990, 1994, 1998	Expenditure
		Jordan	1987, 1992, 1997	Expenditure
		Morocco	1985, 1990, 1998/99	Expenditure
		Tunisia	1985, 1990, 1995, 2000	Expenditure
		Yemen	1992, 1998	Expenditure

(Continued)

Table A.1. (Continued)

Region	*Share of 2001 population represented (%)*	*Country*	*Survey dates*	*Welfare indicator*
South Asia	98.09	Bangladesh	1983/84, 1984–85, 1988, 1992, 1996, 2000	Expenditure
		India	1977/78, 1983, 1986–91, 1993/94, 1995/96, 1999/2000	Expenditure
		Nepal	1985, 1995	Expenditure
		Pakistan	1986/87, 1990/91, 1992/93, 1996/97, 1998	Expenditure
		Sri Lanka	1980, 1985, 1990, 1995	Expenditure
Sub-Saharan Africa	77.86	Botswana	1985/86, 1993	Expenditure
		Burkina Faso	1994, 1998	Expenditure
		Burundi	1992, 1998	Expenditure
		Cameroon	1996	Expenditure
		Central African Republic	1993	Expenditure
		Côte d'Ivoire	1985–88, 1993, 1995, 1998	Expenditure
		Ethiopia	1981, 1995, 2000	Expenditure
		Gambia, The	1992, 1998	Expenditure
		Ghana	1987, 1989, 1998	Expenditure
		Kenya	1992, 1994, 1997	Expenditure
		Lesotho	1986, 1993, 1995	Expenditure
		Madagascar	1980, 1993, 1999	Expenditure
		Mali	1989, 1994	Expenditure
		Malawi	1997	Expenditure
		Mauritania	1988, 1993, 1995, 2000	Expenditure
		Mozambique	1996/97	Expenditure
		Namibia	1993	Expenditure
		Niger	1992, 1995	Expenditure
		Nigeria	1985, 1992, 1997	Expenditure
		Rwanda	1983/85	Expenditure
		Senegal	1991, 1994	Expenditure
		Sierra Leone	1989	Expenditure
		South Africa	1993, 1995, 2000	Expenditure
		Swaziland	1994	Expenditure
		Tanzania	1991	Expenditure
		Uganda	1988, 1992, 1996, 1999	Expenditure
		Zambia	1991, 1993, 1996, 1998	Expenditure
		Zimbabwe	1990/91, 1995	Expenditure

Source: National household surveys.

Notes

Shaohua Chen is senior information officer in the Development Research Group at the World Bank; her e-mail address is schen@worldbank.org. Martin Ravallion is research manager in the Development Research Group at the World Bank; his e-mail address is mravallion@worldbank.org. The authors are grateful to numerous colleagues at the World Bank who helped them obtain the necessary data and answered their many questions, and the staff of numerous governmental statistics offices who collected the primary survey data. The able assistance of Prem Sangraula is gratefully acknowledged. Angus Deaton, Johan Mistiaen, Dominique van de Walle, and the journal's editorial board made useful comments on the first draft.

1. Wade (2004) also questions the 200 million figure. However, he misdiagnoses the problem by confusing changes in the methods used to count the world's poor people with the methodological issues related to the way World Bank (2002) used different data sources. In fact, the Chen and Ravallion estimates used in World Bank (2002) would be judged internally consistent by Wade's criteria. The Deaton critique is more persuasive because it is grounded on a well-researched understanding of the methods involved.

2. For a critical overview of our estimation methods, see Deaton (2002a), which covers the main issues raised in the literature. Ravallion (2002a) replies to Deaton's comments; also see Ravallion (2003a) for further discussion.

3. The latest individual country estimates can be found online at www.worldbank.org/research/povmonitor. The latest year's estimates at the country level are also published in the World Bank's *World Development Indicators* (see, for example, World Bank 2004).

4. Because we are using the same PPP rates as Chen and Ravallion (2001), we use Penn World Tables 5.6, which was the latest available at that time. Version 6.1 has since become available.

5. Thus we do not accept the claims made by Reddy and Pogge (2002) and Wade (2004) that we have lowered the real value of the poverty line. They ignore the fact that there has been (in effect) a PPP devaluation of poor countries relative to the United States since the switch from the 1985- to 1993-based PPPS, reflecting both the new ICP price data and differences in methods of measuring the PPP rate. For further discussion of the Reddy and Pogge criticisms of our methods see Ravallion (2002b).

6. Note that the same poverty line is generally used for urban and rural areas. There are two exceptions. For China and India we estimate poverty measures separately for urban and rural areas and use sector-specific CPIS. For India we also use a corrected version of the rural CPI (the consumer price index for agricultural laborers), as discussed in Datt and Ravallion (1998).

7. For Nigeria we used the CDP per capita growth rate. Substantial changes in Nigeria's method of calculating private consumption made it impossible to construct a consistent series for consumption.

8. Thus $H93=[(1995-1993)/(1995-1989)]\cdot H93(89)+[(1993-1989)/(1995-1989)]\cdot H93(95)$. In a small number of cases this method did not give sensible results in that either M93(89) or M93(95) was outside the interval [M(89), M(95)] even though the national accounts growth rates were positive for both 1989–93 and 1993–95. In these cases we ignored the national accounts data and fell back on simply estimating M(93), using the growth rate in survey means between 1989 and 1995.

9. This assumes that the trend is linear rather than exponential (linear in logs). The exponential trends are 2.9 percent a year using all eight years and 2.5 percent a year ignoring the first year.

References

Ahmad, Sultan. 2003. "Purchasing Power Parity for International Comparison of Poverty: Sources and Methods." World Bank, Development Data Group, Washington, D.C. Available online at www.worldbank.org/data/icp.

Atkinson, Anthony B., and François Bourguignon. 1999. "Poverty and Inclusion from a World Perspective." Paper presented for the Annual World Bank Conference on Development Economics, European Conference, Paris.

Bourguignon, Francois, and Christian Morisson. 2002. "The Size Distribution of Income among World Citizens, 1820–1990." *American Economic Review* 92(4):727–44.

Chen, Shaohua, and Martin Ravallion. 1996. "Data in Transition: Assessing Rural Living Standards in Southern China." *China Economic Review* 7:23–56.

———. 2000. "How Did the World's Poorest Fare in the 1990s?" Policy Research Working Paper 2409. World Bank, Washington, D.C. Available online at http://econ.worldbank.org/resource.php?type=5.

———. 2001. "How Did the World's Poor Fare in the 1990s?" *Review of Income and Wealth* 47(3): 283–300.

Chen, Shaohua, Gaurav Datt, and Martin Ravallion. 1994. "Is Poverty Increasing or Decreasing in the Developing World?" *Review of Income and Wealth* 40:359–76.

Datt, Gaurav, and Martin Ravallion. 1992. "Growth and Redistribution Components of Changes in Poverty Measures: A Decomposition with Applications to Brazil and India in the 1980s." *Journal of Development Economics* 38:275–95.

———. 1998. "Farm Productivity and Rural Poverty in India." *Journal of Development Studies* 34: 62–85.

———. 2002. "Has India's Post-Reform Economic Growth Left the Poor Behind?" *Journal of Economic Perspectives* 16(3):89–108.

Deaton, Angus. 2002a. "Counting the World's Poor: Problems and Possible Solutions." *World Bank Research Observer* 16(2):125–47.

———. 2002b. "Is World Poverty Falling?" *Finance and Development* 39(2):4–7.

———. 2003. "Adjusted Indian Poverty Estimates for 1999–00." *Economic and Political Weekly* 38(4): 322–26.

Foster, James, J. Greer, and E. Thorbecke. 1984. "A Class of Decomposable Poverty Measures." *Econometrica* 52:761–65.

Gibson, John, Jikun Huang, and Scott Rozelle. 2001. "Why Is Income Inequality So Low in China Compared to Other Countries? The Effect of Household Survey Methods." *Economics Letters* 71: 329–33.

Ravallion, Martin. 2002a. "Comment on 'Counting the World's Poor' by Angus Deaton." *World Bank Research Observer* 16(2):149–56.

———. 2002b. "How *Not* to Count the Poor: A Reply to Reddy and Pogge." World Bank, Development Research Group, Washington, D.C.

———. 2003a. "The Debate on Globalization, Poverty and Inequality: Why Measurement Matters." *International Affairs* 79(4):739–54.

———. 2003b. "Measuring Aggregate Economic Welfare in Developing Countries: How Well Do National Accounts and Surveys Agree?" *Review of Economics and Statistics* 85:645–52.

Ravallion, Martin, and Shaohua Chen. 2004. "China's (Uneven) Progress against Poverty." World Bank, Development Research Group, Washington, D.C.

Ravallion, Martin, Gaurav Datt, and Dominique van de Walle. 1991. "Quantifying Absolute Poverty in the Developing World." *Review of Income and Wealth* 37:345–61.

Reddy, Sanjay G., and Thomas W. Pogge. 2002. "How *Not* to Count the Poor." Working paper, Barnard College, New York.

Sen, Abhijit, and Himanshu. 2003. "Poverty and Inequality in India: Getting Closer to the Truth." Working paper, Jawaharlal Nehru University, New Delhi.

Sundaram, K., and Suresh D. Tendulkar. 2003. "Poverty in India in the 1990s. Revised Results for All-India and 15 Major States for 1993–94." *Economic and Political Weekly* 38(46):4865–72.

Wade, Robert Hunter. 2004. "Is Globalization Reducing Poverty and Inequality?" *World Development* 32(4):567–89.

World Bank. 1990. *World Development Report: Poverty*. New York: Oxford University Press.

———. 1997. *China 2020: Sharing Rising Income*. Washington, D.C.

———. 2000. *World Development Report 2000/2001: Attacking Poverty*. New York: Oxford University Press.

———. 2002. *Globalization, Growth and Poverty*. Washington, D.C.

———. 2004. *World Development Indicators*. Washington, D.C.

Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment?

Holger Görg • David Greenaway

Governments the world over offer significant inducements to attract investment, motivated by the expectation of spillover benefits to augment the primary benefits of a boost to national income from new investment. There are several possible sources of induced spillovers from foreign direct investment. This article evaluates the empirical evidence on productivity, wage, and export spillovers in developing, developed, and transition economies. Although theory can identify a range of possible spillover channels, robust empirical support for positive spillovers is at best mixed. The article explores the reasons and concludes with a review of policy aspects.

Of all the drivers of globalization—arm's length trade, migration of workers, and cross-border investment—the last is probably the most visible. This is probably why public anxiety about globalization often manifests itself as hostility toward multinational firms (see Deardorff 2003 for a recent appraisal of such anxieties). From an economic standpoint, cross-border investment may also be at the margin the most important manifestation of globalization. Annual flows of foreign direct investment (FDI) now exceed $700 billion, and the total stock exceeds $6 billion. Over the past decade FDI flows have grown at least twice as fast as trade.

As with arm's length trade, the FDI environment is policy distorted, but it is gradually becoming more liberalized. Of 145 regulatory changes made by 60 countries in 1998, 94 percent created more favorable conditions for FDI (UN 1999). In many cases interventions have extended beyond creating a more liberal environment to providing substantial public subsidies. For example, Head (1998) reports that the government of Alabama paid the equivalent of $150,000 per employee to Mercedes for locating its new plant in the state in 1994. Across the Atlantic the UK government

The World Bank Research Observer, vol. 19, no. 2.
© The International Bank for Reconstruction and Development / THE WORLD BANK 2004; all rights reserved.
doi:10.1093/wbro/lkh019 19:171–197

provided an estimated $30,000 per employee to attract Samsung to the northeast of England in the late 1990s and $50,000 per employee to attract Siemens (Girma and others 2001). Some countries also provide tax incentives. For example, Ireland offers a corporate tax rate of 12.5 percent to all manufacturing firms locating there.

There seems to be a widely held assumption that foreign firms more than pay their way, bringing not only new investment that boosts national income but also secondary spillovers, resulting in productivity growth or higher export growth. Much econometric work has been done in this area, but the results on the importance of spillovers are mixed at best. There is some evidence from case studies of spillover benefits to domestic firms (see Moran 2001), but even at that level there is disagreement in particular instances.[1]

The failure of econometric work to find unambiguously positive effects could be due to a number of factors. Despite theoretical arguments supporting spillovers, they may simply be unimportant in reality. Multinational corporations may be effective at ensuring that firm-specific assets and advantages do not spill over. Another possibility is that spillovers exist and make up some part of the residual that appears in all growth equations, but current statistical methods and data sets are unable to identify them. Furthermore, there may be much heterogeneity in spillovers, and aggregate studies may therefore fail to detect them. Moreover, the lack of good-quality, comprehensive firm- and plant-level data sets is a serious impediment to research.

This article examines in detail the evidence for intraindustry productivity spillovers in theory and in econometric analyses, taking essentially a microeconomic and microeconometric view.[2] It updates earlier surveys, such as Blomström and Kokko (1998) and Lipsey (2002) and highlights methodological issues and the scope for policymakers to enhance potential spillover effects. The review is more focused on spillovers from FDI than are related studies by Keller (2001) or Saggi (2002), who discuss the scope and evidence for international technology diffusion more generally, without much detail on FDI.

This article looks first at what guidance theory can give, on two counts: the possible channels for transmission of spillover benefits and whether host country characteristics are likely to make a difference in the extent or speed with which spillovers occur. It examines the empirical evidence on spillovers in developed, developing, and transition economies and then draws some implications for policy. Should governments intervene, and if so, how? Does policy make any difference?

What Does Theory Tell Us?

A well-developed and extensively surveyed (see Caves 1996; Markusen 1995) body of literature tries to explain why multinational corporations set up overseas rather than export directly or license their product or technology. The most persuasive

explanations emphasize the coexistence of proprietary knowledge and market failures in protecting that knowledge. Thus the firm internalizes certain transactions to protect its brand, technology, and marketing advantages. These motives are taken as given, in particular, the existence of some kind of firm-specific asset, usually some kind of technological advantage, including innovative management and organizational processes as well as new production methods and technologies.

The first question, then, is having chosen a particular location, how might any advantages spill over to the local economy through firms in the same industry? Then, with potential transmission channels identified, are there particular host economy characteristics that make benefits from spillovers more or less likely?

Spillover Channels

When a firm sets up a plant overseas or acquires a foreign plant, it does so in the expectation of realizing a higher rate of return than a given home country firm with an equivalent investment. The source of the higher return is the technological advantage alluded to. Whatever its source, the only way domestic firms can gain from external benefits is if some form of indirect technology transfer takes place—multinational firms will not simply hand over the source of their advantage. The theoretical literature identifies four channels through which spillovers might boost productivity in the host country: imitation, skills acquisition, competition, and exports (table 1).

Imitation. Imitation is the classic transmission mechanism for new products and processes. One mechanism commonly alluded to in the theoretical literature on technology transfer from developed to developing economies is reverse engineering (Das 1987; Wang and Blomström 1992). Its scope depends on the complexity of products and processes, with simple manufactures and processes easier to imitate than more complex ones. The same principle applies to managerial and organizational innovations, although these are thought to be easier to imitate. Imitation is, of course, not the same as replication, and it would be surprising if the rents accruing

Table 1. Potential Channels for Spillover from Foreign Direct Investment

Driver	*Sources of productivity gain*
Imitation	Adoption of new production methods. Adoption of new management practices.
Skills acquisition	Increased productivity of complementary labor. Tacit knowledge.
Competition	Reduction in X-inefficiency. Faster adoption of new technology.
Exports	Scale economies. Exposure to technology frontier.

Source: Authors' compilation; see text for details.

to multinational firms were entirely dissipated by the process. However, any upgrading to local technology deriving from imitation could result in a spillover, with consequent benefits for the productivity of local firms.

Skills Acquisition. Adoption of new technology can also occur through the acquisition of human capital. Even when the locational pull for FDI is relatively low wages, multinational firms tend to demand relatively skilled labor. Generally, they will invest in training, and it is impossible to lock in such resources completely. (This inability to fully protect investment in human capital has long been an argument for infant industry protection as a response to potential first-mover disadvantages; see Baldwin 1969.) The movement of labor from multinational firms to other existing or new firms can generate productivity improvements through two mechanisms: through a direct spillover to complementary workers and through knowledge carried by workers who move to another firm. Haacker (1999) and Fosfuri and others (2001) argue that the knowledge that workers bring with them is the most important channel for spillovers, and some empirical work supports this (Djankov and Hoekmann 1999; Görg and Strobl 2002c).

Competition. Many models emphasize the role of competition (Wang and Blomström 1992; Glass and Saggi 2002). Unless an incoming firm is offered monopoly status, it will produce in competition with indigenous firms. Even if indigenous firms are unable to imitate the multinational's technology and production processes, entry of the multinational firm puts pressure on them to use existing technology more efficiently, yielding productivity gains. Greater competition leading to a reduction in X-inefficiency is analogous to one of the standard gains from arm's length trade and is frequently identified as one of the major sources of gain. In addition, competition may increase the speed of adoption of new technology.

Exports. A further indirect source of productivity gain might be through exports. Crudely, domestic firms can learn to export from multinationals (Aitken and others 1997; Barrios and others 2003; Greenaway and others forthcoming). Exporting generally involves fixed costs to establish distribution networks, create transport infrastructure, and learn about consumers' tastes, regulatory arrangements, and so on in overseas markets. Multinational firms generally come already armed with such information and exploit it to export from the new host country. Through collaboration, or more likely imitation, domestic firms can learn how to penetrate export markets. There is a growing body of literature that links exporting and productivity. Recent work on Germany, Mexico, Morocco, Spain, the United Kingdom, the United States, and Venezuela suggests that productivity levels are higher in exporting firms than in nonexporting firms (Clerides and others 1998; Bernard and

Jensen 1999; Bernard and Wagner 1997; Delgado and others 2003; and Girma and others forthcoming). Central to this literature is whether firms self-select into exporting or increase their productivity after entering export markets.

Host Country Characteristics and Spillovers

The literature on the determinants of FDI emphasizes locational characteristics as important factors in multinationals' decisions on where to invest (Wheeler and Mody 1992; Brainard 1997; Görg 2002). The focus here, however, is on whether there are locational characteristics that affect the speed of adoption of new technology and the spillover of productivity gains.

In a pioneering contribution Findlay (1978) emphasizes the importance of relative backwardness and contagion. Findlay's model suggests that the greater is the distance between two economies in terms of development, the greater the backlog of available opportunities to exploit in the less advanced economy, and so the greater the pressure for change and the more rapid the uptake of new technology. Speed of adoption is also a function of contagion or the extent to which the activities of the foreign firm pervade the local economy. Thus technology transfer will be more rapid if the multinational firm quickly establishes upstream and downstream networks, because domestic firms involved in supply and distribution chains gain exposure to new technology, promoting its diffusion.

Glass and Saggi (1998) also see a role for technological distance between the host and home country, but a different one from Findlay's. Any technology gap signals something to the multinational firm about absorptive capacity. The bigger the gap, the less likely the host is to have the human capital, physical infrastructure, and distribution networks to support inward investment. This influences not only the decision to invest but also what kind of technology to transfer. Specifically, the bigger the gap, the lower the quality of technology transferred and the lower the potential for spillovers. This seems more plausible than Findlay's notion of a lack of absorptive capacity as the driver. Clearly, technological distance will be directly related to the potential gains from spillovers, but it is also likely to be inversely related to the probability that domestic firms are actually able to access them.

Summary

Economic theory gives some guidance on what to expect from cross-border investment and spillovers. In general, multinational firms have firm-specific advantages that might be related to the production methods they use, the way they organize their activities, the way they market their products and services, and so on. Once a multinational has set up a subsidiary, it may be unable to prevent some of the benefits of these advantages from spilling over to indigenous firms through imitation, labor

mobility, competition, or export. Such spillovers have the potential to raise productivity, and exploitation of these potential channels of spillovers might be related to the structural characteristics of the host economy, in particular its absorptive capacity.

What Does the Evidence Tell Us?

Empirical studies on spillovers from FDI were pioneered by Caves for Australia (1974), Globerman for Canada (1979), and Blomström for Mexico (1986). Since then, their empirical models have been extended and refined, although the basic approach remains. Most econometric analyses use a framework that regresses the labor productivity or total factor productivity of domestic firms on a range of independent variables. To measure productivity spillovers from multinational firms, a variable is included that proxies the extent of foreign firms' penetration, usually calculated as the multinational's share of total employment or sales in a given sector.[3] In other words, the regression allows for an effect of FDI on the productivity of domestic firms in the same industry. If the regression analysis yields a positive and statistically significant coefficient on the foreign presence variable, this is taken as evidence that spillovers have occurred from multinational firms to domestic firms.[4] Most studies use either the contemporaneous level of foreign penetration or relatively short lags (most often one year) as their explanatory variables. If anything, therefore, these studies usually measure short-run effects of foreign presence on domestic productivity.

Table 2 sets out details of 40 studies of horizontal productivity spillovers in manufacturing industries in developing, developed, and transition economies. Of those, 22 report unambiguously positive and statistically significant horizontal spillover effects (2 of which find positive and significant effects for only one of several countries studied). All but eight of those reporting unambiguously positive spillovers use cross-sectional data, which may lead to biased results.

Görg and Strobl (2001) argue that panel data using firm-level data are the most appropriate estimating framework for two reasons. First, they permit investigation of the development of domestic firms' productivity over a longer time period, rather than at one point in time. Second, they allow investigation of spillovers after controlling for other factors. Cross-section data, particularly if aggregated at the sectoral level, fail to control for time-invariant differences in productivity across sectors that might be correlated with foreign presence without being caused by it. Thus coefficients on cross-section estimates are likely to be biased. For example, if productivity is higher in the electronics sector than in the food sector, multinationals may be attracted to the electronics sector. Cross-sectional data would show a positive and statistically significant relationship between the level of foreign investment and productivity consistent with spillovers, even though foreign investment did not cause high levels of productivity but rather was attracted by them.

Table 2. Papers on Intraindustry Productivity Spillovers

	Author	Country	Period	Data	Aggregation level[a]	Result[b]
Developing economies						
1	Blomström and Persson (1983)	Mexico	1970	Cross-sectional	Industry	+
2	Blomström (1986)	Mexico	1970/1975	Cross-sectional	Industry	+
3	Blomström and Wolff (1994)	Mexico	1970/1975	Cross-sectional	Industry	+
4	Kokko (1994)	Mexico	1970	Cross-sectional	Industry	+
5	Kokko (1996)	Mexico	1970	Cross-sectional	Industry	+
6	Haddad and Harrison (1993)	Morocco	1985–89	Panel	Micro and industry	?
7	Kokko and others (1996)	Uruguay	1990	Cross-sectional	Micro	?
8	Blomström and Sjöholm (1999)	Indonesia	1991	Cross-sectional	Micro	+
9	Sjöholm (1999a)	Indonesia	1980–91	Cross-sectional	Micro	+
10	Sjöholm (1999b)	Indonesia	1980–91	Cross-sectional	Micro	+
11	Chuang and Lin (1999)	Taiwan	1991	Cross-sectional	Micro	+
12	Aitken and Harrison (1999)	Venezuela	1976–89	Panel	Micro	−
13	Kathuria (2000)	India	1976–89	Panel	Micro	?
14	Kokko and others (2001)	Uruguay	1988	Cross-sectional	Micro	?
15	Kugler (2001)	Colombia	1974–98	Panel	Industry	?
16	López-Córdova (2002)	Mexico	1993–99	Panel	Micro	−, ?
17	Görg and Strobl (2002c)	Ghana	1991–97	Panel	Micro	+
Developed countries						
18	Caves (1974)	Australia	1966	Cross-sectional	Industry	+
19	Globerman (1979)	Canada	1972	Cross-sectional	Industry	+
20	Liu and others (2000)	United Kingdom	1991–95	Panel	Industry	+
21	Driffield (2001)	United Kingdom	1989–92	Cross-sectional	Industry	+
22	Girma and others (2001)	United Kingdom	1991–96	Panel	Micro	?
23	Girma and Wakelin (2001)	United Kingdom	1980–92	Panel	Micro	?
24	Harris and Robinson (2004)	United Kingdom	1974–95	Panel	Micro	?
25	Girma and Wakelin (2002)	United Kingdom	1988–96	Panel	Micro	?

(Continued)

Table 2. (Continued)

Author	Country	Period	Data	Aggregation level[a]	Result[b]
26 Haskel and others (2002)	United Kingdom	1973–92	Panel	Micro	+
27 Girma (2002)	United Kingdom	1989–99	Panel	Micro	?
28 Girma and Görg (2002)	United Kingdom	1980–92	Panel	Micro	?
29 Ruane and Ugur (2002)	Ireland	1991–98	Panel	Micro	+
28 Barrios and Strobl (2002)	Spain	1990–94	Panel	Micro	?
29 Dimelis and Louri (2002)	Greece	1997	Cross-sectional	Micro	+
30 Castellani and Zanfei (2002b)	France, Italy, Spain	1992–97	Panel	Micro	+ for Italy; – for Spain; ? for France
31 Keller and Yeaple (2003)	United States	1987–96	Panel	Micro	+
32 Görg and Strobl (2003)	Ireland	1973–96	Panel	Micro	+
Transition economies					
33 Djankov and Hoekman (2000)	Czech Republic	1993–96	Panel	Micro	–
34 Kinoshita (2001)	Czech Republic	1995–98	Panel	Micro	?
35 Bosco (2001)	Hungary	1993–97	Panel	Micro	?
36 Konings (2001)	Bulgaria	1993–97	Panel	Micro	–
	Poland	1994–97			?
	Romania	1993–97			–
37 Damijan and others (2001)	Bulgaria, Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia, Slovenia	1994–1998	Panel	Micro	? or – + only for Romania
38 Li and others (2001)	China	1995	Cross-sectional	Industry	+
39 Smarzynska-Javorcik (forthcoming)	Lithuania	1996–2000	Panel	Micro	?
40 Zukowska-Gagelmann (2000)	Poland	1993–97	Panel	Micro	–

[a]Micro data are at the firm, plant, or establishment level.

[b]A + indicates positive and statistically significant, – indicates negative and statistically significant, and ? indicates mixed or statistically insignificant results on the foreign presence variable for the aggregate sample.

Taking this into consideration, the evidence on positive horizontal spillovers is much weaker. There are only eight studies employing panel data that find unambiguously positive evidence in the aggregate, and almost all of these are for developed economies: Liu and others (2000) and Haskel and others (2002) for the United Kingdom, Castellani and Zanfei (2002b) for Italy, Keller and Yeaple (2003) for the United States, Ruane and Ugur (2002) and Görg and Strobl (2003) for Ireland, Damijan and others (2001) for Romania, and Görg and Strobl (2002c) for Ghana. Liu and others (2000), however, use industry-level data that aggregates over heterogeneous firms, which may lead to biased results.[5] This leaves only seven studies using appropriate data and estimation techniques that report positive evidence for aggregate spillovers.

Several studies using firm-level panel data find some evidence of negative effects of the presence of multinationals on domestic firms in the aggregate. These include Aitken and Harrison (1999) for Venezuela, López-Córdova (2002) for Mexico, Castellani and Zanfei (2002b) for Spain, Djankov and Hoekman (2000) for the Czech Republic, Konings (2001) for Bulgaria, Zukowska-Gagelmann (2000) for Poland, and Damijan and others (2001) for seven countries in Central and Eastern Europe. Many studies on transition economies find at least some evidence of negative results. Nineteen of the studies find no statistically significant effects on average of multinationals on domestic productivity.[6]

What Explains the Negative or Neutral Effects?

There have been several explanations for the negative results found by some studies. The most plausible is that foreign firms reduce the productivity of domestic firms through competition effects, as suggested by Aitken and Harrison (1999) and Konings (2001). They argue that multinationals have lower marginal costs due to some firm-specific advantage, which allows them to attract demand away from domestic firms, thus forcing the domestic firms to reduce production and move up their (given) average cost curve.

This argument is not necessarily inconsistent with the theoretical discussion in the previous section, which presented competition as one of the channels through which positive spillovers are transmitted. Some firms may experience negative competition effects in the short run (moving up a given average cost curve), whereas other firms may improve efficiency (shifting down their average cost curve) because of increased competition in the short run as well as the long run. Evidence for positive effects of competition are found by Kokko (1996) for Mexico and Driffield (2001) for the United Kingdom.

There are also other explanations for a failure to find evidence of positive aggregate spillovers in the short run. There may be lags in domestic firms' learning from multinationals, which short-run analyses do not pick up. Multinational firms may

be able to guard their firm-specific advantages closely, preventing leakages to domestic firms and therefore spillovers as well. Positive spillovers may affect only a subset of firms, so that aggregate studies underestimate the true significance of such effects. Spillovers may occur not horizontally (intraindustry) but vertically through relationships that are missed in conventional spillover studies.

The first two explanations are straightforward and plausible and require little comment. More detailed discussion is warranted for the last two explanations.

Absorptive Capacity. As discussed, the theoretical literature suggests that not all firms would be expected to benefit equally from knowledge spillovers from multinationals. Whether a firm benefits depends on its relative backwardness and its capacity for assimilating knowledge—its absorptive capacity. Some of the empirical literature has also considered these issues.

Kokko (1994) advances the idea that spillovers depend on the complexity of the technology transferred by multinationals and on the technology gap between domestic firms and multinational firms. Using cross-section industry-level data for Mexico, he finds no evidence for spillovers in industries in which multinationals use highly complex technologies (as proxied by large payments on patents or high capital intensity). A large technology gap on its own does not appear to hinder technology spillovers on average, although industries with large gaps and a high foreign presence experience lower spillovers than others. Expanding on Kokko (1994), Kokko and others (1996) hypothesize that domestic firms can benefit only if the technology gap is not too wide so that domestic firms can absorb the knowledge available from the multinational—an argument similar to that of Glass and Saggi (1998). Thus domestic firms using very backward production technologies and low skilled workers may be unable to learn from multinationals. Using a cross-section of firm-level data for Uruguay, Kokko and others find evidence for productivity spillovers to domestic firms with moderate technology gaps (measured as the difference between the domestic firm's labor productivity and the average labor productivity in foreign firms) but not for firms that use considerably lower levels of technology.[7]

Girma and others (2001), using firm-level panel data, find no evidence of productivity spillovers in UK manufacturing on average—under the assumption that spillovers are homogeneous across different types of domestic firms. There is evidence for spillovers to firms with a small gap between their productivity level and the industry frontier productivity level (called the technology gap). Productivity appears to increase with increasing foreign presence for firms with a technology gap of 10 percent or less, whereas it appears to diminish in firms with larger gaps. Girma (2002) uses threshold regression techniques to quantify the significance of absorptive capacity, and Girma and Görg (2002) use conditional quantile regression techniques to allow for different effects of FDI on establishments at different quantiles of the productivity distribution. Both studies find support for the hypothesis that only

firms with some minimum level of absorptive capacity benefit from productivity spillovers.

In a similar vein, Barrios and Strobl (2002), in firm-level panel data for Spanish manufacturing, find little evidence for any aggregate horizontal spillovers from multinational firms. There is evidence for positive spillovers from foreign presence to domestic exporters but not to nonexporters, which they interpret as evidence that absorptive capacity matters. They argue that exporting firms are more exposed to international competition and therefore are more likely to use more advanced technologies and to benefit from positive spillovers than are nonexporters. Kinoshita (2001), using firm-level panel data for the Czech Republic, also finds no evidence of spillovers on average but finds positive spillovers for local firms that are research and development (R&D) intensive. She interprets this as evidence that absorptive capacity is important.

Damijan and others (2001) also define absorptive capacity in terms of local firms' R&D activities. In their firm-level panel data for a number of Central and Eastern European transition economies, they fail to detect evidence of productivity spillovers affecting the average firm. Taking into account absorptive capacity, by interacting the foreign presence variable with a firm's R&D expenditure, they find evidence of negative spillovers for the Czech Republic and Poland but positive spillovers for Romania, and no evidence for all other countries.

Regional Dimensions. Because human capital acquisition and imitation are considered important channels for knowledge spillovers, domestic firms located near multinationals may be more likely to benefit than other firms. For example, Audretsch (1998:21) argues that geographic proximity is necessary to facilitate knowledge spillovers because "knowledge is vague, difficult to codify, and often only serendipitously recognized." Therefore, transmission costs are assumed to increase with distance.

Several studies have investigated the geographic dimension of horizontal spillovers. Calculating proxies for foreign presence at the regional level and using cross-sectional data for Indonesia, Sjöholm (1999a) fails to find evidence of a regional component. Aitken and Harrison (1999), using firm-level panel data for Venezuela, also fail to find positive spillovers from multinationals to domestic firms in the same region, though they find negative spillovers from multinationals in the same sector in any region in the country. From firm-level panel Girma and Wakelin (2002) find evidence for positive spillovers from FDI in the same region and sector as domestic firms in the United Kingdom, but the results are significant only for firms that have a low technology gap vis-à-vis multinationals.

Importance of vertical linkages. If multinationals prevent the transfer of their firm-specific knowledge to domestic competitors in the same industry, there is no scope for intraindustry knowledge spillovers. It is possible, however, that multinational

firms voluntarily or involuntarily help increase the efficiency of domestic suppliers or customers through vertical input-output linkages. Multinationals may provide technical assistance to suppliers to help them raise the quality of the intermediate products they produce (Moran 2001), or they may simply insist on high quality standards for local inputs, providing incentives for local suppliers to upgrade their technology. Multinationals may also provide active assistance or passive guidelines to domestic customers on the most effective way to use the products the firms supply.

Several recent studies have empirically investigated vertical spillovers (table 3).[8] Kugler (2001) worked with industry-level panel data for 10 Colombian manufacturing industries during 1974–98, using an estimation framework that distinguishes intraindustry and interindustry spillovers. He finds widespread evidence for positive interindustry spillovers, but finds evidence for intraindustry spillovers only in one sector (machinery equipment). However, his framework does not distinguish spillovers through backward or forward linkages. Smarzynska-Javorcik (forthcoming) uses firm-level panel data for Lithuania for 1996–2000 to consider spillovers through backward linkages. Although she found no evidence for aggregate horizontal spillovers, she does find productivity spillovers through backward linkages. Blalock and Gertler (2003) also find results suggesting positive productivity spillovers through backward linkages in their analysis of Indonesian plant-level panel data. They do not find evidence for horizontal spillovers, however.

Driffield and others (2002) allow for spillovers through horizontal, backward, and forward relationships. They examine the relative importance of each using industry-level panel data for UK manufacturing during 1984–92. Their econometric estimations show evidence for positive spillovers through forward linkages but not of statistically significant spillovers through backward linkages. The results for horizontal spillovers are inconclusive. In a further study for the United Kingdom, Harris and Robinson (2004) use plant-level panel data to estimate productivity equations for 20 manufacturing sectors separately. Like Kugler (2001), they distinguish only horizontal and vertical spillovers; they do not separate vertical spillovers into backward or forward linkages. Their results suggest that interindustry spillovers are much more prevalent than intraindustry spillovers. None of the spillovers are always positive, however, and there is evidence of negative spillovers in many sectors. Girma and others (2003), using UK firm-level data, also find substantial differences in whether domestic firms benefit from vertical linkages, depending on their export activities.

Wage Spillovers

If there are positive productivity spillovers from multinational firms to domestic firms and if some of these spillovers are due to increasing labor productivity, domestic firms will pay higher wages in competitive labor markets. Another field of empirical

Table 3. Studies on Vertical Spillovers

Author	*Country*	*Period*	*Data*	*Aggregation level*[a]	*Result*[b]		
					Horizontal	*Backward*	*Forward*
1 Kugler (2001)[c]	Colombia	1974–98	Panel	Industry	?	Many +	NA
2 Smarzynska-Javorcik [illegible]	Lithuania	1996–2000	Panel	Micro	?	+	NA
3 Driffield and others (2002)	United Kingdom	1984–92	Panel	Industry	?	?	+
4 Harris and Robinson (2002)[c]	United Kingdom	1974–95	Panel	Micro	?	?	?
5 Blalock and Gertler (2003)	Indonesia	1988–96	Panel	Micro	?	+	NA

[a]Micro data are at the firm, plant, or establishment level.

[b]A + indicates positive and statistically significant, – indicates negative and statistically significant, and ? indicates mixed or statistically insignificant results on the foreign presence variable for the aggregate sample. NA = not applicable.

[c]Do not distinguish backward and forward spillovers.

Table 4. Studies on Wage Spillovers

Author	Country	Period	Data	Aggregation level[a]	Result[b]
1 Aitken and others (1996)	Mexico	1984–90	Panel	Industry	–
	Venezuela	1977–89	Panel	Industry	–
	United States	1987	Cross-sectional	Industry	+
2 Lipsey and Sjöholm (2001)	Indonesia	1996	Cross-sectional	Micro	+
3 Girma and others (2001)	United Kingdom	1991–96	Panel	Micro	?
4 Driffield and Girma (2003)	United Kingdom	1980–92	Panel	Micro	?

[a]Micro data are at the firm, plant, or establishment level.

[b]A + indicates positive and statistically significant, – indicates negative and statistically significant, and ? indicates mixed or statistically insignificant results on the foreign presence variable for the aggregate sample.

research focuses on this connection, emphasizing horizontal spillovers (table 4).[9] Productivity spillovers are not the only channel for such wage spillovers, however. Multinationals often pay higher wages, even after controlling for size and other firm and sectoral characteristics (Girma and others 2001; Lipsey and Sjöholm 2001; Görg and others 2003). This is attributed to the multinational firms' ownership of firm-specific assets, implying that they use higher levels of technology than domestic firms. If multinationals and domestic firms compete in the same labor market, domestic firms have to pay higher wages to attract workers. Wage spillovers can also be negative, however, if there are negative productivity spillovers from multinationals.

As with productivity, identifying wage spillovers usually involves estimating the determinants of wages in domestic firms and including a measure of foreign presence (multinationals' share of total employment) in the industry as a covariate. Aitken and others (1996) use industry-level data for manufacturing industries for Mexico (1984–90), Venezuela (1977–89), and the United States (1987). They find positive effects in the United States, but negative effects in Mexico and Venezuela. As with productivity spillovers, the result for the United States should be treated with caution because the study uses cross-sectional data. Lipsey and Sjöholm (2001) study the same effect for the Indonesian manufacturing sector using plant-level cross-sectional data for 1996 and find that higher foreign presence in a sector leads to higher wages in domestic firms in the same sector. Girma and others (2001), using firm-level panel data for UK manufacturing for 1991–96, find no effect on average of multinationals in a sector on the wage level in domestic firms but weak evidence of a negative effect on wage growth.

Export Spillovers

A third strand in the literature focuses on whether multinationals spread their knowledge of global markets to domestic firms, thus enabling them to become more

successful exporters. Domestic firms can be affected through three primary channels. First, if multinationals have better access to information about foreign markets, this can spill over through their export activities. Second, domestic firms can learn the multinationals' superior production or management techniques through observation (demonstration effects), enabling the domestic firms to compete more successfully in export markets. Third, competition with multinational firms at home and in foreign markets can induce domestic firms to improve their export performance.

Several studies have examined export spillovers (table 5). Aitken and others (1997) estimate a probit model using export activity by multinationals in the industry and region as a proxy for export information externalities. Using plant-level cross-section data for Mexican manufacturing industries for 1986 and 1989, they find that export activities by multinational firms in a sector positively affect the probability of a firm in the same sector, foreign or domestic, being an exporter.

Using firm-level panel data for the United Kingdom for 1992–96, Greenaway and others (forthcoming) also investigate whether spillovers affect a firm's probability of exporting but extend the analysis to examine what affects a firm's export ratio. In a two-step Heckman selection model, they first estimate the probability of exporting and then estimate the factors that affect a firm's export ratio. They include three measures of multinational presence to capture the three spillover channels.

Their results suggest that multinational firms' exports have a positive effect on domestic firms' probability of exporting but do not affect their export ratio. They also find that R&D spillovers from multinationals to domestic firms and the presence of multinational firms in the sector positively affect the decision to export and the export ratio. Thus, export information externalities appear to matter only for the decision of whether to export. This is not surprising because these externalities can be expected to aid domestic firms in overcoming the sunk costs of exporting, which should affect their probability of exporting but not their export ratio.

Table 5. Papers on Export Spillovers

Author(s)	*Country*	*Period*	*Data*	*Aggregation level*[a]	*Result*[b]
1 Aitken and others (1997)	Mexico	1986/1989	Cross-sectional	Micro	+
2 Kokko and others (2001)	Uruguay	1998	Cross-sectional	Micro	?
3 Greenaway and others (forthcoming)	United Kingdom	1992–96	Panel	Micro	+
4 Banga (2003)	India	1994–2000	Panel	Micro/industry	+
5 Barrios and others (2003)	Spain	1990–98	Panel	Micro	?

[a]Micro data are at the firm, plant, or establishment level.

[b]A + indicates positive and statistically significant, – indicates negative and statistically significant, and ? indicates mixed or statistically insignificant results on the foreign presence variable for the aggregate sample.

Barrios and others (2003) also focus on export information externalities and on demonstration effects through R&D spillovers. Using firm-level panel data for Spanish manufacturing for 1990–98, they estimate a probit model to explain why firms export and a tobit model to estimate what determines the firm's export ratio. They find no evidence that either R&D activity or export activity by multinationals in a sector affects the probability that domestic firms export, although they find spillovers from both types of activity on other foreign-owned firms. The tobit estimations, however, find evidence for positive effects of multinationals' R&D activity on domestic firms' export ratios, but no spillovers from multinationals' export activities on domestic firms. The export ratios of other foreign firms again benefit from both types of spillovers. In an extension Barrios and colleagues (2003) discover that R&D spillovers increase domestic firms' exports only to other developed economies, which are generally markets with a superior technological capability.

Kokko and others (2001) investigate the decision to export by domestic firms in Uruguay using cross-sectional firm-level data for 1998. They include only a simple measure of the presence of multinational firms—their output share in an industry, not their export activity—and it is thus not clear which channel leads to spillovers. However, they distinguish between the presence of multinational firms in import-substituting and export-orientated industries and find evidence only for spillovers from export-oriented multinationals. This suggests that the trade regime within which multinationals operate may determine their potential for generating positive export spillovers.

Summary

An extensive array of empirical studies have searched for productivity spillovers from multinationals of various forms. Much of this work has relied on cross-section methods. With the growing availability of longitudinal data at the plant and firm level, however, more analysts are using panel techniques. This is a helpful development for two reasons: first because the plant or firm is the most appropriate level of scrutiny, and second because there are methodological shortcomings associated with applying cross-section techniques.

Much of the work fails to find positive horizontal spillovers on aggregate, with some studies reporting negative effects of multinational presence on domestic productivity. Evidence on horizontal effects on wages and export spillovers is also mixed. However, studies that further disaggregate data into more homogeneous groups of firms or plants find more encouraging results. In particular, there is evidence that the absorptive capacity of domestic firms and their geographic proximity to multinationals are important determinants of whether domestic firms benefit from FDI in the same sector. This suggests that

spillovers may not affect all firms equally but may benefit only firms with high levels of absorptive capacity or close proximity to multinationals. Furthermore, the few studies that have looked at the potential for vertical (interindustry) spillovers find evidence suggesting that vertical spillovers may be a more important channel for knowledge externalities than horizontal spillovers (see also Moran 2001).

Is There a Role for Policy?

In general, most governments see FDI as having greater potential to improve total factor productivity than an equivalent amount of domestic investment. This would be taken as axiomatic in developing and transition economies and, depending on the origin of the multinational firm, in at least some developed economies. Add to this the potential spillovers from multinational firms to domestic firms that are believed to raise their productivity, yielding a second growth bonus, and it becomes clear why attracting inward investment figures prominently in the policy priorities of so many governments. This leads naturally to three questions: Can active policy intervention influence the level and composition of inward investment? Can particular policies maximize the potential for spillovers, both by encouraging multinationals to transfer technologies and by improving the absorptive capacity of domestic firms? Do targeted policies yield net benefits?

Policy and the Level and Composition of FDI

The role of policy in influencing the level and composition of FDI has been reviewed extensively (see, for example, Balasubramanyam and Salisu 2001; Pain 2000; Hanson 2001). Most work relates to developing economies because policy interventions there have in general been more active, though a growing volume of research relates to industrial countries, where most FDI originates.

Several key points emerge from this work.

- Trade policy is relevant. In general, economies with more open trade regimes have done better at attracting FDI and benefiting from it than countries with inward-oriented regimes (Balasubramanyam and others 1996).
- Although there is some evidence that investment incentives can affect the location choice of multinationals, the effect appears to be small (Coughlin and others 1991; Head and others 2000). Head and colleagues (2000) even argue that competition between potential host governments may render incentives ineffective as they offset each other. Also, this form of competition for FDI may have

affected the distribution of incentives and is likely to have redistributed income from host countries to multinational firms (Haaland and Wooton 1999).

- Trade-related investment measures (TRIMS), such as local content requirements and minimum export requirements, are often introduced to recapture some of the rents that accrue to multinational firms. Although these measures can have positive welfare effects on the host country, the evidence does not point to major effects on levels of inward investment in developing economies (Greenaway 1992).
- The quality of local infrastructure is vitally important, in particular communication and transportation facilities, both in attracting initial investments and in sustaining clusters (Coughlin and others 1991; Coughlin and Segev 2000).
- The availability of relatively skilled labor is an important magnet (Coughlin and Segev 2000) as well as a key driver of agglomeration (Ottaviano and Puga 1998). It has also been argued that host countries are more likely to benefit from spillovers if they have a large supply of skilled labor (Keller 1996) and if domestic firms have a high level of technological capacity (Glass and Saggi 1998).

Overall the evidence seems to suggest that interventions should strive largely to provide a supportive economic environment. More specifically, this flags a role for education and training policies aimed at upgrading general skills, technology policies aimed at developing clusters, and public investment policies aimed at developing efficient and reliable transportation and communication networks.

Policy and Spillovers

The evidence on spillovers reported here is mixed at best. There are no clear results that domestic firms always and unambiguously gain from the presence of multinational firms. Several factors could be at play. Under the optimistic view that spillovers occur but measurement instruments are not fine enough to identify them, the question is whether governments can implement policies to maximize the prospects for extracting benefits from multinational firms. General policies—designed to change the environment within which multinationals operate—include industrial policy, infrastructure development, trade policy, exchange rate policy, and so on. There is evidence to suggest that such policies are related to the overall level of inward investment into an economy over a period of time. General policies may turn out to be the most effective means of boosting the probability of positive spillovers. If, for example, absorptive capacity is the critical driver, education and training policy is likely to be key to facilitating spillovers.

As for specific policies, many TRIMS are targeted at encouraging spillovers (table 6). Local content requirements, which have been widely used, are intended to raise the share of local value added in subsidiary production and in the process encourage

Table 6. TRIMS Targeted at Spillovers

Instrument	*Motivation*
Input TRIMS	
Local content requirements	Specify that some proportion of value added or intermediate inputs is locally sourced.
Local equity participation	Specifies that some proportion of the equity must be held locally.
Local hiring targets	Ensure specified employment targets are hit.
Expatriate quotas	Specify a maximum number of expatriate staff.
National participation in management	Specifies that certain staff must be nationals or sets a schedule for the 'indigenisation' of the management.
R&D requirements	Commit multinationals to investment in research and development.
Technology transfer	Commits multinationals to local use of specified foreign technology.
Output TRIMS	
Export controls	Specify that certain products may not be exported.
Licensing requirements	Oblige the investor to license production of output in the host country.
Technology transfer	Commits multinationals to a specified embodied technology.

Source: Derived from Greenaway (1992).

upstream development, with the intention of stimulating interindustry spillovers. Because one can argue that spillovers are more likely if there is some local ownership, local equity requirements are geared to that end. Local hiring targets and expatriate quotas are intended to raise the share of employment accounted for locally, with a view to encouraging spillovers through the transfer of human capital. R&D and technology transfer requirements are intended to make multinational firms commit to some minimum level of R&D expenditures or transfer technology to local firms.[10]

The economics of TRIMS is not straightforward. In general they are second-best measures. For example, analytically a local content requirement is equivalent to an input tariff, though less efficient. What little work has so far been completed on TRIMS has failed to establish a direct link between them and the transfer of useful technologies (Blomström and others 1994; Greenaway 1992). This appears to be because many of the measures are difficult to specify precisely and to monitor. But it is also because the more general policies referred to are in practice rather more important.

Conclusions

FDI is a key driver of economic growth and development. Most governments consider attracting FDI a priority, particularly in developing and transition economies. It is given this emphasis not just because it boosts capital formation but also because it can enhance the quality of the capital stock. The reason is that multinationals are

assumed to bring with them best practice or, as a minimum, better practice technology and management. Moreover, it is possible (even probable) that a given multinational firm will not be able to protect its superior technology or management fully to prevent some elements from being absorbed by indigenous firms. If spillovers occur, they provide an external benefit from FDI, one that governments are hoping to secure when they offer inducements.

Theory points to reasons why spillovers might arise, but finding robust empirical evidence to support their existence is more difficult. This could indicate that the benefits are in fact illusory, in that multinational firms are effective in protecting their assets. But it could as well be that researchers are looking in the wrong place and with the wrong lens. Many studies focus on the industry rather than the firm or plant. The growing availability of survey data at the firm and plant level makes such study increasingly feasible. Most studies use cross-section data when panel data are required for proper analysis.

Because research on disaggregated data with both cross-sectional and longitudinal variation is still limited, the message is clear: More systematic research is needed. More discriminating work is also required, analysis that probes what really matters—form of entry (greenfield or acquisition), ownership characteristics, corporate governance, absorptive capacity of domestic firms, and so on.

The consensus in the policy literature is also clear: General policies aimed at altering the fundamentals are more important than specific policies aimed at attracting particular investments. Such specific policies seem to affect primarily the distribution of rents. Governments compete in offering investment incentives and in the process create rents for multinational firms. They then use (at least some) TRIMS to try to reclaim some of those rents.

Both econometric evidence and survey and case study work suggest that the characteristics of the economic environment are generally much more important: infrastructure, local labor market conditions, reliability of communications systems, and so on, as well as the overall macroeconomic and trade policy climate. That, of course, does not mean that selective interventions will cease to be extensively deployed. Governments will no doubt continue to see opportunities for targeted measures, and multinational firms will stand ready to accept them. This is another area for future work. Very little is known about the comparative impact of different instruments.

Notes

Holger Görg is lecturer in the School of Economics and a research fellow at the Leverhulme Centre for Research on Globalisation and Economic Policy, University of Nottingham. He is also affiliated with the German Institute of Economic Research, Berlin; his e-mail address is holger.gorg@nottingham.ac.uk.

David Greenway is professor of economics and director of the Leverhulme Centre for Research on Globalisation and Economic Policy, School of Economics, University of Nottingham; his e-mail address is david.greenaway@nottingham.ac.uk. Earlier versions of the article were presented at a UN Economic Commission for Europe/European Bank for Reconstruction and Development meeting in Geneva, a UN Economic Commission for Latin America and the Caribbean conference in Mexico City, an Inter-American Development Bank/World Bank conference in Washington, D.C., and a Centre for Economic Policy Research meeting in Turin. The authors wish to thank in particular Wolfgang Keller, Bob Lipsey, Mauricio Mesquita Moreira, Andres Rodríguez-Claré, and Ian Wooton for helpful comments. In addition, reports from four anonymous referees and the managing editors of the journal were extremely helpful. Financial support from the Leverhulme Trust under Programme Grant F114/BF and the European Commission under grant no. SERD-2002–00077 is gratefully acknowledged.

1. For example, Larrain and others (2000) conclude that the location of Intel in Costa Rica has had positive effects on the local economy. Hanson (2001) argues that there is little evidence for spillovers from Intel on domestic firms. He also argues that Ford and General Motors plants in Brazil have failed to show the expected spillover benefits.

2. A related body of literature examines the macro effect of inward FDI on growth in the framework of cross-country growth regressions. See, for example, Balasubramanyam and others (1996), Borensztein and others (1998), and Alfaro and others (forthcoming) for recent evidence. DeMello (1997) provides a review of that literature.

3. Castellani and Zanfei (2002a) argue for the use of the absolute level of foreign activity in the sector rather than foreign activity as a proportion of total activity, because changes of the same magnitude in foreign and aggregate activities within a sector would have no effect on the dependent variable. Although this is an interesting econometric argument, it is not clear what the economic rationale for using absolute rather than relative FDI penetration would be.

4. Interpretation of this coefficient of course hinges on the assumption that the FDI variable does not merely pick up the effect of other correlated factors on productivity—it assumes that a full vector of productivity-augmenting activities is included in the empirical model. Although this may be problematic in some of the studies reviewed herein, it is beyond the scope of this article to discuss this in detail. The article therefore assumes that the estimated FDI coefficient adequately reflects spillovers.

5. Dunne and others (1989) note this for the case of measuring the growth performance of manufacturing plants in the United States.

6. The magnitude of the coefficients, which indicates the strengths of the spillovers, also differs across studies. Görg and Strobl (2001) attempt to explain the differences in magnitude in a meta-regression analysis, using characteristics of the studies (such as data, variables used, countries covered) as explanatory variables.

7. By contrast, Sjöholm (1999b), using cross-sectional data for Indonesian manufacturing firms, finds that productivity spillovers from foreign to domestic firms are larger the larger the technology gap (also defined in terms of differences in labor productivity) and the higher the degree of competition in the industry.

8. Related theoretical models by Rodríguez-Claré (1996) and Markusen and Venables (1999) show that multinationals can have positive effects on the development of domestic firms through vertical input-output linkages. Görg and Strobl (2002a, b) show empirical evidence that the presence of multinational firms has fostered the entry and development of domestic firms in the Republic of Ireland. Alfaro and Rodríguez-Claré (forthcoming) point out that the Rodríguez-Claré (1996) model makes a case for expecting horizontal (intraindustry) rather than vertical spillovers.

9. A related issue is whether FDI contributes to the shift in labor demand toward skilled labor in the host country. See, for example, Feenstra and Hanson (1997) for empirical analysis for Mexico, Figini and Görg (1999) for Ireland, Blonigen and Slaughter (2001) for the United States, and Taylor and Driffield (forthcoming) for the United Kingdom.

10. The Uruguay Round obligated countries to phase out certain TRIMS (those that violate Articles III and XI of the General Agreement on Trade and Tarrifs), with local content requirements being the most prominent. The key issue here, however, is whether they work.

References

Aitken, Brian J., and Ann E. Harrison. 1999. "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela." *American Economic Review* 89(3):605–18.

Aitken, Brian, Gordon H. Hanson, and Ann E. Harrison. 1997. "Spillovers, Foreign Investment, and Export Behavior." *Journal of International Economics* 43(1–2):103–32.

Aitken, Brian, Ann Harrison, and Robert E. Lipsey. 1996. "Wages and Foreign Ownership: A Comparative Study of Mexico, Venezuela, and the United States." *Journal of International Economics* 40(3–4):345–71.

Alfaro, Laura, and Andres Rodríguez-Claré. Forthcoming. "Multinationals and Linkages: An Empirical Investigation." *Economia.*

Alfaro, Laura, Areendam Chanda, Sebnem Kalemli-Ozcan, and Selin Sayek. Forthcoming. "FDI and Economic Growth: The Role of Local Financial Markets." *Journal of International Economics.*

Audretsch, David B. 1998. "Agglomeration and the Location of Innovative Activity." *Oxford Review of Economic Policy* 14(2):18–29.

Balasubramanyam, V. N., and Mohammed Salisu. 2001. "Foreign Direct Investment and Globalisation." In S. Lahiri, ed., *Regionalism and Globalisation.* London: Routledge.

Balasubramanyam, V. N., Mohammed Salisu, and David Sapsford. 1996. "Foreign Direct Investment and Growth in EP and IS Countries." *Economic Journal* 106(434):92–105.

Baldwin, Robert. 1969 "The Case against Infant Industry Protection." *Journal of Political Economy* 77:295–305.

Banga, Rashmi. 2003. "The Differential Impact of Japanese and U.S. Foreign Direct Investments on Exports of Indian Manufacturing." Working paper, Delhi School of Economics, India.

Barrios, Salvador, and Eric Strobl. 2002. "Foreign Direct Investment and Productivity Spillovers: Evidence from the Spanish Experience." *Weltwirtschaftliches Archiv* 138:459–81.

Barrios, Salvador, Holger Görg, and Eric Strobl. 2003. "Explaining Firms' Export Behaviour: R&D, Spillovers and the Destination Market." *Oxford Bulletin of Economics and Statistics* 65(4):475–96.

Bernard, Andrew, and J. Bradford Jensen. 1999. "Exceptional Exporter Performance: Cause, Effect or Both?" *Journal of International Economics* 47(1):1–26.

Bernard, Andrew, and Joachim Wagner. 1997. "Exports and Success in German Manufacturing." *Weltwirtschaftliches Archiv* 133:134–57.

Blalock, Garrick, and Paul Gertler. 2003. "Technology from Foreign Direct Investment and Welfare Gains through the Supply Chain." Working paper, Cornell University, Ithaca, N.Y.

Blomström, Magnus. 1986. "Foreign Investment and Productive Efficiency: The Case of Mexico." *Journal of Industrial Economics* 35(1):97–112.

Blomström, Magnus, and Ari Kokko. 1998. "Multinational Corporations and Spillovers." *Journal of Economic Surveys* 12(3):247–77.

Blomström, Magnus, and Håkan Persson. 1983. "Foreign Investment and Spillover Efficiency in an Underdeveloped Economy: Evidence from the Mexican Manufacturing Industry." *World Development* 11(6):493–501.

Blomström, Magnus, and Fredrik Sjöholm. 1999. "Technology Transfer and Spillovers: Does Local Participation with Multinationals Matter?" *European Economic Review* 43(4–6):915–23.

Blomström, Magnus, and Edward N. Wolff. 1994. "Multinational Corporations and Productive Convergence in Mexico." In William J. Baumol, Richard R. Nelson, and Edward N. Wolff, eds., *Convergence of Productivity: Cross National Studies and Historical Evidence.* Oxford: Oxford University Press.

Blomström, Magnus, Ari Kokko, and Mario Zejan. 1994. "Host Country Competition, Labor Skills, and Technology Transfer by Multinationals." *Weltwirtschaftliches Archiv* 130:521–33.

Blonigen, Bruce A., and Matthew J. Slaughter. 2001. "Foreign-Affiliate Activity and U.S. Skill Upgrading." *Review of Economics and Statistics* 83(2):362–76.

Borensztein, E., J. De Gregorio, and J.-W. Lee. 1998. "How Does Foreign Direct Investment Affect Economic Growth?" *Journal of International Economics* 45(1):115–35.

Bosco, Maria Giovanna. 2001. "Does FDI Contribute to Technological Spillovers and Growth? A Panel Data Analysis of Hungarian Firms" *Transnational Corporations* 10(1):43–68.

Brainard, S. Lael. 1997. "An Empirical Assessment of the Proximity-Concentration Trade-Off between Multinational Sales and Trade." *American Economic Review* 87(4):520–44.

Castellani, Davide, and Antonello Zanfei. 2002a. "Multinational Companies and Productivity Spillovers: Is there a Specification Error?" Working paper, University of Urbino, Italy.

———. 2002b. "Technology Gaps, Absorptive Capacity and the Impact of Inward Investments on Productivity of European Firms." Working paper, University of Urbino, Italy.

Caves, Richard E. 1974. "Multinational Firms, Competition, and Productivity in Host-Country Markets." *Economica* 41(162):176–93.

———. 1996. *Multinational Enterprise and Economic Analysis*, 2nd ed. Cambridge: Cambridge University Press.

Chuang, Yih-Chyi, and Chi-Mei Lin. 1999. "Foreign Direct Investment, R&D and Spillover Efficiency: Evidence from Taiwan's Manufacturing Firms." *Journal of Development Studies* 35(4):117–37.

Clerides, S. K., S. Lach, and J. R. Tybout. 1998. "Is Learning by Exporting Important? Micro-Dynamic Evidence from Colombia, Mexico, and Morocco." *Quarterly Journal of Economics* 113(3):903–48.

Coughlin, Cletus C., and Eran Segev. 2000. "Location Determinants of New Foreign-Owned Manufacturing Plants." *Journal of Regional Science* 40(2):323–51.

Coughlin, Cletus C., Joseph V. Terza, and Vachira Arromdee. 1991. "State Characteristics and the Location of Foreign Direct Investment within the United States." *Review of Economics and Statistics* 73(4):675–83.

Damijan, Joze P., Boris Majcen, Mark Knell, and Matija Rojec. 2001. "The Role of FDI, Absorptive Capacity and Trade in Transferring Technology to Transition Countries: Evidence from Firm Panel Data for Eight Transition Countries." UN Economic Commission for Europe, Geneva.

Das, Sanghamitra. 1987. "Externalitites, and Technology Transfer through Multinational Corporations: A Theoretical Analysis." *Journal of International Economics* 22(1–2):171–82.

Deardorff, Alan. 2003. "What Might Globalisation's Critics Believe?" *World Economy* 26(5):639–58.

Delgado, M., J. Fariñas, and S. Ruano. 2002. "Firm Productivity and Export Markets: A Non-Parametric Approach." *Journal of International Economics* 57(2):397–422.

DeMello, Luiz R. 1997. "Foreign Direct Investment in Developing Countries and Growth: A Selective Survey." *Journal of Development Studies* 34(1):1–34.

Dimelis, Sophia, and Helen Louri. 2002. "Foreign Direct Investment and Efficiency Benefits: A Conditional Quantile Analysis." *Oxford Economic Papers* 54:449–69.

Djankov, Simeon, and Bernard Hoekman. 2000. "Foreign Investment and Productivity Growth in Czech Enterprises." *World Bank Economic Review* 14(1):49–64.

Driffield, Nigel. 2001. "The Impact on Domestic Productivity of Inward Investment in the UK." *Manchester School* 69(1):103–19.

Driffield, Nigel, and Sourafel Girma. 2003. "Regional Foreign Direct Investment and Wage Spillovers: Plant Level Evidence from the Electronics Industry." *Oxford Bulletin of Economics and Statistics*: 65(4):453–74.

Driffield, Nigel, Max Munday, and Annette Roberts. 2002. "Foreign Direct Investment, Transactions Linkages, and the Performance of the Domestic Sector." *International Journal of the Economics of Business* 9(3):335–51.

Dunne, Timothy, Mark J. Roberts, and Larry Samuelson. 1989. "The Growth and Failure of U.S. Manufacturing Plants." *Quarterly Journal of Economics* 104(4):671–98.

Feenstra, Robert C., and Gordon H. Hanson. 1997. "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras." *Journal of International Economics* 42(3–4):371–93.

Figini, Paolo, and Holger Görg. 1999. "Multinational Companies and Wage Inequality in the Host Country: The Case of Ireland." *Weltwirtschaftliches Archiv* 135:594–612.

Findlay, Ronald. 1978. "Relative Backwardness, Direct Foreign Investment, and the Transfer of Technology: A Simple Dynamic Model." *Quarterly Journal of Economics* 92(1):1–16.

Fosfuri, Andrea, Massimo Motta, and Thomas Rønde. 2001. "Foreign Direct Invesment and Spillovers through Workers' Mobility." *Journal of International Economics* 53(1):205–22.

Girma, Sourafel. 2002. "Geographic Proximity, Absorptive Capacity and Productivity Spillovers from FDI: A Threshold Regression Analysis." GEP Research Paper 02/06. University of Nottingham, UK.

Girma, Sourafel, and Holger Görg. 2002. "Foreign Direct Investment, Spillovers and Absorptive Capacity: Evidence from Quantile Regressions." GEP Research Paper 02/14. University of Nottingham, UK.

Girma, Sourafel, and Katharine Wakelin. 2002. "Are There Regional Spillovers from FDI in the UK?" In David Greenaway, Richard Upward, and Katharine Wakelin, eds., *Trade, Investment, Migration and Labour Markets*. Basingstoke, UK: Macmillan.

Girma, Sourafel, David Greenaway, and Katharine Wakelin. 2001. "Who Benefits from Foreign Direct Investment in the UK?" *Scottish Journal of Political Economy* 48(2):119–33.

Girma, Sourafel, Holger Görg, and Mauro Pisu. 2003. "The Role of Exports and Foreign Linkages for FDI Productivity Spillovers." Working paper, University of Nottingham, United Kingdom.

Girma, Sourafel, David Greenaway, and Richard Kneller. Forthcoming. "Entry to Export Markets and Productivity: A Microeconometric Analysis of Matched Firms." *Review of International Economics*.

Glass, Amy, and Kamal Saggi. 1998. "International Technology Transfer and the Technology Gap." *Journal of Development Economics* 55(2):369–98.

———. 2002. "Multinational Firms and Technology Transfer." *Scandinavian Journal of Economics* 104(4):495–514.

Globerman, Steven. 1979. "Foreign Direct Investment and 'Spillover' Efficiency Benefits in Canadian Manufacturing Industries." *Canadian Journal of Economics* 12(4):42–56.

Görg, Holger. 2002. "Fancy a Stay at the 'Hotel California'? Foreign Direct Investment, Taxation and Exit Costs." GEP Research Paper 02/28. University of Nottingham, UK.

Görg, Holger, and Eric Strobl. 2001. "Multinational Companies and Productivity Spillovers: A Meta-Analysis." *Economic Journal* 111(473):F723–39.

———. 2002a. "Multinational Companies and Entrant Start-up Size: Evidence from Quantile Regressions." *Review of Industrial Organization* 20(1):15–31.

———. 2002b. "Multinational Companies and Indigenous Development: An Empirical Analysis." *European Economic Review* 46(7):1305–22.

———. 2002c. "Spillovers from Foreign Firms through Worker Mobility: An Empirical Investigation." GEP Research Paper 02/13. University of Nottingham, UK.

———. 2003. "Multinational Companies, Technology Spillovers and Plant Survival." *Scandinavian Journal of Economics* 105(4):581–95.

Görg, Holger, Eric Strobl, and Frank Walsh. 2003. "Why Do Foreign Firms Pay More? The Role of On-the-job Training." GEP Research Paper 02/15. University of Nottingham, UK.

Greenaway, David. 1992. "Trade Related Investment Measures and Development Strategy." *Kyklos* 45(2):139–60.

Greenaway, David, Nuno Sousa, and Katharine Wakelin. Forthcoming. "Do Domestic Firms Learn to Export from Multinationals?" *European Journal of Political Economy*.

Haacker, Marcus. 1999. "Spillovers from Foreign Direct Investment through Labour Turnover: The Supply of Management Skills." CEP Discussion Paper. London School of Economics.

Haaland, Jan I., and Ian Wooton. 1999. "International Competition for Multinational Investment." *Scandinavian Journal of Economics* 101(4):631–49.

Haddad, Mona, and Ann Harrison. 1993. "Are There Positive Spillovers from Direct Foreign Investment? Evidence from Panel Data for Morocco." *Journal of Development Economics* 42(1):51–74.

Hanson, Gordon H. 2001. "Should Countries Promote Foreign Direct Investment?" G-24 Discussion Paper 9. UNCTAD, Geneva.

Harris, Richard, and Catherine Robinson. 2004. "Productivity Impacts and Spillovers from Foreign Ownership in the United Kingdom." *National Institute Economic Review* 187:58–75.

Haskel, Jonathan E., Sonia C. Pereira, and Matthew J. Slaughter. 2002. "Does Inward Foreign Direct Investment boost the Productivity of Domestic Firms?" NBER Working Paper 8724. Cambridge, Mass.

Head, Keith. 1998. "Comment on 'Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States.' " In R. Baldwin, R. Lipsey, and J. D. Richardson, eds., *Geography and Ownership as Bases for Economic Accounting*. Chicago: Chicago University Press.

Head, Keith C., John C. Ries, and Deborah L. Swenson. 2000. "Attracting Foreign Manufacturing: Investment Promotion and Agglomeration." *Regional Science and Urban Economics* 29(2):197–218.

Kathuria, Vinish. 2000. "Productivity Spillovers from Technology Transfer to Indian Manufacturing Firms." *Journal of International Development* 12(2):343–69.

Keller, Wolfgang. 1996 "Absorptive Capacity: Understanding the Creation and Acquisition of Technology in Development." *Journal of Development Economics* 49:199–227.

———. 2001. "International Technology Diffusion." NBER Working Paper 8573. Cambridge, Mass.

Keller, Wolfgang, and Stephen Yeaple. 2003. "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States." GEP Research Paper 03/03. University of Nottingham, UK.

Kinoshita, Yuko. 2001. "R&D and Technology Spillovers through FDI: Innovation and Absorptive Capacity. CEPR Discussion Paper DP2775. Centre for Economic Policy Research, London.

Kokko, Ari. 1994. "Technology, Market Characteristics, and Spillovers." *Journal of Development Economics* 43(2):279–93.

———. 1996. "Productivity Spillovers from Competition between Local Firms and Foreign Affiliates." *Journal of International Development* 8(4):517–30.

Kokko, Ari, Ruben Tansini, and Mario C. Zejan. 1996. "Local Technological Capability and Productivity Spillovers from FDI in the Uruguayan Manufacturing Sector." *Journal of Development Studies* 32:602–11.

Kokko, Ari, Mario Zejan, and Ruben Tansini. 2001. "Trade Regimes and Spillover Effects of FDI: Evidence from Uruguay." *Weltwirtschaftliches Archiv* 137:124–49.

Konings, Jozef. 2001. "The Effects of Foreign Direct Investment on Domestic Firms: Evidence from Firm Level Panel Data in Emerging Economies." *Economics of Transition* 9(3):619–33.

Kugler, Maurice. 2001. "The Diffusion of Externalities from Foreign Direct Investment: The Sectoral Pattern of Technological Spillovers." Working paper, University of Southampton, UKm.

Larrain, Felipe B., Luis F. Lopez-Calva, and Andres Rodriguez-Claré. 2000. "Intel: A Case Study of Foreign Direct Investment in Central America." Center for International Development Working Paper 58. Harvard University, Cambridge, Mass.

Li, Xiaoying, Xiaming Liu, and David Parker. 2001. "Foreign Direct Investment and Productivity Spillovers in the Chinese Manufacturing Sector." *Economic Systems* 25(4):305–21.

Lipsey, Robert E. 2002. "Home and Host Country Effects of FDI." NBER Working Paper 9293. Cambridge, Mass.

Lipsey, Robert E., and Fredrik Sjöholm. 2001. "Foreign Direct Investment and Wages in Indonesian Manufacturing." NBER Working Paper 8299. Cambridge, Mass.

Liu, Xiaming, Pamela Siler, Chengqi Wang, and Yingqi Wei. 2000. "Productivity Spillovers from Foreign Direct Investment: Evidence from UK Industry Level Panel Data." *Journal of International Business Studies* 31(3):407–25.

López-Córdova, J. Ernesto. 2002. "NAFTA and Mexico's Manufacturing Productivity: An Empirical Investigation Using Micro-Level Data." Working paper, Inter-American Development Bank, Washington, D.C.

Markusen, James R. 1995. "The Boundaries of Multinational Enterprises and the Theory of International Trade." *Journal of Economic Perspectives* 9(2):169–89.

Markusen, James R., and Anthony J. Venables. 1999. "Foreign Direct Investment as a Catalyst for Industrial Development." *European Economic Review* 43(2):335–56.

McCullogh, Neil, Alan Witners, and Xavier Cirera. 2001. "Trade Liberalisation and Poverty: A Handbook." Working paper, Centre for Economic Policy Research, London.

Moran, Theodore. 2001. *Parental Supervision: The New Paradigm for Foreign Direct Investment and Development.* Washington, D.C.: Institute for International Economics.

Ottaviano, Gianmarco I. P., and Diego Puga. 1999. "Agglomeration in the Global Economy: A Survey of the New Economic Geography." *World Economy* 21(6):707–31.

Pain, Nigel, ed. 2000. *Inward Investment Technological Change and Growth*, London: Palgrave.

Rodríguez-Claré, Andres. 1996. "Multinationals, Linkages, and Economic Development." *American Economic Review* 86(4):852–73.

Ruane, Frances, and Ali Ugur. 2002. "Foreign Direct Investment and Productivity Spillovers in Irish Manufacturing Industry: Evidence from Firm Level Panel Data." Trinity Economic Papers 02/06. Trinity College, Dublin.

Saggi, Kamal. 2002. "Trade, Foreign Direct Investment, and International Technology Transfer: A Survey." *World Bank Research Observer* 17(2):191–235.

Sjöholm, Fredrik. 1999a. "Technology Gap, Competition and Spillovers from Direct Foreign Investment: Evidence from Establishment Data." *Journal of Development Studies* 36(1):53–73.

———. 1999b. "Productivity Growth in Indonesia: The Role of Regional Characteristics and Direct Foreign Investment." *Economic Development and Cultural Change* 47(3):559–84.

Smarzynska-Javorcik, Beata K. Forthcoming. "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages." *American Economic Review.*

Taylor, Karl, and Nigel Driffield. Forthcoming. "Wage Inequality and the Role of Multinationals: Evidence from UK Panel Data." *Labour Economics.*

UN (United Nations). 1999. World Investment Report. Geneva: United Nations.

Wang, Jian-Ye, and Magnus Blomström. 1992. "Foreign Investment and Technology Transfer: A Simple Model." *European Economic Review* 36(1):137–55.

Wheeler, David, and Ashoka Mody. 1992. "International Investment Location Decisions: The Case of U.S. Firms." *Journal of International Economics* 33(1–2):57–76.

Zukowska-Gagelmann, Katarzyna. 2000. "Productivity Spillovers from Foreign Direct Investment in Poland." *Economic Systems* 24(3):223–56.

Policies on Managing Risk in Agricultural Markets

Donald F. Larson • Jock R. Anderson • Panos Varangis

Over the past dozen years, policymakers have largely abandoned long-standing popular approaches for addressing risk in agriculture without fully resolving the question of how best to manage the negative consequences of volatile agricultural markets. The article reviews the transition from past policies and describes current approaches that distinguish between the trade-related fiscal consequences of commodity market volatility and the consequences of price and production risks for vulnerable rural households and communities. Current policies rely more heavily on markets, even though markets for risk are incomplete in numerous ways. The benefits and limitations of market-based instruments are examined in the context of risk management strategies, and innovative approaches to extend the reach of risk markets are discussed.

For decades governments have intervened to reduce risk in markets for internationally traded commodities. Over the past dozen years, however, many of the policies and supporting institutions used for that purpose were reevaluated and found to be not only ineffective and unsustainable but impediments to growth. Most of these approaches have now been abandoned, but governments and policymakers still seek to understand how best to manage the negative consequences of volatile commodity markets because traded commodities remain an important source of export earnings for many developing economies and an important component of income and consumption for the poor.

This article reviews the historical relationship between the work of applied economists and policymakers and the commodity and risk market instruments introduced in the 1980s. It explores how a growing body of analytical work contributed to a change in thinking that moved the emphasis of policy from stabilization to management of risks, and it surveys current thinking on managing rural risks.

The World Bank Research Observer, vol. 19, no. 2.
© The International Bank for Reconstruction and Development / THE WORLD BANK 2004; all rights reserved.
doi:10.1093/wbro/lkh022 19:199–230

Efforts Aimed at Stabilization

By the 1980s unilateral and multilateral interventions in commodity markets to achieve macroeconomic and commodity market stabilization were common. International commodity organizations employed buffer stocks or managed trade, trying to bring order to unstable commodity markets. The United States used support prices and inventories to manage domestic prices. The European Union had a similar scheme and also operated a set of commodity-specific exchange rates—"green rates"—for trade among EU members. Marketing boards and stabilization stocks and funds were common in both developed and developing economies. For developing economies, lines of credit were available at the International Monetary Fund (IMF) and elsewhere to support these operations.

Both historical and practical considerations led to such interventions (Larson and others 1998; Akiyama and others 2001), but a great many of the interventions—especially the multilateral interventions—were also motivated by prevailing economic thought.

At the close of World War II, policymakers focused on ways to prevent short-term trade shocks from turning into the widespread economic decline that characterized the Great Depression years. In an age of gold-standard fixed currencies, central banks were often challenged to manage shocks in export earnings. At Bretton Woods, Keynes (1943) proposed a world currency based on a price index of the 30 most traded commodities. With currencies linked to the index, commodity prices and price-related swings in trade earnings would be stabilized largely automatically. Although Keynes's ideas were not incorporated into the charters of the Bretton Woods institutions, an alternative approach of linking lending to commodity volatility emerged. A succession of internationally backed compensatory financing schemes were proposed in the years following the Bretton Woods conference, including the 1953 Olano Proposal for a Mutual Insurance Scheme, the 1961 Development Insurance Fund, the 1962 Organization of American States Proposal, and the 1963 Swedish and Brazilian proposals at the Committee for International Commodity Trade meetings and the French Proposal for Market Organizations.

Also in 1963 the IMF began to offer compensatory financing to countries experiencing unexpected temporary declines in export earnings. The program is based on net export earnings, rather than a single set of commodities, thus taking advantage of any natural portfolio effect that might arise from diversified exports and imports. With modifications, this program remains the primary instrument among the Bretton Woods institutions for handling the effects of volatile commodity trade. Later, as part of the first Lomé Agreement in 1975, the European Union offered its own compensatory financing schemes, STABEX and SYSMIN, to the African, Caribbean, and Pacific group of states.

In 1950 Prebisch (1950) and Singer (1950) independently offered the hypothesis that the prices of primary commodity exports would fall relative to those of

manufactured imports because of differing elasticities of income and demand. Consequently, the net barter terms of trade for commodity-producing developing economies would decline. This contradicted the long-standing notion of increasing scarcity put forward by Malthus, Ricardo, and Hotelling. Soon thereafter, the two ideas became entwined so that the "commodity dependency" problem was characterized by declining terms of trade and volatile export earnings.[1] Generally, economists argued that instability of export earnings limited development through adverse effects on income, inflation, savings, and investment. As a consequence, international efforts were extended to key commodity markets as well. Later, Massell (1969, 1970) integrated these ideas in a model for estimating the benefits of stabilizing commodity markets. More than a decade after that, Newbery and Stiglitz (1981, p. 18) commented:

> The predictions of the (Massell 1969) model are readily derived... and are quite precise: (i) producers gain and consumers lose from price stabilization if the source of instability lies on the supply side; (ii) consumers gain and producers lose from price stabilization if the source of instability lies on the demand side; (iii) in both cases, gainers could afford to over-compensate the losers, so there are net benefits from price stabilization.

Policies of the era were motivated by macroeconomic considerations, and analysis was largely sectoral. Price levels, price stability, and spatial price differences were the principal policy targets. The macroeconomic focus derived in part from the belief that the domestic income effects or trade effects associated with volatile agricultural and other commodity markets were an impediment to economic growth. The focus was conditioned as well by the dominant view that agriculture's role in development was as a supplier of "surplus" labor (Lewis 1955). The emphasis on price emerged in part from the empirical observation that commodity prices were the primary source of commodity income volatility (Johnson 1947; Massell 1969). There were practical considerations as well, especially for developing economies, where few alternative instruments are available for redirecting resources (Timmer 1989). For traded commodities governments could frequently gain some measure of control by imposing quotas or tariffs while allowing domestic markets to function with fewer interventions. Moreover, information gathering is simpler for prices than for supply, allowing government managers to react more quickly.

A series of international interventions were structured for dealing with price volatility, a concern for both developed and developing economies. Under UN auspices, five international commodity agreements were signed by producing and consuming countries: the International Sugar Agreement (1954), the Tin Agreement (1954), the Coffee Agreement (1962), the Cocoa Agreement (1972), and the Natural Rubber Agreement (1980). A 1968 UN Conference on Trade and Development proposal resulted in a 1975 resolution calling for an Integrated Program for Commodities

covering 10 core commodities. The Common Fund for Commodities was established to provide liquidity for the integrated program. Moving more rapidly, the IMF established its Buffer Stock Financing Facility on June 25, 1969.

Governments began to run unilateral domestic stabilization programs as well. The European Union, Japan, and the United States all operated systems that combined minimum price guarantees with government-controlled inventories. Developing economies took up a variety of stabilization efforts as well (Knudsen and Nash 1990). These included buffer stock schemes (Bangladesh, India, Indonesia, Republic of Korea, Mexico, the Philippines), buffer funds (Côte d'Ivoire, Republic of Korea, Papua New Guinea), marketing boards with monopolies on trade (Ecuador, India, Malaysia, most of Africa), and variable tariff schemes (Chile, Malaysia, Venezuela). Although price stabilization was a common objective, multiple, often competing objectives emerged as well, complicating administration of the programs and speeding their demise.

In Asia and Africa policymakers faced additional challenges. Following a series of devastating famines between 1967 and 1975 in Biafra (Nigeria), Bangladesh, Ethiopia, and throughout the Sahel, self-sufficiency and food security became driving concerns for many developing economies. Controls on trade or domestic supply were modified to meet multiple objectives. Large state enterprises, such as Conasupo in Mexico, the Bulog in Indonesia, and grain boards throughout Africa, were charged with managing domestic inventories of food.

Challenges to Stabilization Approaches

Although the argument that volatility reduced investment and subsequently led to lower rates of growth in commodity-dependent countries was appealing, economists found only weak empirical evidence of a direct link. Using data on Malaysian rubber plantations, Caine (1954) challenged the negative link between revenue instability and investment. Later, MacBean (1966) also challenged the findings using cross-country data, as did Knudsen and Parnes (1975). Deaton (1992) found for Africa overall that the expansions in investments and income during periods of increasing export prices were greater than the contractions during periods of falling prices. Dawe (1996) calculated instability indices for a cross-section of countries based on shares of exports and found that export instability was negatively associated with growth and investment.

Increasingly, economists began to wonder whether the link between low growth and volatile commodity markets had more to do with government mismanagement than with private investment. Bourguignon and Gelb (1988) found evidence for this view for Venezuela, as did Bevan and others (1990) for Nigeria and Indonesia. Hausmann and Gavin (1996) argued that uncertainty over commodity-dependent

government revenues (and fiscal management) had a cascading negative effect on the economies of Latin America. Rodrik (1998) argued that the link between short-term economic shocks and growth was determined by the ability of domestic institutions to manage the political strife that such shocks initiate.

Some economists also argued that the benefits of stabilization were overstated. Friedman (1954) stressed the importance of private savings rather than public stabilization schemes in solving the "producer income problem." Newbery and Stiglitz (1981) argued that the Massell model was flawed in ways that exaggerated the benefits of stabilization. An important and frequent finding is that the welfare gains that are possible from price stabilization are small (Anderson and others 1981; Myers and Oehmke 1988; Wright 1988; Kannapiran 2000). Moreover, the practical implementation of stabilization schemes raises many thorny problems for program administrators (Anderson and others 1977b).

Early on, Bauer and Parish (1952) noted that the stabilization objectives of most marketing boards were ill defined and potentially a guise for taxation. Quiggin and Anderson (1979, 1981) discussed the limits of price bands and buffer funds. Wright and Williams (1990) noted the widespread failure of domestic stabilization schemes of all sorts and linked the failure to the nature of commodity prices and underlying models of storage. Examining the time-series properties of commodity prices, Deaton and Laroque (1992) argued that the series tended to be mean-reverting—a condition for a successful stabilization fund—but that the reversion took place over years; consequently, successful stabilization funds needed impractically large lines of credit. Townsend (1977) and Larson and Coleman (1993) discussed the likelihood of bankruptcy for stabilization schemes, even when hedging markets are used.

As the poor performance of stabilization schemes became more evident, analysts began to emphasize the distinction between policies to change the distribution of prices internationally or domestically and policies to manage uncertainty using markets for price risk. McKinnon (1967) explored futures markets as an alternative to buffer stocks. Later, Gilbert (1985) demonstrated that hedging on forward markets could achieve some of the welfare gains normally associated with buffer stocks. Gemmill (1985) argued that futures markets for cocoa, coffee, and sugar were an attractive mechanism for hedging export earnings risks and that forward contracts could be substantially cheaper than buffer stock operations. O'Hara (1984) looked at the use of commodity bonds to stabilize consumption. Rolfo (1980) investigated the use of futures for cocoa producer prices and calculated the optimal hedge ratio when there was both production (output) and price volatility. Overdahl (1987) demonstrated the benefits of oil futures markets for oil-producing states.

The volume edited by Priovolos and Duncan (1991) brought together much of the new thinking on the use of market instruments to manage government debt. Myers and Thompson (1991) presented a model of external debt management that included commodity-linked bonds. Claessens (1991) pointed out that commodity

bonds can be used to hedge debt management problems associated with volatile export earnings. Wright and Newbery (1991) proposed commodity-linked financial instruments to smooth commodity export revenue, and Anderson and others (1991) looked at the role of partial guarantees and commodity contingency. A related volume, edited by Claessens and Duncan (1993), presented case studies showing how markets could be used to achieve many of the sectoral stabilization objectives of existing programs in a sustainable way.

About the same time, evidence was mounting that many of the interventions intended to facilitate growth had instead become impediments. Many stabilization policies limited competition and misdirected resources. But more important, many policies had inconsistent objectives. The same governments that sought to protect producers from the negative consequences of volatile commodity markets also taxed their producers directly or indirectly to spur industrialization and favor urban interests. Influential studies by Krueger and others (1991) and Mundlak and others (1993) documented the negative consequences of these policies and recommended sweeping reforms.

Most telling was the growing evidence that the interventions failed to have their intended effect, most often because they could not be sustained. Growing expenditures on stabilization and support programs led to a lessening of support in the European Union, Japan, and the United States, whereas untargeted efforts to subsidize consumers or producers proved expensive for developing economies (Akiyama and others 2001). The international commodity agreements were unable to adapt to changes in the market, and by 1996 their economic clauses had all lapsed or failed (Gilbert 1987, 1996), victims of politics and economics (table 1). Funds dedicated to buffer stock management at the Common Fund have never been used for that purpose. The IMF eliminated its Buffer Stock Financing Facility in February 2000. Signaling an end to the era of international commodity market interventions, STABEX and SYSMIN were abolished with the Cotonou Agreement in June 2000.

By the 1990s domestic regimes were being reformed as well in response to the changing view of government's role in commodity markets; a series of political changes, market events, and crises; and the urging of multilateral lenders such as

Table 1. Life Cycles of Recent International Commodity Agreements

Item	*Sugar*	*Coffee*	*Cocoa*	*Rubber*
Initial agreement date	1954	1962	1972	1980
Status of economic clauses	Lapsed in 1963 and 1983	Suspended in 1989	Suspended in 1988	Suspended in 1996; revived in 1997; suspended in 1999
Number of treaties	4	4	4	4

Source: Gilbert (1995) and Varangis and Larson (1996), updated by the authors.

the World Bank (Meerman 1997). How quickly reforms were undertaken and how well they succeeded depended greatly on the timing and initial conditions. Some reforms came as a result of fiscal crises, spurred in part by events in international markets, and were implemented with little planning. Some reforms yielded quick results, with smallholders' incomes rising rapidly as interventions came to an end. The extent of reforms differed greatly by commodity as well, with reforms common in coffee markets and rare in sugar markets (Akiyama and others 2003). But as domestic and international institutions charged with stabilizing commodity prices were systematically dismantled, policymakers became concerned that reforms had exacerbated volatility problems.[2] New approaches were sought.

Thus from the time of the Bretton Woods Conference through the structural reform period of the 1990s, policymakers and development economists seeking to manage the risks associated with commodity markets focused first on macroeconomic issues of stability and growth and later on the efficacy and sustainability of stabilization policies. There was frequently a tendency to blur the distinctions between two sets of problems related to commodity risks: the inability of some governments to prudently manage volatile revenues and expenditures and the limited capacity of vulnerable rural households to diminish the consequences of risks and the high costs of trying to do so.

Though earlier approaches relied on sectoral instruments (such as buffer stocks or trade interventions) for both problems, current approaches advocate separate treatment. This is not to dismiss the link between macroeconomic stabilization policies and rural incomes. Macroeconomic policy associated with stabilization still significantly affects rural incomes through rural–urban terms of trade, remittances from urban and overseas workers with links to rural communities, and government financing of rural development projects and safety nets. But agricultural commodities today are less frequently a source of macroeconomic instability than they were two decades ago because of greater diversification and declining international prices. Dependence on agricultural commodities is more common for households, communities, and regions than for national economies. Exceptions, where export earnings for agricultural commodities remain an important component of national income, are concentrated among the poorest countries, where aid flows and debt muddle the links between commodity stabilization and macroeconomic stabilization (Collier 2002).

Toward Rural Risk Management Strategies

Helping make the conceptual distinction between the problems of macroeconomic stabilization and rural risk management was ongoing work on the role of risk in farming households and communities. Early examples include Schultz (1945), Johnson (1950), and Heady (1952) on the United States. Risk also began to receive

explicit treatment in agricultural modeling exercises (Freund 1956) and early theoretical models of preference (Pratt 1964; Arrow 1965). Dillon (1971), Anderson and others (1977a), and Musser and Patrick (2002) survey the literature. Similar themes were addressed, first by anthropologists and later by economists, in the context of how traditional peasant societies managed risk (Schultz 1964; Stern 1989). Related work examined sharecropping arrangements (Cheung 1969).

Concurrently, household-focused studies provided additional empirical information about the relationship between risk and behavior. This research was made practical by newly available village and household surveys, especially a series undertaken by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). From that research came strong evidence that farmers in poor rural communities are risk-averse and take reasonable actions that result in lower but more stable incomes. Researchers began to distinguish between planning strategies and coping strategies. They also distinguished among price, production, and income risks; between idiosyncratic and systemic risk; and between rare natural disaster risk and more frequent risks. Researchers also explored the capacity of households to self-insure and both formal and informal arrangements for sharing risks within communities. Early examples are Moscardi and de Janvry (1977), Dillon and Scandizzo (1978), Binswanger (1980), Hazell (1982), and Antle (1989). Fafchamps (1999) and Dercon (2002) review informal mechanisms, and Moschini and Hennessy (2001) review agricultural risk studies in the context of formal and incomplete markets.

At the same time, development institutions and policymakers began to search for ways to measure the microeconomic effects of macroeconomic and sectoral policies meant to spur economic growth. This required finding better ways to measure poverty and analyze its causes. This new approach led to several institutional changes by development organizations. Examples from the World Bank include the treatment of uncertainty in project appraisal, *World Development Report 1990: Poverty* and subsequent related research, the rise in lending for targeted safety nets, and the sponsorship of household surveys and related analytical tools.[3]

From these developments emerged a more systemic view of risk and risk management that involves multiple strategies (prevention, mitigation, coping, management) and arrangements (informal, market-based, public) for dealing with risk and instruments that take account of the sources and characteristics of rural risk (Robison and Barry 1987; Anderson and Dillon 1992; McConnell and Dillon 1997; Hardaker and others 2004). The theme was featured in the 2001 updating of the World Bank rural development strategy (Anderson 2001) and social protection strategy (World Bank 2001).

Because the type and severity of the risks confronting farmers and others vary greatly with farming systems, climate, infrastructure, policy, and institutional settings, there is a certain boundlessness to the issues and few general prescriptions about

strategies to manage risk are possible. Rather, the sections that follow discuss some of the formal and informal mechanisms for managing rural risk.

Although the relevance of these mechanisms depends on local circumstances, there are some typical characteristics of development that affect the availability of these instruments and the demand for them. Keeping key differences among countries in mind is especially important when drawing generalizations from research based on specific household surveys, particularly those in India, Ethiopia, and Thailand.

Generally, as countries develop, rural communities become more diversified in their sources of income, the share of the population engaged in agriculture shrinks (Lanjouw and Lanjouw 1995; Larson and Mundlak 1997), and farmers become more commercialized and specialized. Formal markets of all sorts—for inputs, credit, insurance, information, and outputs—are more likely to arise and mature as countries develop. In part all this comes about because governments are better able to safeguard the security of persons and property and to enforce contracts (North 1994). Finally, the most obvious differences are in accumulations—of wealth, infrastructure, human capital—that affect the vulnerability of rural households and communities and the role of policy in managing agricultural risks. This means that the hurdles to accessing risk markets are higher in countries and communities where there is less capacity to self-insure.

Vulnerability, Ex Ante Choices, and Ex Post Adjustments

The consequences of risk for rural households are related both to the types of risks associated with specific income-earning activities and to the capacity of households to absorb losses. Because all economic activity entails some measure of risk, the efficacy of risk management efforts by the household can be judged in the aggregate by examining how well households are able to maintain consistent levels of consumption over time.[4] Households can achieve this in several ways. They can prepare for times of need by saving, holding inventories, and accumulating productive assets that can be sold in times of need. Because risks are likely to affect different activities in different ways, diversification of activities—especially the diversified use of land and labor—can lessen the consequence of any particular risk. Thus for farming activities, for example, choices about production technologies can affect the consequences of weather-related risks. Because there are separate risks associated with markets, decisions concerning self-sufficiency and market participation affect income risks as well.

A growing applied literature on these topics has frequently found shocks related to crop and livestock yields, prices, health, and labor markets. Fafchamps (1999) and Dercon (2002) survey studies characterizing the sources of rural risks in poor

countries. Wolpin (1982), Paxson (1993), and Rosenzweig (2001) examine consumption smoothing in low-income countries. Dercon (1996), Larson and Plessmann (2002), and Morduch (2002) find evidence that farmers choose to diversify into less profitable crops or choose less productive technology.

These strategies and their outcomes act in reinforcing ways. Greater wealth allows households to diversify their income sources by starting nonagricultural businesses or entering into more profitable agricultural activities (Reardon and others 1988; Dercon 1998). Greater wealth can also allow farmers to make investments that can limit the consequences of risks (Rosenzweig and Binswanger 1993). The consequences of rural risk can also reverse the accumulations of human and physical capital that contribute to income and wealth. Households may attempt to supply more labor (Kochar 1995; Rose 2001), and parents may choose to have their children work rather than attend school (Jacoby and Skoufias 1997). In difficult times households may liquidate productive assets (Binswanger and McIntire 1987).

Not all risk management strategies rely exclusively on household resources. Arrangements for risk sharing and mutual insurance are a common feature of rural communities in low-income countries. Most arrangements are informal—they rarely involve written contracts and are not enforced by governing institutions. Alderman and Paxson (1992) and Morduch (1998) provide useful surveys of informal insurance mechanisms. The ubiquity of risk-sharing arrangements among the rural poor in low-income countries is consistent with studies that find rural risks in low-income countries to be largely idiosyncratic (Udry 1991; Townsend 1995; Jalan and Ravallion 1999). The nature of risk may be partly an outcome of diversification strategies. Systemic risk is more significant in developed economies' agriculture, where greater specialization is evident (Miranda and Glauber 1997).

When risks are idiosyncratic, there is scope for mutual insurance arrangements. In turn, the practical distinction between what constitutes systemic or idiosyncratic risks depends on how risks are pooled. Risks that affect all household members may not affect all households in a community. Risks that affect communities may not affect the entire region, state, or country. For agriculture, underlying risks associated with production stem from the interplay between climate-related events and natural endowments. Consequently, geographically diverse pools of agricultural risk exhibit less systemic risk. At the same time, performance risks related to contract enforcement in low-income countries limit the scope for mutual insurance arrangements that extend beyond families, tribes, or villages.

The personal relationships that characterize mutual insurance arrangements are also a dominant feature of other forms of exchange in poor rural areas (Fafchamps and Minten 2001). Where low-cost enforcement mechanisms are absent, performance risks associated with all forms of contracts can be high.[5] However, the scope for pooling and sharing risks of all kinds is dramatically reduced for forms of exchange and insurance based on personal relationships. Storage markets, liquid

markets for output and for assets, financial markets for savings and credit, and formal insurance markets all depend on impersonal trade accounts to varying degrees.

It is not surprising then that constrained household and community insurance mechanisms are only partly effective (Dercon 2002). Moreover, the poorest appear to benefit the least from informal insurance (Reardon and others 1988; Jalan and Ravallion 1999; Goldstein and others 2002). For all participants, informal insurance schemes in rural areas work least well when they are needed most for several reasons. First, the most severe agricultural shocks tend to be systemic, so that all farmers in the community are less able to afford transfers. This is exacerbated when, as is frequently the case, nonfarm income can be covariate with systemic shocks to agriculture (Czukas and others 1998). Because of illiquid markets, shortfalls in food supply can cause food prices to rise rapidly while prices for livestock or other productive assets fall (Rhamato 1991). In situations where household and community risk strategies fail completely, households lack the ability to command food supplies, and famines result (Sen 1981; Ravallion 1997).

Extending Formal Markets for Risk

Though varied, comprehensive in types of risks addressed, and able to solve information problems related to transaction costs and moral hazard, informal mechanisms for managing rural risks also reduce the scope for pooling risks outside of communities.[6] They are unable to take advantage of the potentially beneficial portfolio effects of including individuals who face uncorrelated or negatively correlated natural risks or who have different capacities or willingness to assume risk.

There have been many recent efforts to extend the reach of rural risk markets in developing economies to supplement informal systems. The focus here is on instruments that address agricultural production and price risks, rather than on credit and income risks, for which there is also an extensive literature (for surveys, see Bell 1988 and Besley 1994; for policy issues see Yaron and others 1997; and for lessons on informal systems, see Udry 1995 and Eboh 2000). The primary markets that uniquely address agricultural risks are futures and options markets, which can be used to hedge against price movements, and crop insurance markets, which focus on yield shortfalls.

Risk Markets, Households, and Small Businesses

Small-scale farmers and other small businesses in developing economies rarely use market-based risk instruments. For one thing, the very poor lack assets insurable by crop insurance, price insurance, or similar products. For another, most agricultural risk markets are incomplete in many aspects—time, space, and type of commodity.

Nonetheless, there is some scope for making use of such markets in poor rural areas (Rolfo 1980; Myers 1988; Lapan and Moschini 1996).

There are at least three types of potential benefits of using risk markets. One relates to the indirect effects of insuring individuals. Poverty can be transient and often market related (Jalan and Ravallion 1998). As a result, market-related price and output insurance, delivered directly or indirectly to community households and businesses, may have direct income effects for the insured and economic multiplier effects in the community. In addition, both effects may help fund informal risk systems. There is some related evidence from food aid programs, discussed later.

A second type of benefit relates to funding formal public safety nets and services. During periods of systemic risk, when informal systems are most likely to fail, governments are often called on to provide relief and to step up related services. In some instances governments are unable to fully afford to do so, particularly provincial or local governments that may be obliged to share in the cost of relief. Thus risk markets have a potential role when governments do not have the resources to self-insure.

A third potential benefit is that extending the reach of formal risk markets can help extend the temporal and spatial aspects of related markets for output, storage, inputs, and credit. This is important because it is the emergence from self-sufficiency and the opportunity to participate in markets that marks the earliest stages of development in rural areas.[7]

Price Risk

The most transparent markets for price risk are futures and options contracts traded on organized exchanges. Contracts for coffee, cocoa, maize, soybeans and soybean products, sugar, wheat, and some livestock are traded on an international basis. Most volume is traded in Japan, the United States, and the United Kingdom, but there are long-standing exchanges in Argentina, Brazil, and India, as well as emerging commodity exchanges in China, Hungary, Poland, and Russia.[8] There are also active over-the-counter markets for options on traded agricultural products, including rice and palm oil. Significant barriers stand between these risk markets and the risks faced by farmers, however, including issues of scale, basis risk, information, and enforcement mechanisms (Frechette 2000).[9] Moreover, options are short-term instruments, rarely exceeding nine months, and they are inappropriate for hedging annual income fluctuations (Gardner 1989). However, some mechanisms have emerged to extend price risk markets.

Using inventories. In some countries, warehouses and grain elevators are delivery points for price risk instruments. In the simplest form grain elevators post schedules of forward purchase prices. Elevator companies then hedge their net exposure on

commodity exchanges or related price risk markets. Harwood and others (1999, p. 75) provide an example from the United States.

Contractual arrangements can also be used to link price hedging, inventories, and credit. For rural communities the chief benefit is lowering transaction costs. In warehouse receipt or inventory financing systems, inventory owners place their crops in certified warehouses and enter into a repurchase agreement with the warehouse company, which then offers a loan based on the value of their inventories. When price futures, options, or related markets are available, warehouse companies can use the markets to hedge the value of the inventory collateral.

Such arrangements are frequently accorded special treatment in the law, allowing warehouse managers to quickly liquidate inventories when loan payments are due. In the United States, for instance, certified warehouses can issues transferable receipts (Budd 1991). In Latin America two documents perform the same economic function: the *certificado de deposito* (certificate of deposit), a claim stating the quantity and quality of goods stored, and the *bono de prenda* (product bond), used to assign ownership. Although this institutional arrangement has a long history in Latin America, efforts to establish warehouse receipts are more recent in countries where inventories were long managed by government agencies or state enterprises. Coulter and Onumah (2002) provide examples from Africa; Martin and Bryde (1999) discuss warehouse receipt systems in transition economies.

Aggregating demand. Several characteristics of price risk markets create obstacles to access by small-scale farmers. The contracts themselves are associated with large underlying volumes, and futures and options trading involves large fixed costs. Several efforts have been made to provide access to price risk markets by aggregating local demand. Varangis and Larson (1996) report on Mexico's Agricultural Products Options Program (Programa de Covertura de Precios de Productos Agricolas), which offers subsidized dollar-denominated futures options to maize, cotton, sorghum, and soybean farmers. Guatemala's national coffee association, Asociación Nacional de Café, facilitates price-hedged credit for smallholder producers.

Though the mechanisms of such programs are understood, there has been little analysis of their effects on household decisions and outcomes. To further investigation of this type of risk management program, the World Bank, the European Union, the Netherlands, and Switzerland convened an International Task Force on Commodity Risk Management in Developing Countries (1999) to study the benefits of facilitating access by farmers and small businesses in developing economies to price risk-management instruments. The program focuses on finding local intermediaries, mostly producer cooperatives, to aggregate demand, pay option premia, and disseminate payouts. Ten case studies are available on the program's Web site (www.itf-commrisk.org/itf.asp?page=104).

Yield Risks

In addition to price risks, farmers face yield risks, due to adverse weather, pests, and diseases. Roumasset and others (1989) review studies on the sources of yield risk for grains.

Crop insurance. Formal agricultural insurance institutions are better suited to address yield risks than are informal mutual insurance mechanisms, which have limited reach. Ray (1967) has an early discussion. However, moral hazard and adverse selection problems plague traditional crop insurance schemes. Moral hazard arises when farmers are able to take actions that affect insurance payouts. Inspection and monitoring can limit the problem, but they boost costs—especially in the context of smallholder production in developing economies. Adverse selection results when those purchasing insurance have better information about risks than the insurance provider. As a consequence, unless insurance is compulsory, the self-selected pool of insurance participants will have above-average risks. The adverse selection problem has both spatial and temporal aspects. For example, farmers may choose to insure only crops grown on inferior land (spatial) or participate only when preseason rainfall is low (temporal). In practice, because moral hazard and adverse selection problems both stem from asymmetric information, both types of problems will emerge (Quiggin and others 1993).

Information problems related to crop insurance are well studied in part because efforts to provide comprehensive crop insurance on a commercial basis have so consistently failed (Valgren 1922; Krammer 1983).[10] Thus crop insurance relies heavily on government subsidies. Pomareda (1986), Hazell (1992), and Wright and Hewitt (1994) compare crop insurance in developed and developing economies. Detailed histories of crop insurance and related policies are provided by Lopes and Dias (1986) for Brazil, Yamauchi (1986) for Japan, and Glauber and Collins (2002) for the United States.

The combination of moral hazard, adverse selection, and public subsidy has welfare consequences related to how farmers allocate resources, how natural resources are used, and how public support is allocated. There is an extensive theoretical and applied literature, much of it related to North American experiences. Knight and Coble (1997) and Moschini and Hennessy (2001) survey the literature, and Skees (2000) provides lessons based on U.S. experiences.

Index insurance. Because of the high costs associated with administering traditional crop insurance, interest has grown in alternative instruments for insuring a portion of farm yield risks. These products look to contain administrative costs by eliminating moral hazard and reducing adverse selection and thereby the associated monitoring costs (Skees and others 1999). They do so by using an insurance trigger

linked to farm losses that cannot be manipulated by the insured. Contracts and indemnity payments are the same for all buyers per unit of insurance, so the problems of moral hazard and adverse selection associated with traditional crop insurance are lessened. These features can significantly reduce administrative costs because contracts can be standardized and on-site inspections and damage assessments are avoided.

Conceptually, these products are similar to exchange-linked price insurance for price takers. These products address risks that are systemic to the insured group but leave idiosyncratic risks uninsured, much as basis risks remain with price insurance. In addressing systemic risk only, these products are less appealing to farmers but more attractive to a broad range of people and institutions whose incomes are also affected by the insured events, including banks, agribusinesses, rural financial institutions, agricultural traders, and transport industries. Banks and rural finance institutions could purchase such insurance to protect their portfolios against defaults caused by severe weather events, thereby addressing an important constraint on rural credit.

Area-yield and weather-based insurance are two of the better known examples of index insurance, although other products have also been studied. Skees and Enkh-Amgalan (2002) examine a proposed index-based insurance for livestock in Mongolia. Area-yield crop insurance is a contingent contract that pays out when average yield for a group, usually defined geographically, falls below a specified trigger. Payouts are based on probabilities of the event occurring, which are usually based on historical data. If the pool that defines the trigger is sufficiently large, decisions to enroll or actions on the farm will not affect outcomes, resolving moral hazard and most types of adverse selection problems.

Halcrow (1949), Industries Assistance Commission (1978), and more recently Miranda (1991) discuss proposals for area-yield insurance. Much of the literature is devoted to optimal contract design, including discussions by Miranda (1991), Smith and Baquet (1996), Skees and others (1997), Mahul (1999), and Vercammen (2000). Chambers and Quiggin (2002) consider the influence of area-yield insurance on producer decisions. Miranda (1991) and Skees and others (1997) describe area-yield programs in Canada, Sweden, and the United States. Mishra (1996) describes area-yield insurance in India.

Experience with area-yield products has been mixed for several reasons. Product coverage, based on county or other administrative boundaries, may not correspond to the spatial outcomes of climatological risk (Wang 2000). There is a natural tension in the optimal size of the pool of farmers included in the trigger. Large pools are needed to preclude moral hazard and help offset the fixed costs of offering an insurance product, but large pools may increase the basis risk associated with the insurance trigger. Detailed data are needed to construct the underlying probabilities, and such data may not be available in many developing economies. Experience with

area-yield programs comes primarily from developed economies, especially the United States, where government policies may crowd out market-based products and introduce policy-related risks that market-based products cannot address (Gardner 2002).

A relatively new insurance instrument is weather-based index insurance, with payouts based on the occurrence of a weather event rather than on actual crop losses (Lee 1953; Bardsley and others 1984; Quiggin 1986; Skees 1999; Turvey 2001). Thus insurance contracts could be written against severe rainfall shortfalls (say, 30 percent or more below a defined norm) measured at agreed regional weather stations. The insurance would be sold in standard units, and all buyers would pay the same premium and receive the same indemnity payment per unit of insurance if a shortfall occurs.

Although the theoretical aspects of contract design have been explored, and climate-related risks are well understood in developing economies, less is known about whether farmers are willing or able to pay for such insurance. What little evidence is available suggests that a residual unmet demand for insurance against weather risks remains despite the myriad risk management mechanisms employed by households (Gautam and others 1994; Sakurai and Reardon 1997). Additionally, survey evidence suggests that farmers are willing to pay for certain contract designs based on reasonable premia assumptions (McCarthy 2003).

Still, there are certain challenges in creating weather insurance instruments, particularly in developing economies. First, reliable historic data are needed to allow accurate pricing of the insurance. Though such data are generally available in most developing economies, coverage can be limited. Second, secure weather stations are needed to increase the confidence of those providing the insurance. Automated weather stations and increasingly remote sensing could reduce the risk of tampering with weather observations at local weather stations. Third, farmers may face basis risk if rainfall at the weather station is not highly correlated with rainfall at the individual farm. This is more of a problem for farmers in regions with diverse microclimates than for banks purchasing insurance to protect their regional portfolio or for agribusinesses that have weather exposure over a wider area. Skees and others (2002) discuss examples from Mexico.

There have been few agricultural applications of weather-based index insurance in the world. Weather indices are used for agricultural insurance in Ontario and Alberta, Canada. In Mexico AGROASEMEX, the agricultural reinsurance company, recently used weather derivatives to protect part of its crop reinsurance portfolio exposed to weather risks. In Argentina a rainfall insurance contract is used by a milk-producing cooperative (there is positive correlation between rainfall and milk yields). In 2001 the International Finance Corporation, the private-sector lending arm of the World Bank Group, joined with private investors to create an $80 million facility to reinsure weather risks in developing areas. Agriculture, however, is only

one of several industries affected by weather risks. Markets in North American and Europe have developed primarily to hedge energy-related risks (Muller and Grandi 2000). Consequently, weather markets may prove more liquid than markets for area-yield insurance.[11]

Revenue insurance. There has been considerable discussion about how incomplete markets limit the ability of farmers to hedge income risks (Rolfo 1980; Anderson and Danthine 1983; Lapan and Moschini 1994). Several studies have assessed the potential for revenue insurance, primarily in North America (Miranda and Glauber 1991; Turvey 1992; Babcock and Hennessy 1996; Hart and others 2001).

Conceptually, revenue insurance is a combination of price and traditional crop insurance—although area-yield variations have been considered. A U.S. pilot program uses the average February price of a December settlement corn futures and historical yields to price an insurance product. Payouts are based on a combination of assessed yields and the average price of the December settlement in November. Because of this construction, high prices can compensate for low yields, lessening the contract payout. Application to developing economies is limited because the insurance requires both price and yield risk markets.

Contractual Arrangements and Market Instruments

Pre-export financing. Where domestic credit systems are expensive or function poorly, exporters frequently enter into pre-export financing arrangements to share performance, price, and exchange risks. These arrangements, which combine aspects of formal and informal markets, typically include a local domestic agent and an international trading company.

The two parties enter into a contract for a specific purchase—so many tons of coffee, for example, for a fixed fee. The cost of credit is implicit in the fee. The international company deposits dollar-denominated funds in a domestic bank, and the domestic agent purchases domestic crops and prepares them for export. The international company approves the release of funds to the domestic agent based on certification by a local warehouse or inspection company. Although the contracts usually cover very short periods, they are often repeated when performance has been good.

The parties rely on economic incentives (off-shore credit is typically less expensive) and the prospects of repeated future business, a feature also associated with informal personal transactions. Price risks are shared: the agent takes on price and exchange risks during the purchasing period (because local purchases will be in local currencies), whereas the international company takes on the price risks from the time it acquires supplies in country until the goods reach their eventual market.

The international company may enter into additional risk management arrangements by hedging the good or entering into forward contracts.

Producer clubs. Even though contract enforcement is often difficult in developing economies, sharecropping and labor-sharing arrangements are commonplace in many rural communities. Robertson (1987) provides many examples from Africa. Where production takes place near a processing center, contracts are sometimes structured so that processors provide smallholders inputs on credit in exchange for future product deliveries. Such contracts are common in the sugar and palm oil industries, where crop characteristics create a binding relationship between producer and processor.

More sophisticated arrangements can also be found for specialized products that include types of risk management. For example, in Mexico starch companies will enter into arrangements with producer groups for high-starch maize. Group members are jointly obligated to meet contract requirements. In return, the starch company offers a forward purchase agreement for the maize at a fixed price and partly prefinances inputs and technical advice. The company also partially prefinances crop insurance, so that farmers are not penalized when crops fail. By addressing both price and yield risk, the arrangement allows farmers to adopt newer technologies more readily.

Governments, Insurance, and Rare Events

Some events can overwhelm the actions taken by individuals, families, and communities to manage risks. When the scale of loss of life and property is large, governments step in to limit further loss and help compensate victims. One area where such intervention is important is in providing assistance to prepare for and recover from natural or human-caused disasters, when human and economic losses can be large. Developing economies suffer the greatest costs from disasters: More than 95 percent of all deaths caused by disasters occur in developing economies, and losses due to natural disasters are 20 times greater (as a proportion of gross domestic product) in developing economies than in industrial countries. Poorly planned development can turn a recurring natural phenomenon into human and economic devastation with irreversible effects.[12]

But along with such cases there has been a tendency for public outcry to drive governments to intervene in ways that are demonstrably ineffective and that distort individual incentives to plan more carefully for occasional inevitable bad outcomes, including through selective purchase of insurance contracts. If governments rush to bail people out of the effects of insurable natural disaster risks whenever there is political clamor to do so, commercial insurance markets will be stunted. Such "free"

but unreliable public insurance entices some to take up risky activities with incomplete safeguards and without full consideration of the public and private costs of doing so (for an example related to drought management in Australia, see Drought Policy Review Task Force 1990). Often, when political factors (including the availability of donor assistance) trigger disaster-relief programs, the timing and level of relief is uncertain (Shaw 2002) and relief may be poorly targeted.

Public policy research has long considered questions about the role of governments in sharing responsibilities for insurance and insurance markets (for example, Kunreuther 1978). A potentially good policy would swing into action as needed, without requiring (or allowing) political largesse or creating disincentives for producers to plan for and manage their own natural disaster risks (Anderson and Dillon 1988).

Food Programs and Informal Insurance

Food programs are a special type of public insurance. In wealthy countries, food assistance is part of a general safety net, provided continuously and not only as part of natural disaster relief efforts. Not so in poor countries, where food assistance generally is a response to acute shortages. Natural disasters are often a triggering event, but their consequences are heavily influenced by previous private and public investments and policy. When food shortages occur in their most acute form, as famine, they are almost always associated with a combination of natural disasters and bad policy. Ravallion (1997) reviews public action failures related to famine, from inadequate government responses to food shortages—sometimes deliberately so—to market interventions that have made households more vulnerable to famine.

There is an extensive body of literature on programs that provide food in response to disaster-related shortages, with surveys by Maxwell and Singer (1979), Clay (1986), and Barrett (2001). In addition to the nutritional impact of such programs, researchers have addressed problems of moral hazard and adverse selection, including disincentives for households to produce food and to work. Food deliveries can also displace food and storage markets (Schultz 1960; Sen 1960; Fisher 1963; Barrett 2001). The disincentive effects are intensified by the tendency for some program food supplies to go to unintended recipients, which also reduces the efficiency of the programs. Considerable effort has gone into finding appropriate methods of targeting food assistance to avoid these problems (Besley and Kanbur 1990; Ravallion 1991; von Braun 1995; Alderman and Lindert 1998).

More recently, researchers have considered the relationship between informal insurance systems and food programs. Attanasio and Rios-Rull (2000) provide a numerical analysis drawing on data related to Mexico's PROGRESA program, and Dercon and Krishnan (2003) offer econometric evidence based on surveys from Ethiopia. Both

studies suggest that formal food assistance can crowd out informal insurance, because food assistance changes the consequences of not participating in mutual insurance arrangements. This tension between informal insurance incentives and food assistance prompted Dercon and Krishnan to suggest that food assistance programs use village mutual insurance systems to target assistance.

Nevertheless, informal systems fail when risks are systemic—for example, when extensive or sequential multiple crop failures occur—and formal aid may have limited effects on decisions to participate in informal systems that address idiosyncratic risks. Even when systemic natural events are the cause of food shortages, other types of moral hazard problems related to the frequency of the events remain. When shortages and food aid occur frequently, households' choices may be affected in ways that create a continuing dependency on aid—for example, households may continue to work marginal lands. Alternatively, when shortages are infrequent, aid interventions can provide immeasurable benefits without affecting long-term choices, because households will view the possible risk and the subsequent food aid as rare.

From this Skees and others (2002) argue that food aid policies should be designed around the frequency and systemic nature of disaster events. They suggest establishing objective measures for triggering the prompt release of food aid in response to relatively rare and systemic events, such as droughts or earthquakes, to minimize moral hazard. The use of objective measures also opens up the possibility of finding insurance-based methods to fund such relief. Analogous relationships exists between disaster relief and crop insurance, discussed next.

Disaster Relief and Private Insurance

Natural disasters can have devastating effects for farmers and spawn cascading effects throughout the local economy as agricultural workers and those employed in support services lose jobs and income. The farm income losses associated with the failed crops can sometimes be privately insured. When parametric insurance is considered, such as temperature or area-yield policies, the distinction between disaster relief and insurance as compensating mechanisms diminishes. However, publicly financed disaster relief creates incentives different from those of privately priced insurance and can induce risk-taking and other problems related to moral hazard.

Mexico's Fund for Natural Disasters (FONDEN) illustrates some of these points. The government established FONDEN in 1996 to finance postdisaster reconstruction of public infrastructure and compensate low-income producers for crop and livestock losses arising from natural disasters. FONDEN targets beneficiaries and limits the amounts it disburses per beneficiary. FONDEN was never intended to compete with private insurance, but analysis of historic reinsurance payouts reveals that weather events similar to those covered under FONDEN are the primary source of systemic payouts by farmer mutual insurance funds. The funds were formed to provide mutual

crop insurance to their members. Reserves for paying indemnities and covering operational costs come from member premiums and government contributions (equal to one-third of member premiums). The funds also purchase traditional reinsurance for times when claims deplete reserves. Because privately insured farmers are not eligible to receive payments from FONDEN, the result is a choice between public and private insurance, a situation fraught with moral hazard. Recently, to make disaster relief more transparent and predictable, FONDEN has started to adopt objective rules for declaring catastrophic events, using triggers analogous to those used for index insurance. For example, technical guidelines are given for drought- or frost-related natural disasters.

Parametrization of public disaster programs has several advantages. First, it removes an ad hoc dimension from the declaration of catastrophes, which helps programs provide appropriate levels of relief in a timely and consistent manner. Second, the information required to parametrize relief programs may help governments design better policies. Third, parameterization enables governments to assess the potential program costs. If governments, especially provincial or local governments, find that under some conditions they would be unable to fund their share of the relief program, they may decide to curb benefits, seek more federal support, or purchase reinsurance from private markets.

Government insurance of risks that are sufficiently rare will not induce moral hazard, even when the consequences of the event are considerable. Nevertheless, when rare events are associated with extensive damage, the cost of private insurance may be high. This suggests an appropriate way of sharing risks on the basis of event likelihood, with governments insuring rare but catastrophic risks and private markets insuring more frequently occurring risks.

Conclusion

During much of the past 50 years, agricultural risk management policies advocated by governments and multinational organizations focused on stabilizing national and sectoral incomes, primarily through interventions meant to stabilize the prices of key food or export commodities, such as rice, maize, coffee, and sugar. Frequently, these policies also set out to change relative prices. Successful efforts to manage these markets were rare and usually short-lived. Most countries came to view these interventionist policies as an impediment to growth and subsequently moved to sharply reduce or eliminate domestic market interventions, often in times of fiscal crisis. Contemporaneously, researchers and policymakers gained a better understanding of the role of risk and the negative consequences of volatility for growth and development, in large part through new household-based surveys.

Currently, strategies for managing the negative consequences of volatile rural incomes are emerging that rely more heavily on markets to supplement the many ways governments and households manage risks. These strategies face demanding challenges because the costs of risk avoidance to households and businesses can be high; the capacity for self-insurance by households, groups, and even governments can be limited; and markets that support risk sharing are incomplete. Finding ways that extend the reach of risk markets is therefore important. These strategies must also address risks that markets cannot address, and key questions remain concerning the roles for formal, informal, private, and public insurance markets and the links between them. Issues include the extent to which informal risk-sharing systems benefit from formal insurance markets, how climate risk information can be used to understand the implicit value of publicly provided insurance and the capacity of governments to meet those obligations under all circumstances, and what components of price and yield risk should fall to individuals, governments, and multinational donors.

Notes

Donald F. Larson is senior economist in the Development Research Group at the World Bank; his e-mail address is dlarson@worldbank.org. Jock R. Anderson was an adviser and is presently a consultant in the Agriculture and Rural Development Department at the World Bank; his e-mail address is janderson @worldbank.org. Panos Varangis is lead economist in the Agriculture and Rural Development Department at the World Bank; his e-mail address is pvarangis@worldbank.org. Seniority of authorship is not assigned, but a novel ordering of authors is used. An earlier version of this article was prepared for a seminar held in honor of Ronald C. Duncan (former Chief of the Commodities Division, World Bank) on the occasion of his retirement as executive director of the National Centre for Development Studies and Director, Asia Pacific School of Economics and Management, Australian National University, Canberra, in July 2001 (Anderson, Larson, and Varangis 2002).

1. See modern treatments by Sapsford and Balasubramanyam (1999) and Lutz (1999).

2. As it turns out, evidence of increased commodity price volatility is hard to find (Dehn 2000; Akiyama and others 2003.)

3. See Reutlinger (1970) and Anderson (1989) for discussion concerning uncertainty and public project appraisal. See Grosh and Glewwe (1995), Deaton (1997), and Grosh (1998) for discussions of household surveys, the World Bank and poverty analysis.

4. This test is based on the notion that households that can freely save and borrow will ignore transitory changes in income and base consumption on the permanent component of income. Friedman's (1954) response to Caine (1954) contains early elements of the permanent income hypothesis.

5. Kranton (1996) discusses this in the context of personal exchange generally; Morgai and others (2002) discuss transaction and enforcement costs specifically in the context of mutual insurance schemes. See also related studies by Coate and Ravallion (1993), Platteau (1997), and Ligon and others (2002)

6. Studies of pastoralists show the limits of diversifying climatic risks. See for example, Little and others (2001), McPeak and others (2001), and Smith and others (2001) and references therein.

7. Reinikka and Collier (2001) document how increased market participation by households characterized Uganda's recovery in the 1990s.

8. Williams (2001) provides a survey on the organization of commodity futures market. See Peck (2001) for a discussion of emerging exchanges in the former Soviet Union, Eastern Europe, and China.

9. Basis risk refers to a situation where local prices fail to move exchange prices. This topic is discussed in the context of West African cotton by Satyanarayan and others (1993); coffee in Costa Rica by Claessens and Varangis (1993); and wheat in Pakistan by Faruqee and Coleman (1996).

10. Insurance against specific risks—especially hail and some multiperil livestock insurance programs—have proven successful (Harwood and others 2000).

11. Lack of liquidity, partly a result of crowding-out by other U.S. programs, was a primary reason for a failed attempt by the Chicago Board of Trade to market area-yield options.

12. Christiansen and others (2003) show sobering results that quantify the stunting effects of drought on children in Ethiopia.

References

Akiyama, T., J. Baffes, D. F. Larson, and P. Varangis. 2001. *Commodity Market Reforms: Lessons of Two Decades*. Washington, D.C.: World Bank.

———. 2003. "Commodity Market Reform in Africa: Some Recent Experience." *Economic Systems* 27(1):83–115.

Alderman, H., and K. Lindert. 1998. "The Potential and Limitations of Self-Targeted Food Subsidies." *World Bank Research Observer* 13(2):213–29.

Alderman, H., and C. Paxson. 1992. "Do the Poor Insure? A Synthesis of the Literature on Risk and Consumption in Developing Countries." Policy Research Working Paper 1008. World Bank, Washington, D.C.

Anderson, J. R. 1989. "Reconsiderations on Risk Deductions in Public Project Appraisal." *Australian Journal of Agricultural Economics* 33(2):136–40.

———. 2001. *Risk Management in Rural Development: A Review*. Washington, D.C.: World Bank, Rural Development Department.

Anderson, J. R., and J. L. Dillon. 1988. "Socioeconomic Impacts of Climatic Variability: Implications for Policymakers and Planners." In *The Impacts of Climatic Variations on Agriculture*, vol. 2: *Semi-Arid Regions*, ed. M. Parry, T. Carter, and N. Konijn. Dordrecht, Netherlands: Kluwer.

———. 1992. "Risk Analysis in Dryland Farming Systems." Farm Systems Management Series 2. Food and Agriculture Organization of the United Nations, Rome.

Anderson, J. R., J. L. Dillon, and J. B. Hardaker. 1977a. *Agricultural Decision Analysis*. Ames: Iowa State University Press.

Anderson, J. R., P. Hazell, and P. Scandizzo. 1977b. "Considerations in Designing Commodity Stabilization Schemes." *American Journal of Agricultural Economics* 59(5):908–11.

Anderson, J. R., C. Blitzer, E. Cauchois, and E. Grilli. 1981. "A Dynamic Simulation Model of the World Jute Economy." *European Economic Review* 16(2/3):303–31.

Anderson, J. R., D. F. Larson, and P. Varangis. 2002. "Managing Risks Rather than Markets: An Institutional View." In *Resource Management in Asia Pacific Developing Countries*, ed. R. Garnaut. Canberra: Asia Pacific Press.

Anderson, R., and J. Danthine. 1983. "The Time Pattern of Hedging and the Volatility of Futures Prices." *Review of Economic Studies* 50(2):249–66.

Anderson, R., C. Gilbert, and A. Powell. 1991. "Securitizing Development Finance: The Role of Partial Guarantees and Commodity Contingency." In *Commodity Risk Management and Finance*, ed. T. Priovolos and R. C. Duncan. Oxford: Oxford University Press.

Antle, J. M. 1989. "Nonstructural Risk Attitude Estimate." *Journal of Agricultural Economics* 71(3): 774–84.

Arrow, K. 1965. *Aspects of the Theory of Risk-Bearing*. Helsinki: Yrio Jahnsson Foundation.

Attanasio, O., and J. Rios-Rull. 2000. "Consumption Smoothing in Island Economies: Can Public Insurance Reduce Welfare?" *European Economic Review* 44(7):1225–58.

Babcock B., and D. Hennessy. 1996. "Input Demand under Yield and Revenue Insurance." *American Journal of Agricultural Economics* 78(2):416–27.

Bardsley, P., A. Abbey, and S. Davenport. 1984. "The Economics of Insuring Crops Against Drought." *Australian Journal of Agricultural Economics* 28(1):1–14.

Barrett, C. 2001. "Food Security and Food Assistance Programs." In *Handbook of Agricultural Economics*, vol. 2, ed. B. Gardner and G. Rausser. Amsterdam: Elsevier Science.

Bauer, P., and F. Parish. 1952. "The Reduction of Fluctuations in the Incomes of Primary Producers." *Economic Journal* 62(248):750–80.

Bell, C. 1988. "Credit Markets, Contracts and Interlinked Transactions." In *Handbook of Development Economics*, vol. 1, ed. H. Chenery and T. N. Srinivasan. Amsterdam: Elsevier.

Besley, T. 1994. "Savings, Credit and Insurance." In *Handbook of Development Economics*, vol. 3, ed. A. J. Behrman and T. N. Srinivasan. Amsterdam: Elsevier.

Besley, T., and R. Kanbur. 1990. "The Principles of Targeting." Policy Research and External Affairs Working Paper 385. World Bank, Washington, D.C.

Bevan, D., P. Collier, and J. Gunning. 1990. *Controlled Open Economies: A Neo-Classical Approach to Structuralism*. Oxford: Clarendon.

Binswanger, H. 1980. "Attitudes toward Risk: Experimental Measurement in Rural India." *American Journal of Agricultural Economics* 62(3):395–407.

Binswanger, H., and J. McIntire. 1987. "Behavioral and Material Determinants of Production Relations in Land-Abundant Tropical Agriculture." *Economic Development and Cultural Change* 36(1): 73–97.

Bourguignon, F., and A. Gelb. 1988. "Venezuela: Absorption without Growth." In *Oil Windfalls: Blessing or Curse?*, ed. Alan Gelb and Associates. New York: Oxford University Press.

Budd, N. 1991. "Financing Operation for Commodity Producers: A Guide to Pre-Export Financing of Physical Commodities in Origin Countries." *International Financial Law Review* 10(1):24–8.

Caine, S. 1954. "Instability of Primary Product Prices: A Protest and a Proposal." *Economic Journal* 64(255):610–14.

Chambers, R., and J. Quiggin. 2002. "Optimal Producer Behavior in the Presence of Area-Yield Crop Insurance." *American Journal of Agricultural Economics* 84(2):320–34.

Cheung, S. 1969. *The Theory of Share Tenancy with Special Application to Asian Agriculture and the First Phase of Taiwan Land Reform*. Chicago: University of Chicago Press.

Christiansen, L., H. Alderman, and T. Yamono. 2003. "Child Growth, Shocks and Food Aid in Rural Ethiopia." Policy Research Working Paper 3128. World Bank, Washington, D.C.

Claessens, S. 1991. "Integrating Commodity and Exchange Rate Risk Management: Implications for External Debt Management." In *Commodity Risk Management and Finance*, ed. T. Priovolos and R. Duncan. Oxford: Oxford University Press.

Claessens, S., and R. C. Duncan, eds. 1993. *Managing Commodity Price Risk in Developing Countries*. Baltimore, Md.: Johns Hopkins University Press.

Claessens, S., and P. Varangis. 1993. "Implementing Risk Management Strategies in Costa Rica's Coffee Sector." In *Managing Commodity Price Risk in Developing Countries*, ed. S. Claessens and R. Duncan. Baltimore, Md.: Johns Hopkins University Press.

Clay, E. 1986. "Rural Public Works and Food-for-Work: A Survey." *World Development* 14(10–11): 1237–52.

Coate, S., and M. Ravallion. 1993. "Reciprocity without Commitment: Characterization and Performance of Informal Insurance Arrangements." *Journal of Development Economics* 40(1):1–24.

Collier, P. 2002. "The Macroeconomic Repercussions of Agricultural Shocks and Their Implications for Insurance." WIDER Working Discussion Paper 202/46. World Institute for Development Economics Research, Helsinki.

Coulter, J., and G. Onumah. 2002. "The Role of Warehouse Receipt Systems in Enhanced Commodity Marketing and Rural Livelihoods in Africa." *Food Policy* 27(4):319–37.

Czukas, K., M. Fafchamps, and C. Udry. 1998. "Drought and Savings in West Africa: Are Livestock a Buffer Stock?" *Journal of Development Economics* 55(2):273–305.

Dawe, D. 1996. "A New Look at the Effects of Export Instability on Investment and Growth." *World Development* 24(12):1905–14.

Deaton, A. 1992. "Commodity Prices, Stabilization, and Growth in Africa." Center of International Studies Discussion Paper 166. Princeton University, Princeton, N.J.

———. 1997. *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy.* Baltimore, Md.: Johns Hopkins University Press.

Deaton, A., and G. Laroque. 1992. "On the Behaviour of Commodity Prices." *Review of Economic Studies* 59(1):1–23.

Dehn, J. 2000. "Commodity Price Uncertainty in Developing Countries." Policy Research Working Paper 2426. World Bank, Washington, D.C.

Dercon, S. 1996. "Risk, Crop Choice and Savings: Evidence from Tanzania." *Economic Development and Cultural Change* 44(3):385–514.

———. 1998. "Wealth, Risk and Activity Choice: Cattle in Western Tanzania." *Journal of Development Economics* 55(1):1–42.

———. 2002. "Income Risk, Coping Strategies, and Safety Nets." *World Bank Research Observer* 17(2): 141–66.

Dercon, S., and P. Krishnan. 2003. "Food Aid and Informal Insurance." Centre for the Study of African Economies Working Paper 200-01. Oxford University.

Dillon, J. L. 1971. "An Expository Review of Bernoullian Decision Theory in Agriculture: Is Utility Futility?" *Review of Marketing and Agricultural Economics* 39(1):3–80.

Dillon, J. L., and P. L. Scandizzo. 1978. "Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach." *American Journal of Agricultural Economics* 60(3):425–35.

Drought Policy Review Task Force. 1990. *National Drought Policy, Final Report,* vol. 1. Canberra, Australia: Australian Government Publishing Service.

Eboh, E. 2000. "Rural Informal Savings and Credit Associations as Risk Managers and the Lessons for the Design and Execution of Rural Credit Schemes in Nigeria." *African Development Review* 12(2): 233–62.

Fafchamps, M. 1999. *Rural Poverty, Risk and Development.* FAO Economic and Social Development Paper 144. Food and Agriculture Organization, Rome.

Fafchamps, M., and B. Minten. 2001. "Property Rights in a Flea Market Economy." *Economic Development and Cultural Change* 49(2):229–68.

Faruqee, R., and J. Coleman. 1996. "Managing Price Risk in the Pakistan Wheat Market." World Bank Discussion Paper 334. Washington, D.C.

Fisher F. 1963. "Theoretical Analysis of the Impact of Food Surplus Disposal on Agricultural Production in Underdeveloped Countries." *Journal of Farm Economics* 45(3):863–65.

Frechette, D. 2000. "The Demand for Hedging and the Value of Hedging Opportunities." *American Journal of Agricultural Economics* 82(4):897–907.

Freund, R. 1956. "The Introduction of Risk into a Programming Model." *Econometrica* 24(3): 253–63.

Friedman, M. 1954. "The Reduction of Fluctuations in the Incomes of Primary Producers: A Critical Comment." *Economic Journal* 64(256):698–703.

Gardner, B. 1989. "Rollover Hedging and Missing Long-term Futures Markets." *American Journal of Agricultural Economics* 71(3):311–18.

———. 2002. "Risk Created by Policy in Agriculture." In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, ed. R. E. Just and R. D. Pope. Boston: Kluwer.

Gautam, M., P. Hazell, and H. Alderman. 1994. "Rural Demand for Drought Insurance." Policy Research Working Paper 1383. World Bank, Washington, D.C.

Gemmill, G. 1985. "Forward Contracts or International Buffer Stocks? A Study of Their Relative Efficiencies in Stabilizing Commodity Export Earnings." *Economic Journal* 95(378):400–417.

Gilbert, C. 1985. "Futures Trading and the Welfare Evaluation of Commodity Price Stabilisation." *Economic Journal* 95(379):637–61.

———. 1987. "International Commodity Agreements: Design and Performance." *World Development* 15(5):591–616.

———. 1995. "International Commodity Control: Retrospect and Prospect." Policy Research Working Paper 1545. World Bank, Washington, D.C.

———. 1996. "International Commodity Agreements: An Obituary Notice." *World Development* 24(1):1–19.

Glauber, J., and K. Collins. 2002. "Risk Management and the Role of the Federal Government." In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, ed. R. E. Just and R. D. Pope. Boston: Kluwer.

Goldstein, M., A. de Janvry, and E. Sadoulet. 2002. "Is a Friend in Need a Friend Indeed?: Inclusion and Exclusion in Mutual Insurance Networks in Southern Ghana." WIDER Discussion Paper 2002/25. World Institute for Development Economics Research, Helsinki.

Grosh, M. 1998. "The World Bank's Living Standards Measurement Study Household Surveys." *Journal of Economic Perspectives* 12(1):187–96.

Grosh, M., and P. Glewwe. 1995. "A Guide to Living Standards Surveys and Their Data Sets." Living Standards Measurement Study Working Paper 120. World Bank, Washington, D.C.

Halcrow, H. 1949. "Actuarial Structures for Crop Insurance." *Journal of Farm Economics* 21(2):418–43.

Hardaker, J.B., R.B.M. Huirne, J.R. Anderson, and G. Lien. 2004. *Coping with Risk in Agriculture*. 2nd ed. Wallingford, UK: CABI Publishing.

Hart, C., B. Babcock, and D. Hayes. 2001. "Livestock Revenue Insurance." *Journal of Futures Markets* 21(6):553–80.

Harwood, J., R. Dismukes, M. Vandeverr, and R. Heifner. 2000. "From Risk-Pooling to Safety Nets: Crop and Revenue Insurance in the United States." In *Income Risk Management in Agriculture*. Paris: Organisation for Economic Co-operation and Development.

Harwood, J., R. Heifner, K. Coble, J. Perry, and A. Somwaru. 1999. "Managing Risk in Farming: Concepts, Research, and Analysis." Economic Research Service Agricultural Economic Report 774. U.S. Department of Agriculture, Washington, D.C.

Hausmann, R., and M. Gavin. 1996. "Securing Stability and Growth in a Shock-Prone Region: The Policy Challenge in Latin America." In *Security Stability and Growth in Latin America*, ed. R. Hausmann and H. Reisen. Paris: Organisation for Economic Co-operation and Development.

Hazell, P. B. R. 1982. "Application of Risk Preference Estimates in Firm-Household and Agricultural Sector Models." *American Journal of Agricultural Economics* 64(2):384–90.

———. 1992. "The Appropriate Role of Agricultural Insurance in Developing Countries." *Journal of International Development* 4(4):567–81.

Heady, E. O. 1952. *Economics of Agricultural Production and Resource Use.* Englewood Cliffs, N.J.: Prentice-Hall.

Industries Assistance Commission. 1978. *Rural Income Fluctuations.* Report 161. Canberra, Australia: Australian Government Publishing Service.

International Task Force on Commodity Risk Management in Developing Countries. 1999. *Dealing With Commodity Price Volatility in Developing Countries: A Proposal for a Market-Based Approach.* World Bank, Washington, D.C.

Jacoby, H., and E. Skoufias. 1997. "Risk, Financial Markets, and Human Capital in a Developing Country." *Review of Economic Studies* 64(3):311–35.

Jalan, J., and M. Ravallion. 1998. "Transient Poverty in Post-Reform Rural China." *Journal of Comparative Economics* 26(2):338–57.

———. 1999. "Are the Poor Less Well Insured? Evidence on Vulnerability to Income Risk in Rural China." *Journal of Development Economics* 58(1):61–81.

Johnson, D. G. 1947. *Forward Prices for Agriculture.* Chicago: University of Chicago Press.

———. 1950. "Resource Allocation under Share Contracts." *Journal of Political Economy* 58(2):111–23.

Kannapiran, C. 2000. "Commodity Price Stabilization: Macroeconomic Impacts and Policy Options." *Agricultural Economics* 23(1):17–30.

Keynes, J. 1943. "War Cabinet Committee on Reconstruction Problems: The International Regulation of Primary Products." Reprinted in *Collected Writing of John Maynard Keynes,* vol. 27, ed. D. Moggridge. London: Macmillan and Cambridge University Press. 1980.

Knight, T., and K. Coble. 1997. "A Survey of Literature on U.S. Multiple Peril Crop Insurance Since 1980." *Review of Agricultural Economics* 19(1):128–56.

Knudsen, O., and J. Nash. 1990. "Domestic Price Stabilization Schemes in Developing Countries." *Economic Development and Cultural Change* 38(3):539–58.

Knudsen, O., and A. Parnes. 1975. *Trade Instability and Economic Development.* Lexington, Mass.: Lexington Books.

Kochar, A. 1995. "Explaining Household Vulnerability to Idiosyncratic Income Shocks." *American Economic Review* 85(2):159–63.

Krammer, R. 1983. "Federal Crop Insurance." *Agricultural History* 97:181–200.

Kranton, R. 1996. "Reciprocal Exchange: A Self-Sustaining System." *American Economic Review* 86(4): 830–51.

Krueger, A., M. Schiff, and A. Valdés. 1991. *The Political Economy of Agricultural Pricing Policy,* vols. 1–3. Baltimore, Md.: Johns Hopkins University Press.

Kunreuther, H. 1978. *Disaster Insurance Protection: Public Policy Lessons.* New York: Wiley.

Lanjouw J., and P. Lanjouw 1995. "Rural Nonfarm Employment: A Survey." World Bank Working Paper 1463. Washington, D.C.

Lapan, H., and G. Moschini. 1994. "Futures Hedging under Price, Basis and Production Risk." *American Journal of Agricultural Economics* 76(3):465–77.

———. 1996. "Optimal Price Policies and the Futures Markets." *Economic Letters* 53(1):175–82.

Larson, D., and J. Coleman. 1993. "The Effects of Option Hedging on the Costs of Domestic Price Stabilization Schemes." In *Commodity Risk Management and Finance,* vol. 2, ed. S. Claessens and R. Duncan. Oxford: Oxford University Press.

Larson, D., and Y. Mundlak. 1997. "The Inter-Sectoral Migration of Agricultural Labor." *Economic Development and Cultural Change* 45(2):295–319.

Larson, D., and F. Plessmann. 2002. "Do Farmers Choose to be Inefficient? Evidence From Bicol, Philippines." Policy Research Working Paper 2787. World Bank, Washington, D.C.

Larson, D., P. Varangis, and N. Yabuki. 1998. "Commodity Risk Management and Development." Policy Research Working Paper 1963. World Bank, Washington, D.C.

Lee, I. 1953. "Temperature Insurance—An Alternative to Frost Insurance in Citrus." *Journal of Farm Economics* 35(1):15–28.

Lewis, S. 1955. *The Theory of Economic Growth*. London: Allen and Unwin.

Ligon, E., J. Thomas, and T. Worrall. 2002. "Informal Insurance with Limited Commitment: Theory and Evidence from Village Economies." *Review of Economic Studies* 69(1):209–44.

Little P., K. Cellarius, D. Coppock, and C. Barrett. 2001. "Avoiding Disaster: Diversification and Risk Management among East African Herders." *Development and Change* 32(3):401–33.

Lopes, M., and G. Dias 1986. "The Brazilian Experience with Crop Insurance Programs." In *Crop Insurance for Agricultural Development: Issues and Experience*, ed. P. Hazell, C. Pomareda, and A. Valdés. Baltimore, Md.: Johns Hopkins University Press.

Lutz, M. 1999. "Commodity Terms of Trade and Individual Countries' Net Barter Terms of Trade: Is There an Empirical Relationship?" *Journal of International Development* 11(6):859–70.

MacBean, A. 1966. *Export Instability and Economic Development*. Cambridge, Mass.: Harvard University Press.

Mahul, O. 1999. "The Design of an Optimal Area Yield Crop Insurance Contract." *Geneva Papers on Risk and Insurance Theory* 24(2):159–71.

Martin, E., and P. Bryde. 1999. "Grain Receipts in Economies in Transition: An Introduction to Financing of Warehouse Receipts." In *Agricultural Finance and Credit Infrastructure in Transition Economies: Proceedings of OECD Expert Meeting*. Paris: Organisation for Economic Co-operation and Development.

Massell, B. 1969. "Price Stabilization and Welfare." *Quarterly Journal of Economics* 83(2):234–89.

———. 1970. "Some Welfare Implications of International Price Stabilization." *Journal of Political Economy* 78(2):404–17.

Maxwell, S., and H. Singer. 1979. "Food Aid to Developing Countries: A Survey." *World Development* 7(2):225–46.

McCarthy, N. 2003. "Demand for Rainfall-Index Based Insurance: A Case Study from Morocco.' Environment and Production Technology Division Discussion Paper 106. International Food Policy Research Institute, Washington, D.C.

McConnell, D., and J. L. Dillon. 1997. *Farm Management for Asia: A Systems Approach*. FAO Farm Systems Management Series 13. Rome: Food and Agriculture Organization.

McKinnon, R. 1967. "Futures Markets, Buffer Stocks, and Income Stability for Primary Producers." *Journal of Political Economy* 75(6):844–61.

McPeak, J., C. Barrett, and B. Christopher. 2001. "Differential Risk Exposure and Stochastic Poverty Traps among East African Pastoralists." *American Journal of Agricultural Economics* 83(3):674–79.

Meerman, J. 1997. *Reforming Agriculture: The World Bank Goes to Market*. OED Evaluation Study. Washington, D.C.: World Bank, Operations Evaluation Department.

Miranda, M. 1991. "Area-Yield Crop Insurance Reconsidered." *American Journal of Agricultural Economics* 73(3):233–42.

Miranda, M., and J. Glauber. 1991. "Providing Crop Disaster Assistance through a Modified Deficiency Payment Program." *American Journal of Agricultural Economics* 73(4):1233–43.

———. 1997. "Systemic Risk, Reinsurance, and the Failure of Crop Insurance Markets." *American Journal of Agricultural Economics* 79(1):206–15.

Mishra, P. 1996. *Agricultural Risk, Insurance and Income: A Study of the Impact and Design of India's Comprehensive Crop Insurance Scheme*. Brookfield, Vt.: Avebury.

Morduch, J. 1998. "Between the Market and State: Can Informal Insurance Patch the Safety Net?" Development Discussion Paper 621. Harvard Institute for International Development, Cambridge, Mass.

———. 2002. "Consumption Smoothing Across Space: Testing Theories of Risk-Sharing in the ICRISAT Study Region of South India." WIDER Discussion Paper 2002/55. United Nations University, World Institute for Development Economics Research, Helsinki.

Morgai, R., P. Winters, E. Sadoulet, and A. de Janvry. 2002. "Localized and Incomplete Mutual Insurance." *Journal of Development Economics* 67(2):245–74.

Moscardi, E., and A. de Janvry. 1977. "Attitudes Toward Risk among Peasants: An Econometric Approach." *American Journal of Agricultural Economics* 59(4):710–16.

Moschini, G., and D. Hennessy. 2001. "Uncertainty, Risk Aversion and Risk Management for Agricultural Producers" In *Handbook of Agricultural Economics*, vol. 1A, *Agricultural Production*, ed. B. Gardner and G. Rausser. Amsterdam: Elsevier Science.

Muller, A., and M. Grandi. 2000. "Weather Derivatives: A Risk Management Tool for Weather-Sensitive Industries." *Geneva Papers on Risk and Insurance: Issues and Practice* 25(2):273–87.

Mundlak, Y., D. Cavallo, and R. Domenech. 1993. *Agriculture and Economic Growth in Argentina, 1913–84*. Research Report 76. Washington, D.C.: International Food Policy Research Institute.

Musser, W., and G. Patrick. 2002. "How Much Does Risk Really Matter to Farmers?" In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, ed. R. E. Just and R. D. Pope. Norwell, Mass.: Kluwer.

Myers, R. 1988. "The Value of Ideal Contingency Markets in Agriculture." *American Journal of Agricultural Economics* 70(2):255–67.

Myers, R., and J. Oehmke. 1988. "Instability and Risk as Rationales for Farm Programs." In *Agricultural Stability and Farm Programs: Concepts, Evidence, and Implications*, ed. D. Sumner. Boulder, Colo.: Westview.

Myers, R., and S. Thompson. 1991. "Optimal External Debt Management with Commodity-linked Bonds." In *Commodity Risk Management and Finance*, ed. T. Priovolos and R. Duncan. Oxford: Oxford University Press.

Newbery, D., and J. Stiglitz. 1981. *The Theory of Commodity Price Stabilization*. Oxford: Clarendon Press.

North, D. 1994. "The Evolution of Efficient Markets" In *History in Capitalism in Context: Essays on Economic Development and Cultural Change in Honor of R. M Hartwell*, ed. J. James and M. Thomas. Chicago: University of Chicago Press.

O'Hara, M. 1984. "Commodity Bonds and Consumption Risks." *Journal of Finance* 39(3):193–206.

Overdahl, J. 1987. "The Use of Crude Oil Futures by the Governments of Oil-Producing States." *Journal of Futures Markets* 7(6):603–18.

Paxson, C. 1993. "Consumption and Income Seasonality in Thailand." *Journal of Political Economy* 101(1):39–75.

Peck, A. 2001. "The Development of Commodity Exchanges in the Former Soviet Union, Eastern Europe, and China." *Australian Economic Papers* 40(4):437–60.

Platteau, J. 1997. "Mutual Insurance as an Elusive Concept in Traditional Rural Communities." *Journal of Development Studies* 33(6):764–96.

Pomareda, C. 1986. "The Financial Viability of Agricultural Insurance." In *Crop Insurance for Agricultural Development: Issues and Experience*, ed. P. Hazell, C. Pomareda, and A. Valdés. Baltimore, Md.: Johns Hopkins University Press.

Pratt, J. 1964. "Risk Aversion in the Small and in the Large." *Econometrica* 32(1/2):122–36.

Prebisch, R. 1950. *The Economic Development of Latin America and Its Principal Problems.* New York: UN Economic Commission for Latin America.

Priovolos, T., and R. Duncan, eds. 1991. *Commodity Risk Management and Finance.* Oxford: Oxford University Press.

Quiggin, J. 1986. "A Note on the Viability of Rainfall Insurance." *Australian Journal of Agricultural Economics* 30(1):63–9.

Quiggin, J. C., and J. R. Anderson. 1979. "Stabilisation and Risk Reduction." *Australian Journal of Agricultural Economics* 23(3):191–206.

———. 1981. "Price Bands and Buffer Funds." *Economic Record* 57(196):67–73.

Quiggin, J., G. Karagiannis, and J. Stanton. 1993. "Crop Insurance and Crop Production: an Empirical Study of Moral Hazard and Adverse Selection." *Australian Journal of Agricultural Economics* 37(2): 95–113.

Ravallion, M. 1991. "Reaching the Rural Poor through Public Employment: Arguments, Evidence, and Lessons from South Asia." *World Bank Research Observer* 6(2):153–75.

———. 1997. "Famines and Economics." *Journal of Economic Literature* 35(3):1205–42.

Ray, P. 1967. *Agricultural Insurance: Theory and Practice and Application to Developing Countries.* Oxford: Pergamon.

Reardon, T., C. Delgado, and P. Matlon. 1988. "Determinants and Effects of Income Diversification Amongst Farm Households in Burkina Faso." *Journal of Development Studies* 28(1):264–96.

Reinikka, R., and P. Collier, eds. 2001. *Uganda's Recovery: The Role of Farms, Firms and Government.* Washington, D.C.: World Bank.

Reutlinger, S. 1970. "Techniques for Project Appraisal under Uncertainty." World Bank Staff Occasional Papers 10. Washington, D.C.

Rhamato, D. 1991. *Famine and Survival Strategies: A Case Study from Northeast Ethiopia.* Uppsala, Sweden: Nordiska Afrikainstitutet.

Robertson, A. 1987. *The Dynamics of Productive Relationships: African Share Contracts in Comparative Perspective.* New York and Melbourne: Cambridge University Press.

Robison, L., and P. Barry. 1987. *The Competitive Firm's Response to Risk.* New York: Macmillan.

Rodrik, D. 1998. "Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses." NBER Working Paper 6350. National Bureau of Economic Research, Cambridge, Mass.

Rolfo, J. 1980. "Optimal Hedging under Price and Quantity Uncertainty: The Case of a Cocoa Producer." *Journal of Political Economy* 88(11):100–116.

Rose, E. 2001. "Ex Ante and Ex Post Labor Supply Response to Risk in a Low-Income Area." *Journal of Development Economics* 64(2):371–88.

Rosenzweig, M. 2001. "Savings Behaviour in Low-Income Countries." *Oxford Review of Economic Policy* 17(1):40–54.

Rosenzweig, M., and H. Binswanger. 1993. "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments." *Economic Journal* 103(1):56–78.

Roumasset, J. A., M. Rosegrant, U. Chakravorty, and J. R. Anderson. 1989. "Fertilizer and Crop Yield Variability: A Review." In *Variability in Grain Yields,* ed. J. R. Anderson and P. B. R. Hazell. Baltimore, Md.: Johns Hopkins University Press.

Sakurai, T., and T. Reardon. 1997. "Potential Demand for Drought Insurance in Burkina Faso and Its Determinants." *American Journal of Agricultural Economics* 79(4):1193–207.

Sapsford, D., and V. N. Balasubramanyam. 1999. "Trend and Volatility in the Net Barter Terms of Trade, 1900–92: New Results from the Application of a (Not So) New Method." *Journal of International Development* 11(6):851–57.

Satyanarayan, S., E. Thigpen, and P. Varangis. 1993. "Hedging Cotton Price Risk in Francophone African Countries." Policy Research Working Paper 1233. World Bank, Washington, D.C.

Schultz, T. W. 1945. *Agriculture in an Unstable Economy*. New York: McGraw-Hill.

———. 1960. "Impact and Implication of Foreign Surplus Disposal on Underdeveloped Countries: Value of U.S. Farm Surpluses to Underdeveloped Countries." *Journal of Farm Economics* 42(4): 1019–30.

———. 1964. *Transforming Traditional Agriculture*. New Haven, Conn.: Yale University Press.

Sen, A. 1960. "Impact and Implication of Foreign Surplus Disposal on Underdeveloped Countries—The Indian Perspective." *Journal of Farm Economics* 42(4):1031–42.

———. 1981. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Oxford University Press.

Shaw, J. 2002. "Food Aid in Sub-Saharan Africa: Policy Lessons for the Future." *Canadian Journal of Development Studies* 23(3):571–99.

Singer, H. 1950. "The Distribution of Gains between Investing and Borrowing Countries." *American Economic Review* 40(2):473–85.

Skees, J. 1999. "Opportunities for Improved Efficiency in Risk Sharing Using Capital Markets." *American Journal of Agricultural Economics* 81(5):1228–33.

———. 2000. "Agricultural Insurance Programmes: Challenges and Lessons Learned." In *Income Risk Management in Agriculture*. Paris: Organisation for Economic Co-operation and Development.

Skees, J., and A. Enkh-Amgalan. 2002. "Examining the Feasibility of Livestock Insurance in Mongolia." World Bank Working Paper 2886. Washington, D.C.

Skees, J., J. Black, and B. Barnett. 1997. "Designing and Rating an Area Yield Crop Insurance Contract." *American Journal of Agricultural Economics* 79(2):430–38.

Skees, J., P. Hazell, and M. Miranda. 1999. "New Approaches to Crop Yield Insurance in Developing Countries." Environment and Production Technology Division Discussion Paper 55. International Food Policy Research Institute, Washington, D.C.

Skees, J., P. Varangis, D. F. Larson, and P. Siegel. 2002. "Can Financial Markets Be Tapped to Help Poor People Cope with Weather Risks?" Policy Research Working Paper 2812. World Bank, Washington, D.C.

Smith, K., C. Barrett, and P. Box. 2001. "Not Necessarily in the Same Boat: Heterogeneous Risk Assessment among East African Pastoralists." *Journal of Development Studies* 37(5):1–30.

Smith, V., and A. Baquet. 1996. "Almost Ideal Area Yield Crop Insurance Contracts." *Agricultural and Resource Economics Review* 23(1):75–83.

Stern, N. 1989. "Peasant Economy." In *The New Palgrave: Economic Development*, ed. J. Eatwell, M. Milgate, and P. Newman. New York: Norton.

Timmer, C. 1989. "Food Price Policy: The Rationale for Government Intervention." *Food Policy* 14(1):17–27.

Townsend, R. 1977. "The Eventual Failure of Price Fixing Schemes." *Journal of Political Economy* 91(2):190–99.

———. 1995. "Consumption Insurance: An Evaluation of Risk-Bearing Systems in Low-Income Economies." *Journal of Economic Perspectives* 9(3):83–102.

Turvey, C. 1992 "An Economic Analysis of Alternative Farm Revenue Insurance Policies." *Canadian Journal of Agricultural Economics* 40(3):403–26.

———. 2001. "Weather Derivatives for Specific Event Risks in Agriculture." *Review of Agricultural Economics* 23(2):333–51.

Udry, C. 1991. "Risk, Insurance and Default in a Rural Credit Market: An Empirical Investigation in Northern Nigeria." Yale Economic Growth Center Discussion Paper 636. Yale University, New Haven, Conn.

———. 1995. "Risk and Saving in Northern Nigeria." *American Economic Review* 85(5):1287–300.

Valgren, V. N. 1922. "Crop Insurance: Risks, Losses and Principles of Protection." USDA Bulletin 1043. U.S. Department of Agriculture, Washington, D.C.

Varangis, P., and D. F. Larson. 1996. "Dealing with Commodity Price Uncertainty." Policy Research Working Paper 1667. World Bank, Washington, D.C.

Vercammen, J. 2000. "Constrained Efficient Contracts for Area Yield Crop Insurance." *American Journal of Agricultural Economics* 82(4):856–64.

von Braun, J., ed. 1995. *Employment for Poverty Reduction and Food Security*. Washington, D.C.: International Food Policy Research Institute.

Wang, H. 2000. "Zone-Based Group Risk Insurance." *Journal of Agricultural and Resource Economics* 25(2):411–31.

Williams, J. 2001. "Commodity Futures and Options." In *Handbook of Agricultural Economics*, vol. 1B, *Marketing, Distribution and Consumers*, ed. B. Gardner and G. Rausser. Amsterdam: Elsevier Science.

Wolpin, K. 1982. "A New Test of the Permanent Income Hypothesis: The Impact of Weather on the Income and Consumption of Farm Households." *International Economic Review* 23(3):583–94.

World Bank. 1990. *World Development Report 1990: Poverty*. New York: Oxford University Press.

———. 2001. *Social Protection Sector Strategy: From Safety Net to Springboard*. Washington, D.C.

Wright, B. 1988. "Storage, Stability, and Farm Programs." In *Agricultural Stability and Farm Programs: Concepts, Evidence, and Implications*, ed. D. Sumner. Boulder, Colo.: Westview.

Wright, B., and J. Hewitt. 1994. "All Risk Crop Insurance: Lessons from Theory and Experience." In *Economics of Agricultural Insurance: Theory and Evidence*, ed. D. Hueth and W. Furtan. Boston: Kluwer.

Wright, B., and D. Newbery. 1991. "Financial Instruments for Consumption Smoothing by Commodity-Dependent Exporters." In *Commodity Risk Management and Finance*, ed. T. Priovolos and R. C. Duncan. Oxford: Oxford University Press.

Wright, B., and J. Williams. 1990. "The Behavior of Markets for Storable Commodities." Paper presented at the Annual Conference of the Australian Agricultural Economics Society, Brisbane, Australia.

Yamauchi, T. 1986. "Evolution of the Crop Insurance Program in Japan." In *Crop Insurance for Agricultural Development: Issues and Experience*, ed. P. Hazell, C. Pomareda, and A. Valdés. Baltimore, Md.: Johns Hopkins University Press.

Yaron, J., M. P. Benjamin, and G. L. Piprek. 1997. "Rural Finance: Issues, Design, and Best Practice." Environmentally and Socially Sustainable Development Studies and Monographs 14. World Bank, Washington, D.C.

Oil, Macroeconomics, and Forests: Assessing the Linkages

Sven Wunder • William D. Sunderlin

How does an oil boom affect the forest cover of tropical oil-exporting countries? What macroeconomic linkages and policies are decisive? A comparison of research findings on long-run land-use changes in eight tropical developing economies reveals that the direct physical impacts of the oil industry on forests are unquestionably less than its derived macroeconomic impact. In most cases oil wealth indirectly but significantly protects tropical forests. The core mechanism is that oil rents cause macroeconomic "Dutch disease" decreasing the price competitiveness of agriculture and logging, strongly diminishing pressures for forest degradation and deforestation. But domestic policy responses to oil wealth are also vital determinants of the forest outcome. When governments use oil wealth for urban spending sprees, this reinforces the core effect by pulling more labor out of land-using and forest-degrading activities. When oil revenues finance road construction or frontier colonization, however, the core forest-protective effect can be reversed. Repeated currency devaluation and import protection of land-using domestic sectors also increase pressures on forests. Other international capital transfers, like bilateral credits, aid, or debt relief, can have impacts similar to those of oil wealth, either alleviating pressures on forests or aggravating specific forest-detrimental policies. These insights point to forest-friendly safeguards that can realistically be made in the design of structural adjustment programs, considering the important tradeoffs between development and conservation objectives.

Over the past decade there has been growing interest in the relationship between macroeconomics and the environment, including the links to deforestation and forest degradation. This is due to a growing recognition that the fate of tropical forests is determined by factors outside forests and the forestry sector, factors which have often been called the underlying causes of deforestation (Contreras-Hermosilla 2000). A wealth of theoretical economic models has been developed, with multi-country regression models as the predominant category (Angelsen and Kaimowitz

The World Bank Research Observer, vol. 19, no. 2.
© The International Bank for Reconstruction and Development / THE WORLD BANK 2004; all rights reserved.
doi:10.1093/wbro/lkh018 19:231–257

1999). However, the United Nations Food and Agriculture Organization (FAO) deforestation data normally used in these exercises are highly problematic (see later discussion). Thus, it is dubious to what extent the observed cross-country patterns can be given a time-series interpretation (Kaimowitz and Angelsen 1998). Cross-country analysis should thus be complemented by country-comparative case studies (Kaimowitz and others 1998; Reed 1992, 1996; Wood and others 2000). These studies, however, have analyzed mostly short-run effects of macroeconomic change, notably the environmental effects of structural adjustment.

The comparative research described here was conducted by the Center for International Forestry Research (CIFOR) and is documented more extensively elsewhere (Wunder 2003b). It looks at the macroeconomic determinants of changes in land use and forest cover since the 1970s. Eight developing economies with tropical forests were analyzed, five with detailed case studies (Cameroon, Ecuador, Gabon, Papua New Guinea, and Venezuela) and referred to as primary cases and three (Indonesia, Mexico, and Nigeria) with more summary-type or secondary case studies. The countries were selected to cover a variety of conditions, including geographic location, country size, income per capita, and proportion of forest coverage. A subsidiary criterion was the existence of previous CIFOR research on land-use change (Cameroon, Indonesia, and Ecuador).

This article focuses mainly on the five primary case study countries. For forest impacts, the concentration is on forest conversion to other land uses and deforestation, defined as a (temporary or permanent) removal of trees to less than 10 percent crown cover, which is similar to the FAO's definition (FAO 2000). Selective logging is thus not deforestation but may degrade forests and enable conversion. The link from oil wealth and macropolicies to logging and forest degradation is analyzed elsewhere (Wunder 2003a).

All of the case study countries are tropical countries that export oil, a choice made for two reasons. First, the macroeconomic "laboratory" of oil exporters offers a good opportunity to study links between external economic changes and forests. Oil economies often fluctuate dramatically due to heavy reliance on a single export commodity with unstable world market prices. The policy responses to frequent boom and bust cycles also differ enormously, both over time and across countries (Bevan and others 1999a; Collier, Gunning, and Associates 1999; Little and others 1993; Neary and van Wijnbergen 1986). This is because oil wealth buys governments higher degrees of freedom in defining individual policy responses (Gelb and Associates 1988; Karl 1997). This large variation makes it easier to track the eventual effects of different policies on forests.

Second, earlier studies provide support for the hypotheses that on average oil- and mineral-exporting tropical countries have more forests left and lose them at a slower rate than nonmineral-exporting countries. This is true not only for a bivariate group comparison but also for multivariate cross-country deforestation models controlling

for third causal factors (Mainardi 1998; Sunderlin and Wunder 2000). The FAO's *Forest Resource Assessment 2000* data indicate that specialized mineral exporters, which derive more than 50 percent of their export revenues from oil and minerals, have no less than 47.7 percent of the area of remaining tropical forests (Wunder 2003b:chap. 2). This estimate is fairly conservative.[1] In other words, the cross-country data suggest that there are some characteristics of oil and mineral economies that in most (but not all) cases inadvertently protect forests. This article seeks to explain this forest-protecting mechanism and understand how it is affected by domestic policy responses. The core hypothesis is that in the oil-exporting countries, deforestation pressures are lower when oil revenues are booming than during oil bust periods. This shifts the reasoning from a static cross-country framework to an intertemporal, comparative one.

The article briefly reviews hypotheses and methodologies and outlines the deforestation data problems and how they were dealt with. It presents empirical results for the five primary case study countries and takes a closer look at three of the key causal linkages in the model. It then examines the role of different policy instruments and finally discusses policy insights that extend beyond the oil-exporting countries.

Theories and Methods

Why should oil wealth reduce pressures on forests? Sizable foreign exchange earnings from oil, sometimes supplemented by foreign borrowing, raise government spending, increasing aggregate demand. This causes the real exchange rate to appreciate through growing inflation and nominal currency revaluation. Nontraded and quasi-nontraded (import-protected) sectors expand, while nonoil traded goods lose competitiveness and decline. This is the classical Dutch-disease pattern (Corden 1984), named after the Netherlands' experience with gas revenues in the 1960s and 1970s (*The Economist* 1977).

In developing economies, primary sectors have been the main victims of Dutch disease, especially agriculture and the "purely traded" export sectors (Collier, Gunning, and Associates 1999; Neary and van Wijnbergen 1986; Roemer 1984). To the extent that large parts of the agricultural and timber sectors are exposed to foreign competition, an oil boom generally discourages the expansion of agriculture and logging. That also tends to reduce area expansion in these sectors and hence curbs deforestation for agricultural conversion and for a number of other primary activities that potentially claim forested lands (shrimp farming, small-scale mining).

What impact has there been on forests from the oil-led expansion of the nontradable sectors? Most nontradables (public and private services, construction, and so on) and trade-protected quasi-nontradables (manufacturing) are urban, so most oil booms are accompanied by accelerated urbanization. Rural labor is drawn to the

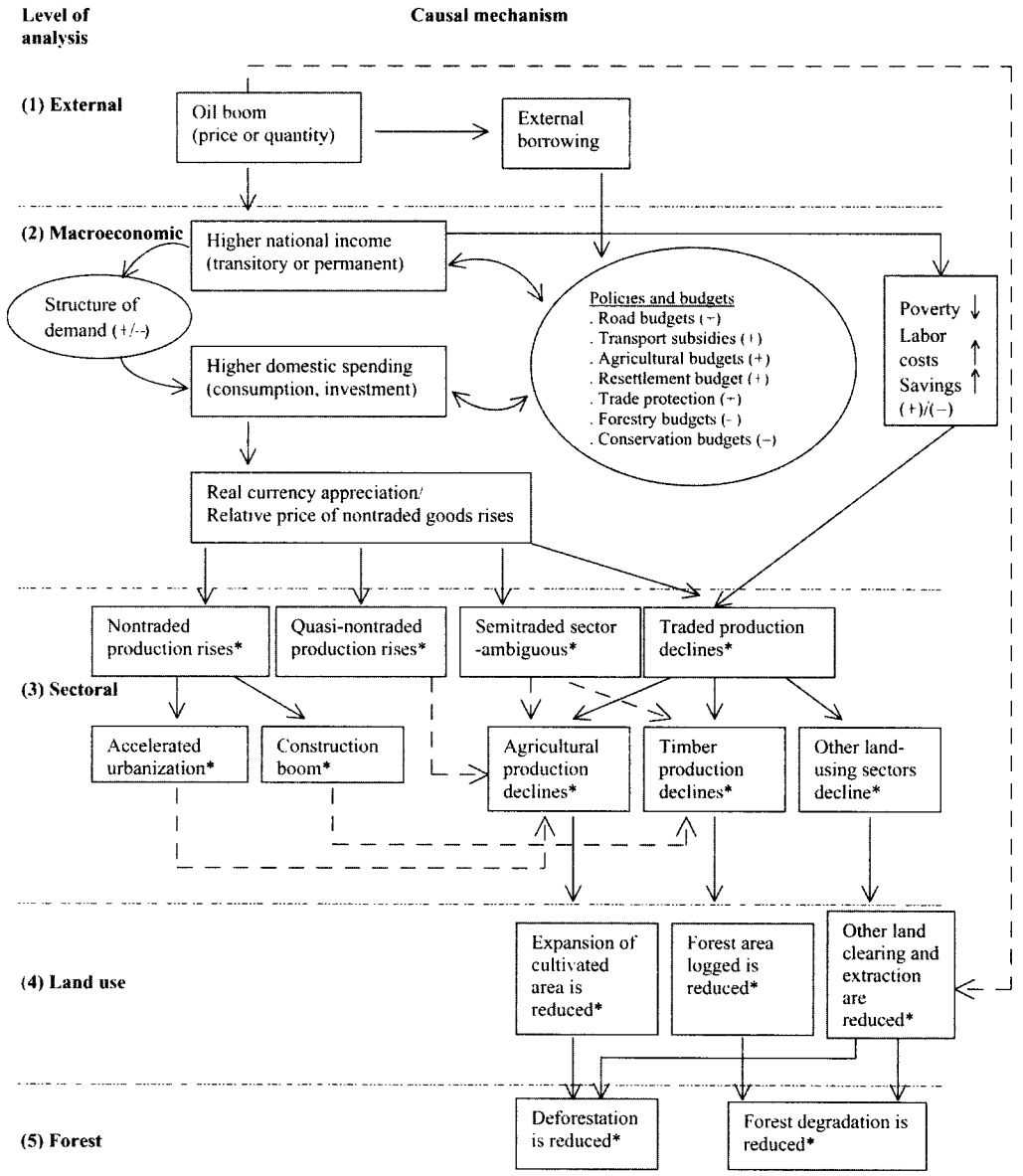
cities, abandoning natural-resource based livelihoods for urban activities that tend to have more benign forest impacts. Conversely, in times of urban crisis some of these people return to their villages, reexpanding food-crop production into forests as a default rural safety net. Growing cities also leave "ecological footprints" on forests, through demand for timber for construction, fuel wood for cooking, or protein-rich foods (meat, dairies) that can lead to forest conversion. Often peri-urban forests are most affected by these pressures. Still, urban sprawl in itself was a negligible source of deforestation in the case study countries.[2] In most cases, agricultural production for urban markets also became more sedentary and land-intensive (fewer land inputs per unit of output), and part of urban demand was also satisfied through imports.[3] Rapid urbanization is therefore good news for the conservation of a country's forest cover in most cases.[4]

As this rudimentary overview shows, it is important to take into account a variety of linkages between macroeconomic factors and forests. In a recent analogous study on the root causes of biodiversity loss, all macro-level changes were assumed to jeopardize biodiversity (Wood and others 2000). But it is more realistic to assume that some underlying factors increase environmental pressure whereas others reduce it, the net effect depending on the balance between them. One way of analyzing multi-level linkages with opposing forest cover effects is to use a computable general equilibrium (CGE) model (see Kaimowitz and Angelsen 1998:61–68, for an overview). However, such models have difficulty dealing with the spatial specificity of deforestation. They also generally require a wealth of information. The data gaps for the case study countries proved to be too large to use a CGE model without first bridging data gaps by making "creative" CGE parameter assumptions. For the sake of greater transparency, a partial recursive approach was used instead (figure 1).

The analysis runs from the external level (1) of foreign-exchange inflows and the macroeconomic level (2) down to sectoral production (3), land use (4), and the forest levels (5). At the external level when oil wealth, or foreign borrowing against future oil revenues, finances large increments in road budgets or resettlement projects or subsidies for transport or agriculture, forest loss may increase (marked by a plus sign in figure 1). The opposite could be the case if budget allocations for conservation and forestry regulations are strengthened (marked by a minus sign).

Structural changes outside the policy sphere also affect the forest outcome in an ambiguous way (left side of figure 1). For instance, if higher incomes induce consumers to buy more meat and dairy products, that tends to increase deforestation for cattle raising, as in Latin America. But if higher income leads to a shift from tubers produced on swidden land to more land-intensive rice production, that can reduce forest loss, as in Central Africa. Reduced poverty in a booming economy goes hand in hand with higher labor costs (reducing deforestation), but there will also be more funds available for investment, which can promote more forest clearing in capital-scarce frontiers (right side). The relative strength of these counterhypothetical,

Figure 1. Linking Resource Booms to Forest Cover Outcomes



* Relative to preexisting trends (growth and structural change).

→ Core-hypothesis causality: oil wealth protects forests (trend indicated in target box).

⇢ Counter-hypothetical causality: oil wealth eliminates forests (counteracting trend indicated in target box).

\+ Expected to accelerate forest loss and degradation.

\- Expected to decelerate forest loss and degradation.

+/– Ambiguous in effect.

Source: Authors' construction.

forest-eliminating partial effects differs from case to case (dotted lines in figure 1). In addition, there is the macroeconomic Dutch disease effect described already (center-left), causing real currency appreciation and changes in relative prices.

At the sectoral level (3) Dutch disease causes traded sectors to decline while non-traded (services, construction) and quasi-nontraded sectors (industry) rise. If timber production and agriculture are fully traded sectors with perfect foreign substitutes, Dutch disease at the land-use level (4) will unambiguously alleviate pressures to log new forest areas and convert forests to agriculture and other traded-sector land uses (such as shrimp farming impacting mangroves)—at least compared with pre-existing sectoral trends. If these extrasectoral effects are dominant in their impact on forests (5), deforestation and forest degradation would also be reversed or at least reduced. Whether the forest-protection effect is proportional to the land-use effect depends on specific parameters, such as the number of species extracted per hectare or the extent to which abandoned agricultural areas convert back into forests.

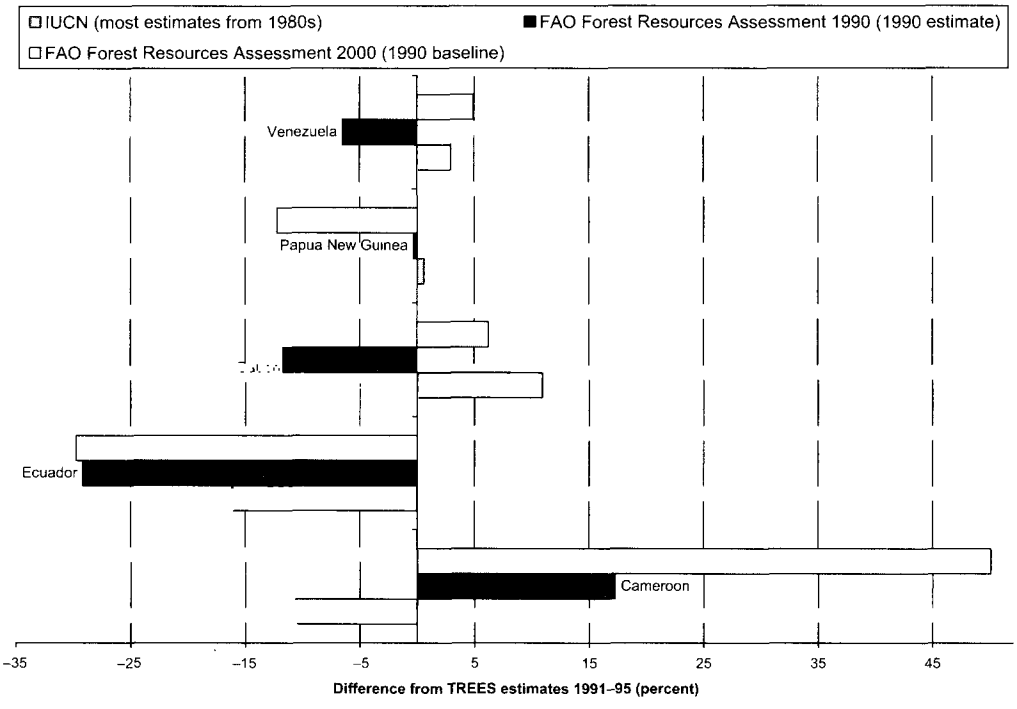
Contrary effects may occur to the extent that logging and agriculture are semi-traded or quasi-nontraded, for example, through import protection of part of the sector. In that case greater urbanization may cause a construction boom with higher domestic timber demand or a beef-and-dairy boom accelerating deforestation for domestic ranching. The partial approach does not produce a bottom-line calculus of whether these contrary effects in net terms reverse the forest-protecting effect. Yet it is a flexible framework for pulling together the patchwork of land-use factors, in spite of incomplete data coverage and variable spatial scenarios.

Deforestation and Land-Use Data

Although hundreds of deforestation models and analyses have been developed over the past decade, country-level statistics on forests and deforestation tend to be lacking or unreliable. The adequacy of FAO forest statistics, the most frequently used source, has been discussed critically elsewhere (Grainger 1996; Matthews 2001; Rudel and Roper 1997). Here, observations concern only the five case study countries. A comparison of forest stock estimates from the European Union's TREES project for the early 1990s with those from FAO (FAO 1993, 2001) and the World Conservation Union (IUCN) reveals typical stock variations in the 5–15 percent range, but the gap can be 30–50 percent for countries with large forest-savannah transition zones, such as Cameroon, or forest fragments in deforested landscape, such as Ecuador (figure 2 and table 1).[5] Accounting for much of these large disparities are differences in canopy cover criteria, spatial scales of resolution, time scale, and sample coverage (Wunder 2003b:chap. 3).

There are no annual deforestation estimates for any of the case study countries, and it is thus not possible to do a proper testing of time-series relationships. The FAO

Figure 2. Differences in FAO and IUCN Tropical Forest Cover Estimates from TREES Estimates



Note: TREES estimates are from maps between 1991 and 1995.

Source: TREES (Mayauxand others 1998); IUCN *Conservation Atlas* figures cited in Mayaux and others (1998); FAO 1990 estimates (FAO 1993:table 1); FAO 1990 baseline (FAO 2001).

produces average deforestation estimates for every full decade, but even these tend to be highly problematic for the case study countries. The deforestation figures from *Forest Resources Assessment 2000* (FAO 2001) for the 1990s are strikingly different from those for the 1980s in *Forest Resources Assessment 1990* (FAO 1993). The difference is explained more by changing methods and assumptions than by measured differences. According to these data, forest cover loss appears to have doubled in the 1990s in Cameroon and decreased by two-thirds in Venezuela and by more than 90 percent in Gabon. Papua New Guinea's annual forest loss remains at 113,000 ha, but *Forest Resources Assessment 2000* retrospectively set deforestation in the previous period (1975–85) to zero, so that the flow estimate would still be compatible with the new forest stock figures. For Venezuela the large reduction in estimated deforestation reflects the changes in methods from a population-based model prediction to a national expert consensus around a much more conservative figure. As explained in the notes to table 1, *Forest Resources Assessment 2000* deforestation figures are based

Table 1. Comparing Forest Cover Estimates: FAO's Forest Resources Assessment (FRA) 2000 and 1990 and Authors' Estimates (thousands of ha unless otherwise noted)

	FRA 2000				*FRA 1990*			*Inferred in 1990 forest area between FRA 2000 and FRA 1990*		*Authors' "best guess"*	
Country	*Total forests 2000*[a]	*Annual deforestation 1990–2000*	*Annual deforestation rate 1990–2000(%)*	*Baseline 1990*[a]	*Total forests 1990*[a]	*Annual deforestation 1980–90*	*Annual deforestation rate 1980–90 (%)*	*%*	*Number of deforestation years (FRA 2000)*	*Forest c over ~1990*[a, b]	*Deforestation 1990s*
Cameroon	23,858	222[c]	0.9	26,078	20,372	122	0.6	28.0	26	17,000–24,000	150–200
Ecuador	10,557	137[d]	1.2	11,927	12,026	238	1.8	–0.9	–1	15,500 (11,500–17,000)	>180
Gabon	21,862	10[e]	0.0	21,962	18,265	116	0.6	20.2	370	20,500–23,000	0
Papua New Guinea	30,601	113[f]	0.4	31,731	36,043	113	0.3	–12.0	–38	32,000–37,000	50–70
Venezuela	49,506	218[g]	0.4	51,686	46,052	599	1.2	12.2	26	49,000 (44,000–49,000)	250–400

Source: FAO (1993, 2001); online data at www.fao.org/forestry/fo/country/index.jsp (accessed 31 July 2001); and authors' estimates.

[a]Including plantations.

[b]Preferred point estimate or likely range under variable assumptions and definitions.

[c]Cameroon, 1975–99 interpolation and extrapolation.

[d]Ecuador, 1985–92 interpolation and extrapolation.

[e]Gabon, 1970–99 interpolation and extrapolation.

[f]Papua New Guinea, 1975–2000 interpolation.

[g]Venezuela, 1985–95 interpolation and extrapolation.

on long-term interpolation and extrapolations from other decades, so at best they say something about forest loss in the recent past rather than specifically in the 1990s.

If the amount of forest lost in the study countries is unknown, along with how the pace of loss has changed in subperiods, how can the causes of forest loss be estimated? The analysis here employs what FAO calls the "convergence of evidence" method. This involves gathering all available data and using basic math and common sense to deduce what land-use changes are most likely to have occurred. All national estimates, subnational trends specified in two global deforestation study databases (Geist and Lambin 2001; unpublished collection of Thomas Rudel) and country sources, and trends in predesignated deforestation "hot spots" were critically examined. For Cameroon, primary data gathered for a CIFOR project were used, providing three- to four-period estimates. Following Houghton and others (1991) and Barbier (2001), cultivated area expansion was also examined as an alternative deforestation indicator. Except for the savannah regions of northern Cameroon and the Llanos region in Venezuela, most unoccupied land in the study countries is forested, and by far most forest loss can be attributed to the expansion of agriculture (including livestock).

Estimates of deforestation in the 1990s for the five primary case study countries based on this screening of a large number of land-use sources are reported in the last column of table 1. In some cases, estimated ranges were preferred to point estimates. For Cameroon, Ecuador, and Venezuela the estimates fall between those of *Forest Resources Assessment 1990* and *Forest Resources Assessment 2000*; for Gabon and Papua New Guinea the estimates are significantly lower than both FAO figures. Despite the absence of hard data (except for Cameroon), this yielded a rough idea of historical forest trends. This article is limited to simply identifying periods of "high" or "low" forest loss and employing them in the analysis below. (Wunder 2003b:chaps. 4–9, provides a detailed quantitative assessment of the intricate picture of land-use changes and deforestation in each of the study countries.)

The country-specific land-use screening exercises also gave a clear indication of the uses to which converted forestlands were being put. Although agriculture was always the principal alternative land use, the types of land-hungry subsectors differed greatly across the cases. In Ecuador and Venezuela, pastures for cattle ranching were overwhelmingly dominant. In Cameroon, Gabon, and Papua New Guinea, extensive swidden food crop systems were the primary land use. The multitude of export crops grown in Cameroon accounted for only a minor share of deforested area, because in Cameroon export crops are cultivated in a more land-intensive manner than food crops.

The screening also gave a more realistic view of which sectors were definitely not to blame for the bulk of deforestation. The direct land-conversion effects from oil and mining, judged to be a significant cause in some past campaigns to save the rainforest (RAN and Project Underground 1998; WWF 2002), were found to be negligible sources of forest loss. In Cameroon oil was produced off-shore. In Venezuela oil is mainly from

nonforested savannahs. In Gabon most oil sources are in forests, but the industry occupies less than 10,000 ha (0.05 percent of forest area). In Papua New Guinea the industry occupies just 1,200 ha. In Ecuador 99 percent of oil production comes from the Amazon forest, but accumulated direct conversion has been only about 3,000–6,500 ha (0.04–0.09 percent of Ecuador's Amazon forest). Indirect access-provision and pollution effects have in some cases been much larger than the direct effects. But these effects were much reduced when the industries used best practice.

Country Stories

This section examines the five primary case study countries for evidence of the impact of oil wealth on forests.[6]

Gabon

Gabon provides a textbook case of confirmation of the core hypothesis. Its transformation to an oil exporter in the early 1970s gave this sparsely populated country the highest per capita oil rent in the case study countries. Despite a mini-bust in 1986–89 and highly fluctuating oil revenues in the 1990s, the entire post-1973 period was an era of high oil wealth.

Oil revenues, which were unequally distributed, caused massive, economywide structural changes. An appreciating real exchange rate eliminated smallholder cash crops like coffee and cocoa. Nontraded sectors thrived, in particular oil-financed public employment and urban construction. With the total neglect of rural areas and road building, and with substantial urban rent-seeking, there was a rural exodus of people in the most productive age groups. The agricultural lands they abandoned grew back into forest. A village chief in northeast Gabon describes a situation in which reduced cropping and lower human presence go hand in hand with forest rehabilitation: "Nobody lives here any more.... The young are leaving, and the elephants and gorillas run freely through our gardens, destroying what little we grow to eat."[7] A resettlement program that brought people out of the forest into concentrated roadside settlements (rather than moving them into the "empty" forestland) reinforced that trend.

Two national forest inventories indicate that high oil wealth likely led to a marginal absolute expansion of national forest area between 1970 (20,567,338 ha) and 1990 (20,677,000 ha; Wunder 2003b:86–90). For the 1990s FAO's *Forest Resources Assessment 2000* revised annual deforestation estimates downward to only 10,000 ha (0.05 percent). Within this overall picture, there were local deforestation processes in peri-urban areas, especially during recent mini-crises, when some people lost their urban jobs and increasingly turned to peri-urban "weekend farming" to

improve their livelihoods. On the other hand, forests away from urban areas returned to abandoned agricultural lands, as indicated by a number of village case studies using remote sensing data (Wunder 2003b).

Should oil revenues begin to decline rapidly, reducing the real value of Gabon's currency, wages, and nontraded prices, there would be an increase in the domestic production of cash and food crops, which are now mostly imported from neighboring countries. Because most of Gabon is covered by forests, this higher land demand would be a significant stimulus to deforestation.

Venezuela

Venezuela's transformation from a specialized agricultural exporter in the 1920s to a mono-exporter of oil from the 1930s onward has many similarities to Gabon's story. It is another case that confirms the core hypothesis in absolute terms. National forest maps show marked net forest regrowth in abandoned agricultural areas from 1920–50, when people rushed into the cities to take advantage of economic opportunities arising from oil wealth. But in the 1950s Venezuela invested heavily in roads, which together with fuel subsidies greatly reduced the cost of transporting agricultural products. (Even in the early 1990s a liter of gasoline was cheaper than a liter of bottled water.) This promoted the expansion of the cattle sector, which has accounted for almost all of the country's expansion of cultivated area since World War II. Cultivated area expanded from 2.4 million ha in 1945 to 19.5 million ha in 1978. But 16.4 million ha (95.6 percent) of the 17.1 million ha expansion were for cultivated pasture and only 0.76 million ha (4.6 percent) for cropland. No pasture data were collected after 1978, but data on the number of cattle indicate that the strong expansion continued. By 1996 pastures accounted for 95 percent of cultivated-area expansion since 1945 (Wunder 2003b:144–47; data from the Ministry of Agriculture and Breeding).

Cattle ranching was a semi-traded sector, with import protection during some periods and for some products. It expanded procyclically with urban incomes due to higher demand for protein-rich food. Meanwhile, cropped area stagnated, despite large population growth. Unlike pasture, growth in cropped area was negatively correlated with both rising urban incomes and declining price competitiveness. In this sense, crop cultivation was the true victim of Dutch disease.

Although Venezuela still had low forest loss rates over 1950–80, both deforestation assessments and agricultural area data indicate that the loss has accelerated in the past two decades. With the deep economic and political crises of the 1980s and 1990s, the speed of forest extraction and clearing increased, even in the areas south of the Orinoco River that had previously been remote from the bustling urban centers. This spatial expansion was closely related to a depreciating real exchange rate, which stimulated logging, artisan mining, and even food crop cultivation. Since

World War II Venezuela has thus witnessed increasing forest loss, though still at a slower pace than its neighbors, which have stronger agricultural sectors.

Cameroon

Cameroon had the most pronounced economic cycles in the sample countries. The prosperity of 1978–85, with a convergence of high international prices for its main exportables (oil, coffee, and cocoa) and access to foreign capital, gave way to misery in 1986 when the external environment suddenly reversed sharply, with a collapse in world market prices for oil and crops and soaring real interest rates. During 1986–94 Cameroon could not unilaterally devalue the CFA franc, whose value was set at the regional level. This clearly intensified the economic crisis. Cameroon has been recovering slowly since the 50 percent CFA devaluation in 1994.

Specific analysis, tailored to compare the effects of boom and bust and with good coverage of the entire humid forest zone, allowed a more exhaustive evaluation of the core hypothesis. The boom (1979–85), though less pronounced than that in neighboring Gabon, had a clear urban bias. Public sector employment rose by two-thirds in just six years, and urban construction also increased. This accelerated rural–urban migration, which led to a slowdown in deforestation. In the crisis period, when the exchange rate was overvalued (1986–94), cash crops in the humid forest zone (mainly cocoa) were stagnant. But an upsurge in food-crop production caused a strong increase in deforestation in the forest zone.

The assessment of the shift in deforestation trends is highly reliable for Cameroon, because satellite imagery and agricultural survey data were collected for periods directly coinciding with the macroeconomic cycles. Research by CIFOR and its partners combined time-series satellite imagery with socioeconomic survey data on 5,000 households in 125 villages, generating primary data on both land use and rural household economies. In a block in Ndélélé, East Province, annual deforestation quadrupled between 1973–86 and 1986–96. In the Bertoua area in East Province, forest loss almost tripled, from 0.3 percent in 1973–86 to 0.8 percent in 1986–91. In the peri-urban area of Yaoundé forest, clearing doubled between 1973–88 and 1987–95.

Household survey data from villages in all three provinces of the humid forest zone confirm that forest clearing increased markedly after the onset of the crisis, as farmers increased their cultivation of food crops (Mertens and Lambin 2000; Sunderlin and others 2000). Reduced urban labor absorption and net return migration to rural areas were found to be key factors in the dramatic resurgence of deforestation.[8] Since the devaluation, cash crops have also experienced a slow revival, and deforestation continues to be high. Unlike in Gabon, oil wealth was not large enough to reverse forest loss and cause forest area to expand. The economic rents were not large enough to fully compensate for other factors, notably high rural population growth. But they caused an abrupt reduction in the pace of deforestation.

Cameroon thus provides a strong relative confirmation of the core hypothesis: During the oil-wealth period, the rate of forest loss dropped markedly.

Ecuador

The per capita size of the boom was larger in Ecuador than in Cameroon but much smaller than in Gabon and Venezuela. Due to rising production, oil revenues remained high until the mid-1980s. A bust followed, accompanied by a political crisis in the 1990s. Although there have been mini-oil bonanzas, the entire post-1985 period is best characterized as an economic downturn.

Nevertheless, deforestation actually accelerated during the oil boom, stayed high for a decade before likely decelerating. The government spent a large share of oil revenues in ways that promoted more extensive land uses. It built new and better roads connecting the highlands with the lowlands.[9] Fuel subsidies fostered extensification by making transport cheaper, though compared with roads, the effect of subsidies is nonspatial and reversible.[10] The government also used some oil money to support both spontaneous and planned frontier colonization that caused forest loss.[11] As in Venezuela, cattle were also a crucial factor, reinforcing the spatial extensification impacts of government policies. A growing urban middle class used part of its new purchasing power to buy cattle-derived proteins, thus creating higher demand matching the supply-side factors that enabled a large-scale expansion of pastures. Government trade policy partially protected meat and dairy products from import competition, allowing domestic producers to expand into marginal forestlands with meager returns.

In Ecuador these counterhypothetical factors were stronger than the core effect, and policy was decisive in creating that outcome. Dutch disease effects did reduce cropland expansion in the 1970s, and after the devaluations of the mid-1980s these reductions were reversed. But on the whole the forest eliminating pasture policy nexus was stronger.

Hence, the Ecuador country case study was contrary to the hypothesis in both absolute and relative terms. Forest cover decreased in absolute terms during the oil boom, and the pace of deforestation also picked up over the preboom period. This is indicated by both national forest cover data (with some comparability problems) and by agricultural area statistics, which are more reliable. The slowdown in deforestation in the 1990s, indicated by various regional forest data on hot spots of deforestation, may eventually be enhanced by the recent dollarization, which is likely to cause loss of competitiveness that will harm land-using sectors.

Papua New Guinea

Papua New Guinea became a specialized mineral exporter after 1972. Copper and gold predominated until 1992, when significant petroleum production began. The

size of these mineral rents relative to the size of the economy was somewhat greater than in Ecuador. Firm macroeconomic management succeeded in controlling the impact of rents until the early 1990s, but since then fiscal control has been increasingly lost. The fixed kina exchange rate introduced in 1975 greatly hampered nonmineral exports until 1994, when a floating kina coupled with economic mismanagement led to a large real devaluation. In other words, there were fairly high mineral revenues throughout the whole period, but with different economic management cycles.

The most reliable land-use data, from the Papua New Guinea Resource Information System (PNGRIS) and covering the 1975–96 period, show that cash crops never became a significant cause of deforestation. Even after the kina devaluation, rural violence, inflexible land tenure arrangements, and infrastructure problems were large impediments. Thus in Papua New Guinea improved price competitiveness was not enough to induce expansion in the cash crop sector. An exception is the oil-palm sector, which caused some deforestation. As in Gabon, government policies tended to ignore rural infrastructure, which greatly reduced forest loss. A large share of mineral revenues went into consumption. Some mineral revenue was wasted, some was turned into capital flight, and little was invested to enhance production.

At the national level forest loss was clearly driven by swidden cultivation of food crops, the demand for which grew in tandem with the population. But the country's rigid land tenure structure, which strongly favored land intensification over extensification, was discouraging expansion into forestlands. Hence the increase in demand for land was much less than the increase in food crop production. Between 1975 and 1996 intensive land use expanded at 0.7 percent a year, but total land use increased by only 0.2 percent, far below rural population growth rates of around 2 percent (Allen and others 2001). Intensification is more labor-demanding than swidden cultivation in the forest fringes, but new forest clearing for swidden cultivation meets severe sociocultural constraints. Intensification is achieved by technically improving cultivation (terracing, improving drainage, composting, rotating crops, growing nitrogen-fixing fallow species), but also by introducing new crops or varieties (such as potatoes, sweet potatoes, and African yams; Bourke 2001).

Annual forest loss rates were 50,000–70,000 ha (about 0.2 percent). This is a low rate and was probably stable over time, though with respect to the small size of the population and the economy it was significant.[12] Few value-added and service sectors have developed that might have drawn people out of food crop agriculture and into urban activities to uncouple deforestation from population growth.

On the whole, mineral wealth in Papua New Guinea did not stop deforestation. It did slow forest loss, in particular by curtailing the production of cash crops. None of the other cases was as complex as that of Papua New Guinea. Factors such as land tenure, crime, and political instability were equally important in shaping land use.

Summarizing the Country Evidence

Developing economies are subject to long-run processes of structural change, such as demographic and economic growth, urbanization, shifts of resources from primary to secondary and tertiary sectors, changing consumption patterns, and expanding land use. The core hypothesis of the forest-protecting impact of mineral rents has to be evaluated against these normal development trends. Table 2 summarizes the

Table 2. Comparing Macroeconomic and Forest Cover Trends

Country	*Macroeconomic cycles*	*Forest cover change cycles*	*Main sources used to determine forest cover change*	*Evaluation of the core hypothesis*
Gabon	1960–73: Preboom; 1974–85: boom; 1986–89: mini-bust; 1990s: fluctuations	1970–1990s: Net forest regrowth; recent: Some periurban clearing, probably little net change	Remote sensing (two national maps,* peri-urban and village studies)	Absolute confirmation (short and long run)
Venezuela	1920/30s: rise of petro-economy; 1956–58: mini-boom; 1974–83: boom; 1984– : crisis and mini-booms	1920–50: forest regrowth; 1950–1980s: slow loss; 1980s–1990s: more rapid loss	National forest maps 1920, 1950, 1991;* regional forest maps; agri-cultural area data and estimations*	Absolute confirmation, before World War II; relative confirmation, after World War II
Cameroon	1960–78: preboom; 1979–85: boom; 1986–94: bust, fixed exchange rate; after 1995: devaluation, recovery	1973–85: slow loss; 1986–94: rapid loss; after 1994: probably high loss	Remote sensing images (national,* regional) and primary agriculture survey data from the humid forest zone	Relative confirmation
Ecuador	1960–73: preboom; 1974–81: boom (rising); 1982–85: boom (declining); 1986–95: bust; after 1996: mini-booms	Before 1975: moderate loss; 1975–90: rapid loss; 1990s: probably slower loss	National forest maps (1962, 1987, 2000*); regional forest maps; agri-cultural area data.	Rejection, absolute and relative
Papua New Guinea	1972–94: mineral boom (rising), fixed overvalued kina; after 1995: oil boom, financial capital outflows, devalued kina	Whole period: Probably stable, slow loss, linked to food-crop expansion; after 1994: Perhaps loss acceleration	National maps from aerial photos (1975) and satellite images (1992–93)*; PNGRIS land-use change database	Relative confirmation

Source: Wunder (2003b:chap. 10).
*Limitations in data comparability over time.

evidence for the five primary country case studies by juxtaposing their macroeconomic cycles and their land-use cycles.

Gabon and pre–World War II Venezuela are hypothesis-confirming cases in absolute terms. Large oil rents basically wiped out agriculture, and many abandoned areas grew back into forests. Forest cover increased in absolute terms. In Cameroon the oil effects were not strong enough to produce such an outcome. The boom was smaller than those in Venezuela and Gabon and thus could not nullify the forest-cover impact of rural population growth. But there was a clear relative reduction. The pace of deforestation decreased dramatically in the oil boom period and then picked up again during the crisis.

Papua New Guinea was also a case of relative confirmation, though a more uncertain one. Real exchange rate effects were mediated by shifts in economic policy, and several nonmineral factors had a crucial influence. Still, mineral wealth is one of the explanations for low deforestation rates. Finally, Ecuador was the only case that rejects the core hypothesis, mainly due to the policy of extensive road building and a nexus of factors that linked this expansion and land-extensive cattle ranching (including dairy farming) to oil wealth.

Tracing Linkages

The juxtaposition of periods in table 2 exhibits some (but not all) of the patterns one would expect for the core hypothesis. This is hardly surprising, given the long causal chain described in figure 1, the extended period of study, and the presence of country-specific peculiarities. The main transmission stages are from oil wealth to the real exchange rate and relative prices, from prices to sectoral production (agriculture and timber), and from sectoral production to forests. Detailed analysis of all these linkages for the study countries, including how to deal with various data problems related to deforestation and to macroeconomic variables, is available in Wunder (2003b). Some general comments on the strength of the linkages are presented here.

In most countries oil wealth produced the expected appreciation of the real exchange rate, with a shift in relative prices in favor of nontradables, though sometimes with a time lag (Wunder 2003b:chap. 10). For several countries, foreign borrowing was an integral feature of oil wealth. They often borrowed against their new oil wealth either to increase already high foreign exchange inflows or to prolong a boom period and so delay the downward adjustment in government expenditure linked to oil busts. Higher capital inflows from borrowing caused more real currency appreciation.

Management of nominal exchange rates also proved important. In the simple Dutch disease model currency devaluation has no impact on relative prices or competitiveness, because domestic prices adjust instantaneously so that the real

exchange rate remains unchanged. In the reality of the case study countries, domestic prices were sticky, and overvalued exchange rates could persist for years. Hence, repeated devaluations (as in Ecuador and Indonesia in the mid-1980s) were vital in reviving traded sectors, whereas fixed exchange rate regimes exposed them to reduced competitiveness in other countries, notably in Cameroon and Papua New Guinea before 1994.

Agriculture was a prime victim of Dutch disease, but often it was the purely traded export sectors that were hardest hit by declining competitiveness. In Gabon and Venezuela appreciation of the exchange rate practically liquidated the cash crop export sectors. In Cameroon and Papua New Guinea it was probably the most important among several factors leading to economic crisis. The food crop sector was not always unambiguously hurt by appreciation of the real exchange rate. At the macro level food crops were semi-traded because of imperfect substitutes and partial trade protection over time, but also because of "natural" protection from trade provided by the high costs of transport to remote or inaccessible regions. To the extent that semi-traded goods were strongly linked to higher income (meat, dairy products, luxury staples), domestic suppliers profited from higher demand, as was the case with producers of nontraded goods. To the extent that semi-traded goods were close substitutes for importables and had low income elasticities (such as tubers and plantains), producers lost market shares, similar to those in traded sectors.

Did effects on agricultural production translate directly into forest impacts? As explained, forests were the default vegetation cover in most regions, so higher demand for land would in most cases cause corresponding loss of forests. However, the linkage of higher agricultural production with higher demand for land could be somewhat variable. In Papua New Guinea lack of physical access and legal rights to new land promoted intensification on already occupied soils, so that land demand increased less than production. The opposite was the case for cattle ranching. In both Ecuador and Venezuela the aggregate cattle carrying capacity declined over time, reflecting the spread of ranching to still more marginal lands with lower per hectare returns.

Still, in all the case study countries agriculture was the big land-use competitor with forests. Gains for agriculture meant losses for forests. The somewhat uneasy implication is that most of what is good news for agriculture tends to be bad news for forests, and vice versa. As the next section shows, this also means that policies that are biased against agriculture may, unintentionally, be forest conserving—and more effectively so than policies aimed directly at forest conservation.

Decisive Policy Responses

The country analysis shows that the net impact of oil wealth on forests is often to enhance forest protection, as predicted by the core hypothesis. Yet specific case study

outcomes ranged from absolute confirmation to relative confirmation and, in one case, to rejection.[13] Country-specific preconditions were in part responsible for the variability of outcomes. For instance, large oil booms are conducive to forest protection, but in Latin America a meat and cattle tradition in the region exerted significant pressures on forests when incomes rose. In Central Africa and Papua New Guinea deforestation is mainly for land-extensive swidden cultivation, though in Papua New Guinea there was a strong intensification response.

Yet beyond these preconditions, distinct country-specific policy responses strongly shaped the variation in outcomes. Governments were not passively reacting to the changing fortunes of the world market or, as some claim, simply adopting adjustment programs designed by the Bretton Woods institutions. On the contrary, the rent-rich oil states developed an ability to steer clear of external pressures and influences, delaying adjustment and resisting cutbacks and reforms. Internally, they were also able to buy off powerful stakeholder groups, though this came at the cost of increased rent-seeking and corruption. In some cases oil wealth in itself was conducive to armed conflict with separatist movements trying to appropriate the rich natural resources (Collier 2000; Ross 2001; Wunder 2003b:chap. 10). In the aggregate it is fair to say that the oil-rich countries had greater room for political maneuver than most developing economies and that they used this political space in ways that had important consequences for forests.

Which policies, then, proved most effective in protecting forests, regardless of whether there was any intent to protect them? Experience in Gabon, where long-run land-use determinants have favored conservation, can be combined with policy ingredients from other study countries to create a list of factors that have tended to result in forest conservation (table 3). This is not a list of policy recommendations—few of these policies are propoor development policies. It is simply a list of policies that de facto have protected forests in the case study countries.

Conclusion and Perspectives

This study supports the core hypothesis that oil and other mineral wealth tends to protect forests (though not in all cases) through indirect, economywide effects that discourage land- or forest-based commodity production and reduce their competitiveness. This macroeconomic impact of mineral rents on forests is bound to be more significant than the direct, physical effects of mineral production in forested areas. Most of the countries studied conformed to the core hypothesis in relative terms (oil wealth *reduces* pressures that degrade and convert forests), some even in absolute terms (oil wealth *reverses* pressures that degrade and convert forests), and only one (Ecuador) of the primary case study countries was *contrary* to the hypothesis. The absolute conformers (Gabon, pre–World War II Venezuela) had high oil rents per capita. The only negative

Table 3. Policies in Case Study Countries That Inadvertently Resulted in Forest Conservation

Policy	*Comments*
Neglecting demands for new road building and road maintenance in rural areas.	Countries with large road-building programs had high deforestation rates (Ecuador, Indonesia) and those neglecting rural roads had low deforestation rates (Gabon, Papua New Guinea). This macro-level observation confirmed micro results strongly tying roads to forest loss.
Selling fuel domestically at its "normal," nonsubsidized price.	This policy is forest-conserving. Conversely, selling cheap, subsidized fuel reduces transport costs for goods (crops, livestock, wood products) from remote areas and thus promotes land extensification. This had an impact especially in countries where the fuel subsidies reached extreme levels, as in Venezuela.
Spending large amounts of funds on cities.	A strong urban development bias, such as that seen in Gabon, protected forests, by attracting labor migration out of rural areas. Conversely, spending on social infrastructure in forested frontiers eventually helps attract migrants, sustain settlement, and promote forest conversion to alternative uses.
Keeping overvalued exchange rates.	Most nontraded sectors are urban, so overvalued exchange rates helped sustain urban biases and jeopardized cash crop production. On the other hand, sharp, repeated currency devaluations were a powerful tool to make agriculture and timber extraction more competitive.
Overtaxing export agriculture by confiscatory price stabilization schemes.	Commodity funds that de facto transferred cash crop earnings from farmers to the government or to an administrative bureaucracy impeded a larger scale expansion of cash crops, especially in the African case study countries, which in most cases would have caused additional deforestation.
Heavily taxing logging companies to capture stumpage values.	In Papua New Guinea in the 1990s, a sharp rise in taxes reduced the speed of harvesting. However, if logging concessions are overly generous (in the sense of low taxes), as occurred for certain periods in Cameroon, Indonesia, and Venezuela, companies rush to cash in high timber rents, and this tends to accelerate forest conversion.
Intensifying food production and liberalizing food imports.	The net impact of general trade liberalization on forests is ambiguous, but import protection of cattle and certain land-extensive (typically, swidden) food-crop sectors helped these sectors expand production into marginal forestlands with very low per hectare returns.

(Continued)

Table 3. (Continued)

Policy	*Comments*
Forcing rural people to settle in concentrated roadside agglomerations.	Many colonial and postcolonial settlement programs, especially in Central Africa, concentrated swidden cultivators in sedentary roadside settlements with more land-intensive methods, thus reducing forests clearing. Conversely, an Indonesian-style *transmigrasi* resettlement of people without land to a (forest) land without (a lot of) people causes deforestation.
Wasting agricultural budgets on agro-industrial "white elephants" and ignoring smallholders.	Oil-financed modernization strategies to promote sedentary, capital-intensive cropping tended to require less land per unit of value added than traditional farming. Yet much funding for agro-industry was diverted or wasted, so lack of agricultural development meant avoided forest loss.
Nourishing a rent-seeking environment in which few people find it worthwhile to produce.	In high-rent oil countries personal income is increasingly divorced from production and determined instead by the success of rent-seeking efforts. This has reinforced urban biases and has provided disincentives for commodity production—further relieving pressures on forests.

Source: Author's compilation.

secondary case was Mexico, and as in Ecuador (and recently in Venezuela), a Latin American roads–colonization–cattle nexus drove the counterhypothetical outcome.

Deforestation data for all study countries are poor and involve much guesswork, but agricultural census and land-use survey data can sometimes compensate for this lack of reliable information. This is because in all study countries conversion to agricultural land (including pastures, fallows, and degraded croplands) was the dominant ultimate use of cleared forestland. Forests receded basically because people decided to cultivate tree-covered lands. Within agriculture, production and land used for "purely traded" export crops was clearly held back by oil-led Dutch disease effects on competitiveness. For semi-traded food crop sectors, trends were ambiguous, but in most cases land expansion was also constrained by rising wages and urban migration, which were especially important when these crops were produced in swidden, land-extensive systems. Cattle ranching was often linked procyclically to oil wealth through import protection and a high income elasticity of consumption for cattle-derived, protein-rich foods. In regions where this cattle effect was dominant (Latin America), the core hypothesis was less likely to hold than in others (Central Africa, Papua New Guinea) where the reduced expansion of land-extensive crops was the dominant force. This underscores regional peculiarities in the relation between higher national income and forest loss.

Did governments have an important say in how oil wealth affected forests? They certainly did, even though these influences were unintentional. Governments normally are the sole custodians of a country's mineral riches.[14] An urban bias in the spending of oil revenues (increased public employment and urban investments) would generally protect forests, whereas spending on new and better rural roads, infrastructure in frontier areas, and (especially) agricultural and fuel subsidies counteracted the core forest-protecting impact. Notably, expansions or cuts in the budgets of government forestry and conservation agencies—sometimes observed to be a key environmental factor in crisis-ridden countries (Reed 1996; Sunderlin and Rodríguez 1996)—had little effect. In most case study countries the implementation capacity of these agencies was low, irrespective of the level of resources available (see also Kaimowitz and others 1998). In addition to spending decisions on oil wealth, several policies significantly influenced the use of land and forests, notably exchange rate policy, import protection of selected sectors, and forestry concession policies.

The list of 10 forest-protecting policies in table 3 invites two general observations. First, only one of the factors—taxing logging concessions—affects forests directly. All the other measures are outside the sector, side effects of policies not targeted at forests—what could be called "blind conservation strategies." This underscores the crucial importance of understanding the underlying causes of deforestation.

Second, the list is somewhat pessimistic in that most of these inadvertent conservation policies are not conducive to economic growth or poverty alleviation. Many are directly harmful. Compared with a standard of best practice development policies, arguably only 3 of the 10 policies—elimination of fuel subsidies, high taxes on logging stumpage value, and intensification and import liberalization of resource-wasteful sectors—would receive a positive evaluation. This indicates that the hard tradeoffs between tropical forest conservation and economic development occur not only at the micro level but also at the macro policy level. On the other hand, the list identifies three tangible areas in which positive synergies may be present.

Implications beyond Oil

The policy results reported in the last section may be provocative and raise legitimate questions about whether, first, the chosen countries are representative of oil countries and, second, to what extent results from oil-producing countries in tropical areas are applicable to developing economies that are not endowed with oil. On the first question, the five primary case study countries represent a fairly broad mixture of developing countries in terms of geography, gross domestic product level, agricultural traditions, and ecological conditions. Perhaps they inadequately represent dry forest countries, where firewood overharvesting and overgrazing can be causes of deforestation. They are also all small to medium-size economies, which is

why the analysis was eventually supplemented with three big-country cases from each southern continent: Mexico, Nigeria, and Indonesia. Nigeria and Indonesia were cases of relative confirmation of the core hypothesis (deforestation rates dropped during the oil boom but did not turn negative), whereas Mexico was a case of rejection.

The second question is harder to answer. Developing economies specializing in oil production are on average richer, more urbanized, more high-cost, and less agricultural than other developing economies (Sunderlin and Wunder 2000). In the political economy sphere, many oil countries suffer from "resource curse" problems of underinvestment in human capital, ill governance, rent-seeking, institutional decline, and economic stagnation. These features definitely make them a special sample. For instance, rent-seeking and corruption related to illegal logging are known to cause severe forest degradation. However, in our group of countries, the fact that rent-seeking was happening in the urban sectors and that corruption was connected with agro-industrial programs meant that corruption came to have a forest-protecting effect, something that is obviously not fully generalizable to other countries.

Still, many of the macroeconomic phenomena and policies analyzed here are equally common in nonoil-producing countries. Perhaps the main differences in terms of policy responses is that in nonoil-producing countries a wider range of private sector activities would be expected (with differential impacts on forests), in particular a higher diversity of agricultural scenarios with different land-use intensities, as well as stronger production responses. However, there is no reason to believe a priori that nonoil-producing countries would systematically face either weaker or stronger forest protection effects from a substantial foreign exchange transfer from abroad.

Do these findings have implications for countries that are not blessed with mineral wealth? As suggested by the wide applicability of the Dutch disease model, the impact of a mineral boom's spending effect is similar to that of other international rent transfers, such as remittances, foreign aid, and debt relief. All of these foreign exchange inflows tend to increase aggregate demand, cause real currency appreciation, and speed urbanization. A large-scale global reduction or write off of foreign debt under the Heavily Indebted Poor Countries Debt Initiative, for example, would, on the whole, also lead to less tropical deforestation. However, the deviating case studies show that this effect would not be guaranteed in every country. Hypothetically, the forest protecting effect of debt reduction would be expected to be stronger in a poor African country dominated by swidden cultivation than in a middle-income Latin American country where most forest clearing is for pasture. In the Latin America case rising incomes for an urban middle class with a large appetite for meat can increase forest loss.

A second field of application concerns the claim that structural adjustment programs have strong negative effects on forests and the environment and thus need to be environmentally screened and redesigned (Reed 1992, 1996). Counterarguments have been that many environmental effects are unavoidable or too complex

to analyze or that there are internal contradictions among different environmental objectives. This study confirms that many actions to improve foreign exchange inflows by revitalizing traded sectors will almost inevitably have negative impacts on forests. In particular, it confirms the powerful role of currency devaluation, a key policy tool in most structural adjustment programs in promoting land- and forest-using sectors. Our study gives less support to the assertion that specific fiscal cutbacks in forest regulating agencies have detrimental effects (see previous discussion). Instead, it points to the danger that sharp general declines in public spending can partially "reruralize" the economy at the expense of forests.

Finally, trade liberalization and export incentives have been singled out as highly ecologically damaging components of structural adjustment programs. The results of this study suggest that the argument is often valid but that import liberalization can also restrict highly wasteful and forest-damaging domestic sectors, thus increasing the natural resource efficiency of land uses to the benefit of forests. For instance, it may well be preferable to fill the barbecue of an Ecuadorian family with meat from the Argentine pampas, rather than from deforested erosion-prone and nutrient-poor slopes in the Ecuadorian Andes. Likewise, it might well be better for global forest conservation if a Central African urban family builds its staple diet on imported Thai high-yield variety rice rather than on local plantains, whose production requires reiterative burning of extensive peri-urban forest plots. The net balance of trade impacts on forests will differ across countries, and the impact on forests will differ from that on other environmental assets. This underscores that asset- and country-specific assessments of structural adjustment effects are necessary, reducing the scope for generalization. However, this study also shows that, despite the complexities, it is possible to analyze these effects. This should also serve as an encouragement to those interested in modifying macroeconomic tools for the purpose of improving environmental outcomes.

Notes

Sven Wunder and William D. Sunderlin are Senior Scientists at the Center for International Forestry Research (CIFOR) in Bogor, Indonesia. Their e-mail addresses are s.wunder@cgiar.org and w.sunderlin@cgiar.org, respectively. They thank Arild Angelsen, Ken Chomitz, David Kaimowitz, Tom Rudel, Stuart White, and three anonymous reviewers for comments on earlier drafts of this article (and corresponding book chapters). They are also grateful to Ahmad Dermawan and Ambar Liano for research assistance and secretarial help.

1. If Brazil, now a low mineral exporter but endowed at the state level with important mineral exports, is excluded from the denominator, that share rises to 72.1 percent (Wunder 2003b:chap. 2).

2. Caracas is said to grow at the rate of about 1 ha a day, yet the additional land demand of 365 ha a year corresponds to only 0.09–0.15 percent of Venezuela's forest loss. In Greater Jakarta, one of the world's fastest-growing metropolitan areas, forests receded from 73,266 ha in 1969 to 43,691 ha in

1989, yet the annual clearing of about 2,000 ha contributed only 0.1–0.3 percent to Indonesia's deforestation (Prasetyo 1992).

3. The highest level of analysis in this study is the nation-state, so this article does not look at the global consequences of oil wealth and of changed international trade patterns.

4. Sunderlin and Wunder (2000:318–20) demonstrate, using comparative data for 66 countries, that high urbanization in a subset of mineral-rich countries is one of the structural characteristics related to a higher share of forest cover and a lower rate of forest loss.

5. Most sources are from the early 1990s. TREES data from 1991–95 are used as a benchmark. IUCN data are from the latest available nationwide map (various years), whereas the *Forest Resources Assessment 2000*'s 1990 estimate (FAO 2001) is calculated backward to its 1990 base.

6. This section summarizes the main lessons from chapters 4–8 in Wunder (2003b).

7. Chief Mboula Thaopile, Nioungou village, cited in Adams and McShane (1996:207).

8. Demographic surveys showed that average annual population growth exploded from 0.75 percent in 1976–86 to 4.6 percent in 1987–97. During the boom period the urban economy had absorbed most of the rural population surplus. In 1986–92 rural to urban migration stagnated, and as the crisis continued (after 1992), there was net urban–rural return migration (Sunderlin and Pokam 2002).

9. In 1974, the first full oil boom year, Ecuador spent 48.4 percent of public investments on roads (Gelb and Marshall-Silva 1988:184). Many roads were built through forests, causing immediate deforestation as well as continuing deforestation for about a decade following completion of the roads (Pichón 1997; Rudel and Horowitz 1993; Wunder 2000).

10. As in Venezuela, massive fuel subsidies in Ecuador were politically difficult to reverse after the boom, and in 1986 their cost reached an astonishing 9 percent of gross domestic product (Mosley 1991:414). Together with the new roads, subsidies drastically increased the mobility of goods and production factors in the rural economy. Although only about 20 percent of peasant production was marketed in the 1960s, 60 percent was in the 1970s (Larrea 1992:350–51).

11. Development banks specialized in cattle, the most extensive form of land conversion, and expanded their credit volumes thanks to earmarked oil revenues. Several regional and national land colonization institutes received oil money that had been earmarked by the government for agricultural development (Rudel and Horowitz 1993, pp. 56–7; Wunder 2003b, pp. 237–8).

12. Data from PNGRIS need to be translated first to obtain deforestation information defined according to FAO standards. There have probably been few fluctuations over time. For example, the increase in logging triggered comparatively little additional forest clearing. But with Papua New Guinea's small population of 4.7 million (1999), a point estimate of 60,000 ha is larger on a per capita deforestation basis, at 12.8 ha/1,000 people, than Ecuador's (12.1) and Cameroon's (11.9) (Wunder 2003b:chaps. 8, 10).

13. Among the three secondary cases—Indonesia, Nigeria, and Mexico—the first two were probably cases of relative confirmation. Forest loss was not reversed, but was weakened during oil boom periods. As in other cases, cash crop production declined precipitously, while food crops were semi-traded with an intermediate production performance. The same happened in Mexico, but as in Ecuador and Venezuela, the Latin American nexus of road building–colonization programs–cattle meant that Mexico contradicted the core hypothesis. There was procyclical deforestation for pasture creation, although evidence was also found at the subnational level (Chiapas state) that supported the hypothesis.

14. A partial exception here was Papua New Guinea, where both regional governments and local landowners directly received a nontrivial share of oil and mining revenues.

References

Adams, J. S., and T. O. McShane. 1996. *The Myth of Africa: Conservation without Illusion*. Berkeley, Calif.: University of California Press.

Allen, B. J., R. M. Bourke, and L. Hanson. 2001. "Dimensions of Papua New Guinea Village Agriculture." Paper presented at Papua New Guinea Food and Nutrition 2000 Conference, PNG University of Technology, Lae, Papua New Guinea, 26–30 June 2000.

Angelsen, A., and D. Kaimowitz. 1999. "Rethinking the Causes of Deforestation: Lessons from Economic Models." *World Bank Research Observer* 14(1):77–98.

Barbier, E. B. 2001. "The Economics of Tropical Deforestation and Land Use." *Land Economics* 77(2):155–72.

Bevan, D., P. Collier, and J. W. Gunning. 1999. *Nigeria and Indonesia*. Oxford: World Bank.

Bourke, M. 2001. "Intensification of Agricultural Systems in Papua New Guinea." *Asia Pacific Viewpoint* 42(2/3):219–35.

Collier, P. 2000. "Economic Causes of Civil Conflict and Their Implications for Policy." Global Policy Forum. Online document available at www.globalpolicy.org/security/issues/diamond/wb.htm.

Collier, P., W. Gunning, and Associates. 1999. *Trade Shocks in Developing Countries*, vols. 1 and 2. New York: Oxford University Press.

Contreras-Hermosilla, A. 2000. *The Underlying Causes of Forest Decline*. Bogor, Indonesia: Center for International Forestry Research.

Corden, W. M. 1984. "Booming Sector and Dutch Disease Economics: Survey and Consolidation." *Oxford Economic Papers* 36(3):359–80.

The Economist. 1977. "The Dutch Disease." 26 November.

FAO (Food and Agriculture Organization of the United Nations). 1993. *Forest Resources Assessment 1990: Tropical Countries*. Rome.

———. 2000. *Forest Resources Assessment 2000: On Definitions of Forest and Forest Change*. Rome.

———. 2001. "Results of the Global Forest Resources Assessment 2000." Secretariat note. Item 8(b) of the Provisional Agenda, Fifteenth Session, Committee on Forestry, Rome.

Geist, H. J., and E. F. Lambin. 2001. *What Drives Tropical Deforestation? A Meta-Analysis of Proximate and Underlying Causes of Deforestation Based on Subnational Case Study Evidence*. Louvain-la-Neuve: Ciaco.

Gelb, A., and Associates. 1988. *Oil Windfalls: Blessings or Curse?* New York: Oxford University Press.

Gelb, A., and J. Marshall-Silva. 1988. "Ecuador: Windfalls of a New Exporter." In A. Gelb and Associates, eds., *Oil Windfalls: Blessing or Curse?* New York: Oxford University Press.

Grainger, A. 1996. "An Evaluation of the FAO Tropical Forest Resource Assessment 1990." *Geographical Journal* 162(1):73–9.

Houghton, R. A., D. S. Lefkowitz, and D. L. Skole. 1991. "Changes in the Landscape of Latin America between 1850 and 1985." *Forest Ecology and Management* 38:143–72.

Kaimowitz, D., and A. Angelsen. 1998. *Economic Models of Tropical Deforestation: A Review*. Bogor, Indonesia: Center for International Forestry Research.

Kaimowitz, D., Erwidodo, O. Ndoye, P. Pacheco, and W. D. Sunderlin. 1998. "Considering the Impact of Structural Adjustment Policies on Forests in Bolivia, Cameroon, and Indonesia." *Unasylva* 49(149):57–64.

Karl, T. L. 1997. *The Paradox of Plenty: Oil Booms and Petro-States*. Berkeley: University of California Press.

Larrea, C. 1992. "The Mirage of Development: Oil, Employment, and Poverty in Ecuador." PhD diss., Graduate Programme in Social and Political Thought, York University, Ontario.

Little, I. M. D., R. N. Cooper, W. M. Corden, and S. Rajapatirana. 1993. *Boom, Crisis and Adjustment: The Macroeconomic Experience of Developing Countries*. New York: Oxford University Press.

Mainardi, S. 1998. "An Econometric Analysis of Factors Affecting Tropical and Subtropical Deforestation." *Agrekon* 37(1):23–45.

Matthews, E. 2001. *Understanding the Forest Resources Assessment 2000.* Washington D.C.: World Resources Institute.

Mayaux, P., F. Achard, and J.-P. Malingreau. 1998. "Global Tropical Forest Area Measurements Derived from Coarse Resolution Satellite Imagery: A Comparison with Other Approaches." *Environmental Conservation* 25(1):37–52.

Mertens, B., and E. F. Lambin. 2000. "Land-Cover-Change Trajectories in Southern Cameroon." *Annals of the Association of American Geographers* 90(3):467–94.

Mosley, P. 1991. "Ecuador." In P. Mosely, J. Harrigan, and J. Toye, eds., *Aid and Power: The World Bank and Policy-Based Lending.* London: Routledge.

Neary, P., and S. van Wijnbergen, eds. 1986. *Natural Resources and the Macroeconomy: A Theoretical Framework.* Oxford: Basil Blackwell.

Pichón, F. J. 1997. "Settler Households and Land-Use Patterns in the Amazon Frontier: Farm-Level Evidence from Ecuador." *World Development* 25(1):67–91.

Prasetyo, L. B. 1992. "Application of a Geographical Information System (GIS) for Land-Use Changes Study towards Better Understanding of Deforestation Processes: Case Studies in Jabotabek and South Sumatra, Indonesia." PhD diss., University of Tsukuba, Japan.

RAN (Rainforest Action Network), and Project Underground. 1998. *Drilling to the Ends of the Earth: The Ecological, Social and Climate Imperative for Ending Petroleum Exploration.* San Francisco: RAN and Project Underground.

Reed, D., ed. 1992. *Structural Adjustment and the Environment.* Boulder, Colo.: Westview Press.

———. 1996. *Structural Adjustment, the Environment, and Sustainable Development.* London: Earthscan.

Roemer, M. 1984. "Dutch Disease in Developing Countries: Swallowing Bitter Medicine." Working paper, Harvard Institute for International Development, Cambridge, Mass.

Ross, M. L. 2001. *Timber Booms and Institutional Breakdown in Southeast Asia.* Cambridge: Cambridge University Press.

Rudel, T., and B. Horowitz. 1993. *Tropical Deforestation: Small Farmers and Land Clearing in the Ecuadorian Amazon.* New York: Columbia University Press.

Rudel, T., and J. Roper. 1997. "The Paths to Rain Forest Destruction: Cross-National Patterns of Tropical Deforestation, 1975–1990." *World Development* 25(1):53–65.

Sunderlin, W. D., and J. Pokam. 2002. "Economic Crisis and Forest Cover Change in Cameroon: The Roles of Migration, Crop Diversification, and Gender Division of Labor." *Economic Development and Cultural Change* 50(3):581–606.

Sunderlin, W. D., and J. A. Rodríguez. 1996. *Cattle, Broadleaf Forests and the Agricultural Modernization Law of Honduras: The Case of Olancho.* Bogor, Indonesia: Center for International Forestry Research.

Sunderlin, W. D., and S. Wunder. 2000. "The Influence of Mineral Exports on the Variability of Tropical Deforestation." *Environmental and Development Economics* 5:309–32.

Sunderlin, W. D., O. Ndoye, H. Bikié, N. Laporte, B. Mertens, and J. Pokam. 2000. "Economic Crisis, Small-Scale Agriculture, and Forest Cover Change in Southern Cameroon." *Environmental Conservation* 27(3):284–90.

Wood, A., P. Stedman-Edwards, and J. Mang, eds. 2000. *The Root Causes of Biodiversity Loss.* London: Earthscan.

Wunder, S. 2000. *The Economics of Deforestation: The Example of Ecuador.* New York: Houndmills, Macmillan, and St. Martin's.

———. 2003a. "Foreign Exchange Inflows, Competitiveness and the Expansion of Logging in Five Tropical Countries." Paper presented at the IUFRO workshop Forest Science/Policy Interface in Europe, Africa and the Middle East, June, Copenhagen.

———. 2003b. *Oil Wealth and the Fate of the Forest: A Comparative Study of Eight Tropical Developing Countries*. London: Routledge.

WWF (World Wide Fund for Nature). 2002. *To Dig or Not to Dig? Criteria for Determining the Suitability or Acceptability of Mineral Exploration, Extraction and Transport from Ecological and Social Perspectives*. Gland, Switzerland.

Vouchers for Basic Education in Developing Economies: An Accountability Perspective

Varun Gauri • Ayesha Vawda

Advocates argue that voucher programs can correct the incentive problems of education systems in developing economies. An accountability perspective, based on a principal-agent framework, was developed to clarify the arguments for and against education vouchers. An assessment of findings on voucher programs in industrial countries and a review of voucher or quasi-voucher experiences in Bangladesh, Chile, Colombia, Côte d'Ivoire, and the Czech Republic support the usefulness of the analytic framework. The assessment concludes that the policy relevance of voucher programs for developing economies remains uncertain. Major voucher initiatives have been attempted only in countries with a well-developed institutional infrastructure. Some studies find favorable benefits for at least some population groups, but others find limited effects and evidence of increasing social stratification in schools. Whether vouchers lead to better outcomes or greater stratification appears related to specific contexts, institutional variables, and program designs.

Education systems in developing economies face enormous problems. In many of the poorest countries, there are large gaps in affordable access and staggering differences in attainment between children from poorer and richer households. Even in many middle-income countries that have achieved nearly universal coverage in primary and secondary education, the quality of instruction and learning is low, particularly for poor people. Government spending is often inadequate and inefficiently and inequitably allocated across education inputs and levels of education. Even where education systems are adequately funded, they can be indifferent to families' concerns because they are controlled by inattentive officials or by particular social classes and interest groups. In these settings, high rates of teacher absenteeism and

The World Bank Research Observer, vol. 19, no. 2.
© The International Bank for Reconstruction and Development / THE WORLD BANK 2004; all rights reserved.
doi:10.1093/wbro/lkh017 19:259–280

low enrollment rates for girls are symptomatic of systems with inadequately aligned incentives.

What kind of an education system is best able to address these problems? In the broadest terms, there are two archetypes for education systems. In the public archetype, the government finances education and manages all aspects of schooling, including hiring teachers and constructing schools. The public archetype is useful for building a system from the ground up and for ensuring uniformity among schools, but it is typically less effective at motivating teachers and schools to respond to families' concerns. In the private archetype, schools are privately owned, and families pay the entire cost of tuition. The private archetype gives parents choices among schools, and schools have a strong financial motivation to keep their clients happy. But families unable to pay for a private school lose out. Using the vocabulary of the World Bank's (2003) *World Development Report 2004: Making Services Work for Poor People*, the public archetype entails the long route of accountability in which students' interests are secured when citizens' voice influences the compacts that policymakers establish with providers, and the private archetype entails the short route of accountability in which the client power of family preferences influences provider organizations and frontline professionals.

Analysts and reformers have argued that a combination of the two archetypes—public financing with private provision—is the best way to combine universal access with systemic responsiveness. Parents receive vouchers that can be redeemed at qualifying private schools, or private schools are reimbursed by the state based on their enrollment rates. Thus parents choose the schools their children attend, and schools are financed based on the number of students they attract and are allowed substantial management autonomy to make themselves more attractive. Critics worry that a decline in financing for public schools will eventually destroy the system of public education, resulting in difficult-to-measure but real consequences for social cohesion, and that voucher programs will exacerbate rather than lessen what are already significant inequalities in access to good education.

Despite the popularity (and notoriety) of voucher proposals, there is little empirical evidence on their effects, especially in developing economies. Programs that subsidize education are not uncommon in developing areas, particularly those that aim to allay the direct and indirect costs of schooling for girls, low-income groups, and ethnic minorities.[1] Generally speaking, the objective is to increase the likelihood that children in particular groups enroll in and complete school. Voucher programs, on the other hand, generally aim to increase the quality of education among students who are already enrolled by expanding the range of choices.

Using a principal-agent framework, this article examines the available studies on the impact of voucher programs and draws inferences about what might be expected from voucher programs in developing economies, what kinds of voucher programs might be most useful, and what elements of the institutional infrastructure will be

important for their implementation. The analysis compares the theoretical predictions to the evidence on the operation and impact of voucher plans in industrialized countries and then reviews five voucher and quasi-voucher experiments in developing and transition economies. It draws inferences about the ways in which education vouchers might be useful in low- and middle-income countries.

Vouchers and the Principal-Agent Problem

In the public archetype, a centralized education department designs a national curriculum, finances education out of general revenues, and pays capital and operating costs directly. It also makes all managerial and staffing decisions; negotiates teacher salaries directly with national unions; remunerates and promotes teachers on the basis of negotiated, experience-related criteria; employs evaluations as indicators of need and not performance; and assigns students to schools. Critics contend that the system results in overstaffing, too many unmotivated teachers, unnecessarily high taxes, school administrators indifferent to families, and passive parents with no option but to enroll their children in schools with which they are dissatisfied.

These critics advocate voucher systems that depart from the public archetype in three key aspects. First, students are not assigned to a public school based on residence but depending on the details of the program's design, have choices among a variety of other public or private schools. Although elements of choice and competition also exist in public systems—parents choose a school by choosing a residence, and private school options usually exist—vouchers significantly augment them.

Second, schools have strong incentives to expand student enrollments because a significant part of school financing is proportional to the number of students enrolled in a given school. The idea is to shift schools' primary accountability for performance from the education department, which is politically compromised in its efforts to enforce quality standards, to parents and students, who are the best judges of the education they want for their children. In theory, these incentives will lead the better schools to take steps to improve quality, enhance efficiency, and develop innovative approaches to learning. Poorly performing schools will not attract students and will either close or be forced to find a market niche. Some schools might then satisfy demands that the bureaucratically constrained archetypal system cannot meet, such as specializing in computers, the arts, specific languages, certain ethnic traditions or religions, or learning methods for socially disadvantaged students.

This aspect of voucher systems focuses not on the simple existence of subsidies to private schools but on the degree to which payments vary with enrollment. In several European countries, for instance, political resolutions of historical religious struggles entail notions of equal treatment of different denominations, and the state reimburses sectarian schools for some portion of their costs. Most of these are not

really voucher systems because the reimbursements are not proportional to enrollment, are proportional to enrollment but relatively small in magnitude, or are adjusted irregularly, with the result that schools do not have strong incentives to expand enrollments.[2]

Third, voucher systems require schools to have enough managerial control to respond to parental demand. To be responsive to demand, schools need substantial control over staffing and personnel decisions, budget, and instructional methods. At least limited control over capital expansion, calendar, and curriculum also provide schools with needed flexibility. Voucher programs and proposals differ significantly in the extent of control granted to local schools, leading to large variations in expected outcomes. How much leeway schools have in selecting students or charging additional fees on top of the per student allocation, for example, is likely to result in substantial differences in how much socioeconomic sorting a voucher system will exhibit.

Such sorting is one of the principal concerns of voucher opponents. They argue that if vouchers are available to all students, children from advantaged backgrounds (greater income, education, and access to information) would have a significant edge in enrolling in better-performing schools. As more advantaged students choose these schools, performance would continue to improve, leaving students from disadvantaged backgrounds behind in increasingly less attractive education settings. These dynamics would accelerate not only if students chose schools but if schools were allowed to choose students, either openly or indirectly. New schools would be reluctant to serve disadvantaged students because the costs of educating them would be relatively high. Opponents of vouchers also argue that for a variety of social and political reasons, voucher programs might not function as supporters imagine: Politicians might be reluctant to let public schools close, parents might not value or discern differences in educational quality, and professional norms might impede competitive practices among schools.

How can one assess the relevance of the voucher debate for developing economies, where educational institutions are more varied and resource constraints more severe than in industrial countries? Setting aside, at least provisionally, the assumptions that are difficult to prove or disprove generally—parents know their children's best interests, parents are in a better position to observe school effort than administrative officials, and schools respond to financial incentives just as most other organizations do—how well voucher programs can be expected to function depends on key parameters of the institutions and resources in a given developing area.

To identify these parameters, it is useful to cast the voucher reform as a payment mechanism in a principal-agent relationship: The state is a principal that pays schools, its agents, for providing educational services that further its objectives. Consistent with the voucher idea, agents are assumed to have sufficient management autonomy to deliver the objectives. Clients are free to choose from among the

Table 1. The Expected Effect of Key Social and Institutional Parameters on Voucher Programs

Social or institutional characteristic	*Expected effect of voucher programs*
Parents use student body composition as a proxy for school quality	Increases socioeconomic or racial sorting
Enrollment is weakly correlated with school effort	Weakens productivity effect
Teachers and school owners are poorer and more risk averse	Reduces welfare gains
Determinants of school quality or enrollment are exogenous to the school	Weakens productivity effect
Professional norms are weak	Discourages curricular innovation
Monitoring of reported attendance is ineffective	Weakens productivity effect

Source: Authors' compilation.

agents. The state rewards schools in a linear compensation contract: Payments are proportional to the number of students they enroll. As a result, the compensation scheme employs intense incentives.[3] The state's education objectives are, stated loosely, the same for most governments in the contemporary world: to impart literacy, numeracy, a stock of cultural and scientific knowledge, and cognitive skills; to transmit social norms and world views; and to provide educational opportunities that structure life chances based on local interpretations of freedom, equality, and nondiscrimination. In a voucher system, the state usually continues to rely on a national curriculum, the broader institutional landscape, and civil rights laws to guide schools toward those objectives, but it uses student enrollment as the exclusive indicator of the effort a given school has exerted to achieve them.[4]

The principal-agent literature is now fairly advanced, and its findings can be applied directly to the architecture of voucher programs in education (Milgrom and Roberts 1992). The findings can be used to assess key institutional parameters that are likely to affect voucher systems, particularly as they might function in developing economies (table 1).

Bias and Noise in the Estimate of Effort

Theory indicates that compensation with intense incentives should be based only on performance measures that are strongly correlated with the agent's effort.[5] It is reasonable to ask, then, how well enrollment estimates a school's effort at achieving the state's objectives. Parents probably observe aspects of school effort that ministry officials might overlook, such as the attentiveness of staff, the dedication of teachers, and help in securing placement in higher level schools. But parents' assessments might also have systematic biases, such as the tendency to conflate the composition of a school's student body, particularly along socioeconomic and racial dimensions,

with the quality of the education offered, and to conflate the quality of education offered with the effort a school exerts.[6]

Because family background, not school performance, usually explains most of the variance in student performance, such a confusion would bias the state's indicator of school effort. That bias would also create a powerful incentive for schools to attract a student body that parents would find desirable. The preconditions for significant socioeconomic or racial segregation would be in place. If the potential for such bias is substantial, it will make sense for the compensation formula to include additional variables that correct for the effect of student body composition on demand for a school and on the learning outcomes for which the school is responsible.

Moreover, enrollments can also be a noisy estimate of effort. Remoteness or transportation costs, changes in the birth rate, migration, returns to education in the economy, and (arguably) cultural expectations about who should be in school are all exogenous determinants of enrollment that are uncorrelated with school effort. In developing economies these exogenous determinants of enrollments could weaken the desired effect of voucher programs on school productivity. Weights for these factors would not be hard to devise, and they would not require frequent adjustment because these exogenous factors change slowly, and changes are generally predictable.

Risk-Averse Agents

The less comfortable an agent is with risk, the higher the welfare cost the agent bears from intense incentives.[7] In voucher programs, schools that suffer enrollment declines receive lower revenues, with commensurate impact on the salaries and professional reputations of staff. The poorer the country, the more likely it is that teachers are poor and risk-averse, and the higher the welfare cost of voucher programs to them and their families. A related problem is the transaction costs of transferring ownership of the facility, or the opportunity cost of letting it sit idle, which carries higher welfare costs in countries where capital is in short supply.

The Productivity of More Effort

Intense incentives are worthwhile only if increments of additional effort produce better performance. Intense incentives for schools to increase enrollment, although they might elicit greater effort at first, might not improve academic outcomes if, for example, the quality of teacher training is inadequate nationwide, textbooks are routinely stolen, it is difficult to recruit teachers to certain areas, teacher time is siphoned off for political purposes, population density is too low, cultural norms limit girls' attendance, or students are malnourished.

There might also be circumstances in which the marginal effect of school effort is powerful, at least over a certain range of effort, as when modest numbers of public

school students are given vouchers to attend private schools, which often have the capacity to accommodate small numbers of new students with just a little more effort. In that program design (vouchers are awarded to some but not all students), an issue emerges about whether the voucher scheme includes intense incentives for the public schools the students have left and what effects incremental effort on the part of these schools might have on school quality and on the willingness of the students to stay. In other words, it is important to distinguish a partial equilibrium effect (the incremental gain in learning for students who use vouchers) from the general equilibrium effect (which sums the effect for students who use vouchers and the effect on students left behind in public schools).[8]

Relative Compensation among Activities

If a compensation scheme with intense incentives rewards certain activities at lower rates, the agent will not perform them. In voucher programs schools are not rewarded for stressing norms or principles of fairness with which many parents might disagree. So if the rules governing, say, equal treatment or ethnic pluralism are not well enforced, the payment scheme will not give schools a reason to pursue those objectives. Of course, the same can be true of compensation schemes without intense incentives, such as those based on subjective evaluation. It can be argued that because processes are difficult to observe, they should not be included in the compensation scheme.[9]

A related phenomenon is that voucher programs might not stimulate innovation in instruction and curricula, as proponents hope, and might even dampen it, because parents in many contexts are conservative about teaching methods, the selection criteria of higher-level schools and universities remain traditional, and the formula for compensation does not pay schools for innovation or professional development.

The Value of Monitoring

With intense incentives it pays to monitor the agent's performance carefully (Milgrom and Roberts 1992). In a voucher program, a school will be rewarded if it can exaggerate enrollment rates and get away with it. It will also be rewarded if it successfully lowers standards for expelling students or if it raises the average grades students can expect to receive, enticing more students to choose the school. Without reliable inspectors and a strong current of professionalism among educators, education departments in developing economies will be hard pressed to monitor how schools behave in response to intense incentives, which in turn will lower the usefulness of the incentives.

Voucher Programs in Industrialized Countries

Although the framework described here comes directly from theory, empirical work on voucher programs in industrial countries supports its usefulness. In applying the framework, it should be emphasized again that voucher programs take a variety of forms, depending on such things as rules on student eligibility, student admissions, information dissemination, fiscal and pedagogical accountability, the mean and the distribution of the voucher value, and school-level management autonomy. All these influence the expected impact of a given program on academic achievement, equity, innovation, and the state's other educational objectives. Impact evaluations of voucher programs remain sparse. Even so, experiences can be analyzed to determine how key institutional and social variables influence program effects.

United States

If enrollments are a biased or noisy indicator of school effort, the expected impact of voucher programs on school effort is likely to be weak, with little final impact on outcomes. In the United States, studies of the academic effect of voucher programs in small, privately funded efforts in New York City; Washington, D.C.; Dayton, Ohio; and Charlotte, North Carolina, and targeted, publicly financed programs in Milwaukee, Wisconsin; Cleveland, Ohio; and Florida have found limited or mixed results, consistent with that expectation.[10]

In New York a private foundation offered scholarships of up to $1,400 to elementary school students enrolled in low-quality public schools. Some 20,000 students applied for the scholarships, and 1,300 were selected through a lottery. Using the lottery as an instrumental variable for private school attendance, Myers and others (2000) compared average reading and math test scores of students who enrolled in private schools with a comparable group of students who did not, and found no statistically significant difference after the second year of the program. Mayer and others (2002) also found no statistically significant difference overall after the third year. But both studies found significant and positive differences for African Americans enrolled in the scholarship program, though not for other racial and ethnic groups. Working with the same data, Krueger and Zhu (2002) argue that the positive effect for African Americans disappears if student with missing baseline data are included and that the effect is sensitive to the definition of race that is used.

Studies of the experiments in Dayton and Washington, D.C., also found no differences in achievement between voucher and control group students overall but some possible benefit for African American students (Howell and others 2000; Howell and Peterson 2002). Evaluation of the publicly financed voucher program in Milwaukee has generated considerable controversy, even though it involved only 341 students in 7 nonsectarian schools. Witte (2000) found no consistent difference in achievement

scores among voucher program participants and public school students, but Greene and others (1997, 1998) reanalyzed the data, comparing results with those for a group of voucher applicants who could not find space in a participating school. They found that participating students did better after four years of enrollment. Rouse (1998) used the same data and found that voucher students did better in math but not in reading and that the math advantage increased over time.

Studies of the effects of these voucher programs on public schools and on the students who remain in the public system have been hard to conduct because the numbers of students involved have been so small. In Florida's voucher program students in schools deemed to have "failed" two years in a row are given the option of using vouchers in private schools. One study of the program found that all 78 failing schools improved to avoid the voucher threat and argues that this is evidence that voucher programs have positive effects for participants and nonparticipants alike (Greene 2001). But it is unclear whether the improvements in those schools can be attributed to vouchers per se or to the social and political pressure following a failing grade.

New Zealand

More direct evidence on bias in the estimate of school effort comes from New Zealand. In the late 1980s and early 1990s successive liberal and conservative governments established a "quasi-voucher" system in basic education (Wylie 1998). Control over teacher hiring, operating budgets, selection of academic missions, student fees, and local fundraising was transferred to self-governing school boards composed of the principal, one teacher, and elected parents. Residency rules were loosened so that parents could choose any school for their children. The system did not establish intense incentives based on enrollment, but schools started to compete for students anyway because they received more operating funds as enrollment increased, salary scales and prestige for principals were linked to school size, and schools gaining students were widely perceived to be successful, which motivated school boards to expand enrollments.

Studies of parental choice in New Zealand (controlling for census-based predicted enrollments and nonmandatory certificate exam scores in secondary schools) found that schools serving largely disadvantaged groups experienced declining enrollment and rising shares of minority students (Fiske and Ladd 2000, 2003). Schools serving advantaged populations were more likely to experience rising enrollment and steady or falling shares of minority students. It appeared that white students were either fleeing schools with large minority populations or pursuing schools with advantaged students. Additional research suggested that minority students were less likely to consider high-status schools as an option and less likely to attend a nonlocal school (Smithfield Project 1995).

Although parents' decisions to flee schools with high minority populations might be individually rational, such actions are also consistent with the notion that in some contexts enrollment rates are biased estimates of school quality. There is also evidence of noise in the correlation between enrollment and quality: when one secondary school suffered a number of suicides, enrollment declined dramatically even though it was far from clear that the school atmosphere was causally associated with the suicides (Fiske and Ladd 2000). Schools also used a variety of clever but legal techniques to recruit more advantaged populations. In 1997 these enrollment schemes were used by more than 50 percent of schools in Auckland and Christchurch and 24 percent in Wellington (Fiske and Ladd 2000). The apparent increase in socioeconomic polarization in New Zealand was probably also related to the fact that schools were able to set the level of student fees, as well as the fact that less advantaged parents had a harder time accessing information about the better schools and traveling to them.

Sweden

Though systematic studies are not available, similar accounts have surfaced about the voucher program in Sweden. From the early 1990s onward, Sweden transferred control and management of schools to municipalities, which began to finance education based on their own revenues and block transfers from the central government. Municipalities now grant privately managed "independent" schools, some of which had been receiving state assistance, per pupil subsidies equal to the per pupil financing granted to public schools.

The enrollment share of independent schools increased from 1 percent in 1991 to 4 percent in 2002. Parents with children in independent schools appear to be better educated than parents of children in public schools, and they seem to be making choices that avoid schools with large shares of non-Nordic immigrants (Daun 2003). In one large municipality, some schools with large losses in enrollment were unable to attract better teachers, but others were able to establish new market profiles (Daun 2003).

United Kingdom

Evidence on systematic bias in the estimate of effort is mixed in the United Kingdom, and evidence on the outcomes of the voucher program is unclear. A series of laws beginning in 1980 created a quasi-market in government-financed basic education (LeGrand 1991; Walford 1997, 2003). The 1988 Education Reform Act transferred control of budgets and personnel hiring to state-maintained schools, linked school funding to age-weighted enrollment figures, allowed parents to send children to any school with available space, and required schools to follow the national curriculum.

In 1993 schools were allowed to select up to 10 percent of their students on the basis of specific abilities, and existing private schools or independent sponsors were permitted to establish grant-maintained schools. Seven new schools were formed from 1993 to 1997, and seven more have been established under the Labour government, which has retained the voucherlike system.

A series of case studies has argued that the choice system has increased socioeconomic segregation among schools, as students sorted based partly on the socioeconomic mix in schools and as schools started to select students (Ball and Vincent 1998; Gerwitz and others 1995). But statistical analyses of segregation by class have been inconclusive (Gibson and Asthana 2000; Gorard and Fitz 2000; Levacic and Woods 1999), partly because in the previous system, which assigned students to schools based on residence, "selection by mortgage" had already created substantial sorting.

Achievement scores of students in the system increased during the 1990s, and some studies argue that competition among schools, as measured by private sector enrollment share, number of schools, or a Herfindahl index, is associated with higher test scores (Bradley and Taylor 2002; Millington and Bradley 1998), but other studies find mixed results. One study used interviews with headmasters to try to establish a link between structural competition in a market, measured by the number of firms (or, in this case, schools) or a Herfindahl index, and competitive behavior and found that the relationship is looser than believed because of such attenuating factors as product differentiation (type of education offered) and amount of space available (Levacic 2001). It also found that the impact of competition on performance is sensitive to the measure of competition used. In the early 1990s, the government introduced nationwide testing and required publication of test results and school inspections—a system of "naming and shaming." It is possible that the accountability system, rather than competition for students, motivated school effort.

Incentive Problems

Some European countries with voucher systems, recognizing the incentive that flat per pupil payments create for schools to select relatively advantaged students and for parents to choose those "successful" schools, transfer additional resources to schools based on the composition of the student body. Holland pays 1.9 times the standard voucher value for each minority student and 1.25 times the value for an economically disadvantaged student (Patrinos 2002a). Sweden also transfers additional resources based on numbers of minority students and students with learning disabilities.

In almost all countries, constellations of teachers, local politicians, and voters have successfully resisted efforts to close schools, even schools with low enrollments and declining quality. That is suggestive of the risk aversion (and the political power) of the actors in the education sector, including teachers. Experiences in

industrial countries also suggest that voucher programs can result in less attention to noncompensated school activities, such as curricular innovation.

Consistent with the predictions, case studies have found that pedagogy in England and Wales has become more uniform as schools have come to be ranked on the same hierarchical academic scale. Schools have seemingly expended less effort on pedagogical innovation because they were not rewarded for it and may even have been punished for it because parents tend to be pedagogically conservative (Walford 2003). Fiske and Ladd (2000) also report that some teachers felt that collegiality had declined in New Zealand schools and that parents, regardless of socioeconomic status, rated the quality of schools similarly, resulting in a consistent focus on traditional academics in most schools and little curricular innovation.

Both findings are consistent with the notion that when certain activities—in this case professional relations among teachers and pedagogical innovation—are rewarded at lower rates, they will receive less attention. In the United States voucher schools were less likely to have students with disabilities than the public school population (Myers and others 2000), probably because voucher schools were not compensated for taking on students with disablities.

Voucher Programs in Developing and Transition Countries

Although there have been experiments with demand-side financing in a large number of developing and transition countries (Patrinos 2002b), true voucher programs are rarer. The reforms in Chile and Colombia are probably the only genuine examples. Bangladesh, Côte d'Ivoire, and the Czech Republic have had some quasi-voucher initiatives, which help illustrate the variety of contexts in which voucher programs might be implemented and the results they might achieve.

Chile

Starting in 1980, Chile transferred management of public primary and secondary schools to municipalities, abolished pay scales and civil servant protections for teachers, started to finance municipal and nonfee-charging private schools at equal rates tied strictly to attendance, and encouraged parents to choose schools based on performance. The democratic government that assumed power in 1989 reestablished salary scales and employment protection for teachers, but otherwise maintained Chile's voucher system. It is probably the closest national-level approximation of a voucher system among developing economies (Gauri 1998).

The Chilean voucher system led to a dramatic increase in students enrolled in private voucher schools, from 15 percent of total enrollment at the beginning of the 1980s to 33 percent in 1996, almost entirely at the expense of municipal schools.

Although many teachers shifted to the private subsidized sector, almost no municipal schools closed. There is evidence that the private subsidized schools perform better, based on test scores, than municipal schools (Aedo and Larrañaga 1994; Rodríguez 1988), but this private advantage disappears or turns negative when student-level socioeconomic data are included as controls (McEwan 2001; Mizala and Romaguera 1998). McEwan and Carnoy (2000) find that Catholic schools perform better than municipal and nonreligious private voucher schools, but they spend more per student than the other groups of schools.

A study that attempted to measure the effects of private school competition on municipal schools found that communities with higher concentrations of private school enrollment had modestly higher positive test scores in the national capital (a net 0.2 standard deviation gain over 15 years) but small negative effects in the rest of the country (McEwan and Carnoy 1999). Another study found that communities with higher private enrollment shares saw public school performance fall from 1982 to 1988 (though the point estimate was significant only at the 10 percent level; Hsieh and Urquiola 2002). The study concludes that even if a voucher system creates incentive effects that lead to improvements in municipal schools, the fact that the better students migrate from municipal to private schools could lead to an overall decline in municipal school performance.

That study also argues that although small numbers of public students might benefit from vouchers to attend private schools, when a voucher system induces large number of students to move to private schools the overall impact can be assessed only by taking the sum of the (assumedly positive) effects for the migrating students, the (assumedly positive) effect of competition on public schools, and the (assumedly negative) effect of the loss to public school students of their most talented peers. It finds no change in national aggregate indicators of achievement, including Chile's ranking in international test scores and the achievement gap between subsidized and nonsubsidized elite schools. There is also evidence that both municipal and private schools in Chile took active measures to select more advantaged students during this period (Gauri 1998; Espínola 1995).

Chile's experience with vouchers, consistent with the predictions mentioned previously, suggests that when enrollments are the indicator for school effort, schools take steps to make themselves more attractive to parents by enrolling a more advantaged clientele. New Zealand's experience shows that such sorting effects can be problematic when the supply of schools is fixed. Chile's experience illustrates that sorting can also occur when there is a strong supply response. In Chile the effects of intense incentives based on enrollment were modest in the national capital and zero or negative elsewhere. That is also consistent with the expectation that when school effort is not directly related to productivity, intense incentives do not lead to better performance. That no municipal schools were closed is consistent with the fact that intense incentives can carry costs for risk-averse agents, who will fight efforts to

relocate or close schools. Finally, Chile's voucher formula included adjustments for rural schools, in recognition of the need to include covariates of enrollment in intense incentives.

Colombia

Starting in 1992, Colombia offered vouchers to entering sixth-grade students residing in low-income neighborhoods who had previously attended a public school. The vouchers, renewable through the end of secondary school, were cofinanced by the central government and participating municipalities. Where local demand exceeded the municipal allotment, vouchers were assigned by lottery. The program was designed to help poor students make the transition to secondary school in areas where public schools were filled to capacity. Financing to public schools was not reduced when they lost students to the program.

The value of the voucher was initially high enough to pay for tuition at low-cost private schools, but it was not indexed to inflation. By 1998 participating students were typically making out-of-pocket payments equal to the voucher value to cover tuition costs. Most elite private schools in Colombia elected not to accept the vouchers. The program provided vouchers to 125,000 students, or about 1 percent of national secondary enrollment, before it was discontinued in 1997 (Angrist and others 2001; Calderón 1996; King and others 1997, 1998; Montenegro 1995).

A quasi-experimental study compared educational and other outcomes among samples of students who won and lost the voucher lottery (Angrist and others 2001). Lottery winners had lower grade repetition rates than losers but were not more likely to be enrolled in school. A sample of lottery winners also scored 0.2 standard deviations higher on standardized tests, controlling for age, gender, parents' schooling, and residence, and almost 0.3 standard deviations higher in a two-stage least squares regression that took into account private school scholarships obtained by lottery losers and scholarships not used by lottery winners. The effects were slightly larger and estimated more precisely for girls than for boys. Lottery winners spent US$52 more on school fees than losers, gave up $41 in reduced earnings because they remained in school longer, and received scholarships that were $74 higher, for a net household contribution of $19. The public spent an extra $24 for each voucher student, net of reduced public school costs.

A complete analysis of the net impact of the program in Colombia would estimate not only the direct gains for students who used vouchers but also the program's effect on public school students who lost classmates to the voucher program and the effect on the new classmates of lottery winners. Short of research of that scope, however, Angrist and others (2001) at least make plausible the argument that in certain circumstances the marginal impact of incremental private school effort can be substantial. That is consistent with the predictions mentioned already, though it should

be noted that programs like Colombia's do not create intense incentives for schools but instead exploit incentives in existing private schools. The findings from the Colombia program are also consistent with the predictions that the marginal impact of school effort will be lower in rural settings (most participating schools were in the large urban areas) and that schools behave as if families use the socioeconomic composition of their student body as an indicator of quality (most elite schools in Colombia refused to accept the vouchers).

Bangladesh

Community-managed, not-for-profit schools enrolled 80–95 percent of secondary school students in Bangladesh in 2001, depending on how religious schools (*madrassas*) are classified. The government subsidized 80 percent of the base teacher salaries at these nongovernment schools, accounting for 79 percent of total government expenditures at the secondary level in 1997. Because the schools were supposed to follow state criteria on number and recruitment of students, the subsidies functioned as a sort of voucher: When schools attracted enough students to warrant hiring another teacher, the government subsidized that increase in enrollments by paying for most of the additional teacher's salary. In private secondary schools student fees for admission, tuition, books, uniforms, stationery, sports, after-hours tutoring, and other activities constituted an average of half to two-thirds of private school revenues. Demand for secondary education was strong enough, and entry requirements in the sector liberal enough, that overall enrollments doubled from 1990 to 1997, when they reached 7 million students.

But the norms for the transfer of the subsidies were weakly enforced. One survey found that in 1998 only 29 percent of principals reported a visit by an inspector in the recent past (World Bank 2000). As a result, schools applied for and received subsidies without complying with enrollment and other norms, and the quasi-voucher system did not necessarily create intense incentives to expand school enrollments. The private fees, however, did serve that function.

By all accounts, the quality of secondary education in Bangladesh was inadequate despite high per pupil expenditures by international standards. The private schools did not train their teachers or develop new teaching methods, instead relying on the traditional pedagogy of memorization. Textbooks were often unavailable, and charges of cheating, by both students and schools, were not uncommon. The principal purpose of secondary education was to screen and winnow university applicants on the basis of the all-important examinations. Promotion rates were as low as 75 percent between grades, 15 percent of students who enrolled in the first year of secondary school completed a secondary degree, and 6 percent went on to a university.

The Bangladeshi experience with a quasi-voucher system is consistent with several theoretical predictions. Intense incentives can fail to achieve objectives without

a functioning monitoring system. School effort will not be related to academic outcomes if exogenous factors, such as textbook shortages and examination pressures, limit returns to effort. Risk-averse actors will lobby to reduce the risk to which voucher programs expose schools. External pressures, such as university exams, will limit curricular innovation and teacher training (World Bank 2000).

Côte d'Ivoire

Côte d'Ivoire subsidizes private primary schools at rates that are negotiated with umbrella groups for religious (Catholic and Protestant) and secular schools, that vary with school location and tuition charges, and that are loosely tied to the number of students enrolled. These subsidies ranged from $40 to $66 per pupil in 1999. At the secondary school level reimbursements to private schools even more closely resembled a voucher system. In 1999 the government reimbursed private secondary schools $200–$233 per year for each "state-sponsored" student. These voucher values were above market tuition rates at some private schools, but about one-tenth the fees at the top ones.

Qualifying for sponsorship was not transparent, but it was tied to test scores, which had been the subject of corruption controversies in previous years. Generally, private schools had small permanent teaching staffs and hired public sector teachers on a contractual basis or used "rental" teachers from the government. Private enrollments were 13 percent of the national total at the primary level and 36 percent at the general secondary level. Some 42 percent of private students at the primary and secondary levels received either direct or indirect state support. The per capita private education subsidy was significantly higher for families in the top income quintile than for families in the lower quintiles, but the same was true for public education, which favored urban areas.

Outcomes studies of education subsidies in Côte d'Ivoire are not available. One analysis compared the results of a standardized test administered to five Francophone Sub-Saharan countries (Michaelowa 2001). It noted that although primary education expenditure as a share of gross domestic product (GDP) was 50 percent more in Côte d'Ivoire than in Cameroon and three times more than in Madagascar, and its per capita GDP was higher than that of both countries, test scores among fifth graders in Côte d'Ivoire were lower. Enrollment rates in Côte d'Ivoire were 54 percent, lower than in Cameroon but higher than in Madagascar. In some regions of Côte d'Ivoire first-grade enrollment rates for girls were as low as 12 percent.

Explanations for the inefficiency in expenditures included the short academic year (at 820 hours, one of the shortest in the world); double-shift classes for some students, which further reduced the hours of schooling; fees and other obstacles to textbook access that resulted in pupil:textbook ratios of 5:1 in urban areas and 10:1 in

rural areas; high teacher salaries (an average of nine times gross national product per capita); and small class sizes, which were the lowest among the five comparator nations (LaRocque 1999; World Bank 1998).

Although detailed analyses of the voucher program in Côte d'Ivoire are not available, the case illustrates that even if schools are given intense incentives, external constraints on performance, such as the labor market for teachers, national rules regarding the school year, and expectations regarding girls' education, can diminish the returns to school effort. In the circumstances, compensation based on enrollment will be weakly productive in raising achievement.

Czech Republic

Private schools were legalized in the Czech Republic in 1990. At the same time, state-run schools were given authority over enrollment and curricula. Although private schools at first received "equal treatment" with respect to public financing, in 1995 their public funding was lowered to 60–90 percent of the funding for state schools. Following complaints about the arbitrariness of the state's funding decisions, a new formula in 1999 directed that private schools should receive funding based on a set of defined quality measures.

In that scheme state-run schools received separate recurrent budget allocations, determined on a per student, voucherlike basis. The recurrent component had two parts: a base support level, which varied by type of school (on average 50 percent of the per student payment to state schools), and a quality-based payment, with a maximum total set at 90 percent of the state sector per student subsidy. The average private school received just under 80 percent of the per student allocation that public schools received. Private secondary schools could charge tuition, which in 1998 averaged 55–65 percent of the per student allocation going to public secondary schools. Although the enrollment share remained tiny for private primary schools, the secondary school share went from 0.1 percent in 1990 to 9.8 percent in 1999 (Filer and Munich 2003; World Bank 2001).

Assessments of the voucherlike system of education financing in the Czech Republic remain provisional. One study found that parents with higher earnings and more education were more likely to choose a private school for their children, but many private schools found their market niche by enrolling students who did not gain admission to the most desirable, oversubscribed public secondary schools. There is little published data on the criteria private schools use to select students or on whether enrollments were functioning as a useful estimate of school effort. Provisional evidence suggested that areas with relatively weak public schools were more likely to have private schools established (Filer and Munich 2003).

Conclusion

Voucher programs are a potential solution to the problem that governments face in motivating schools, as their agents, to put forth effort. Making school payments proportional to enrollment creates intense incentives to satisfy parents. Enrollment is a useful measure of school effort. But because parents frequently conflate student body composition with learning opportunities, voucher programs can create a strong incentive for schools to select advantaged students. Findings in Chile and New Zealand are consistent with this concern. Where administratively feasible, it makes sense to set the voucher value for disadvantaged students at higher levels, as Holland does. Where that is not feasible, which is likely in most developing economies, eligibility for voucher programs might be restricted to the poor.

Intense incentives are worthwhile only if more school effort produces better results. For small voucher programs that send modest numbers of students to urban private schools with surplus capacity, as in Colombia's experiment, that might well be true, at least for participating students. (Evidence on aggregate results is still unavailable.) In programs with wide eligibility, the ability of schools to improve learning among large numbers of students is likely to be limited in many developing areas by factors beyond the schools' control, such as the number of qualified teachers, the availability of textbooks, and pedagogical traditions.

Voucher programs that do not reward innovation may reduce diversity and innovation in teaching if parents are pedagogically conservative. Voucher programs in Bangladesh, Chile, Côte d'Ivoire, New Zealand, and the United Kingdom did not promote pedagogical innovation. Case studies suggest that pedagogy might even have become more uniform in those countries than before the programs. If implementing voucher programs, governments will need to continue to finance and support teacher training and professional development in private schools.

Teachers, school owners, and parents in developing economies are often risk-averse. As a result, strict voucher programs in which poorly performing schools are closed and teachers are laid off carry higher welfare costs and might encounter strong political resistance.

Finally, voucher programs reward schools that can get away with exaggerating enrollment rates or loosening education standards. So the effect of intense incentives to expand enrollments will be distorted unless the government establishes a functioning monitoring system, which can be expensive.

The usefulness of voucher programs for developing economies remains uncertain. Major voucher initiatives have only been attempted in two countries with relatively well-developed institutional infrastructures, Chile and Colombia. Some studies have found favorable benefits for at least some population groups, but others have found limited effects and evidence of increasing social stratification in schools. Whether

vouchers lead to better outcomes or greater stratification appears related to specific contexts, institutional variables, and program design.

Notes

Varun Gauri is Economist in the Development Research Group at the World Bank; his e-mail address is vgauri@worldbank.org. Ayesha Vawda is Education Specialist at the World Bank; her e-mail address is avawda@worldbank.org. The authors thank Shantayanan Devarajan, Harry Patrinos, David Plank, Miguel Urquiola, and three anonymous reviewers for useful comments on earlier drafts and Imran Hafiz and Hedy Sladovich for help in preparing the manuscript.

1. Patrinos (2002b) reviews the evidence on subsidies to increase education demand in developing economies, including, for example, Bolsa Escola in Brazil, Progressa in Mexico, Food for Education in Bangladesh, and a community grants program in Pakistan.

2. It is possible that schools will exhibit competitive behavior even in the absence of explicit, intense incentives. In some cases, rivalry for professional status can lead to a "culture of competition," as in the New Zealand system.

3. Formally, incentives in a voucher system are modeled as $r = \alpha + \beta(e + x + \gamma y)$, where r represents total payments to the school, α is a base payment for capital costs or in-kind inputs, e is school effort as measured by the number students enrolled, x is noise in the measurement of enrollments, y is a set of factors that varies with enrollment, and γ is a parameter that varies from 0 to 1. The higher the voucher value, β, the more "intense" the incentives the school faces (Milgrom and Roberts 1992).

4. Another approach would model parents as principals, either alongside or instead of the state as a principal, with the school remaining the agent. But that approach, although useful as an exercise, would have limited value for policy. The analytic virtue of the principal-agent framework is that it identifies important contractual parameters of the voucher scheme in the hope that they might be modified to improve social outcomes. If parents are not concerned with broad social outcomes, or if they cannot shape the parameters of contracts with schools—there are reasons to believe that both are true—an approach that makes them principals has limited value for policymaking. The state might design a voucher program in which schools are paid not only for each student enrolled but an additional amount for students from minorities or from disadvantaged backgrounds, or less if an inflow of immigrants raises average enrollment rates and lowers marginal costs for all schools in a neighborhood, or it may link payments to a weighted average of enrollments and test scores. But parents are concerned primarily with the education of their own children and are not likely to pay less if the school fails to fulfill a social objective. Moreover, because schooling, for economies of scale and social and historical reasons, is provided collectively, parents would have to negotiate the terms of the contract with schools among themselves first, resulting in a difficult collective action problem. As a result, they would be hard pressed to design and modify key parameters of contracts with schools. The framework adopted here focuses on, to the use the language of World Bank (2003), the policymaker–provider link, and it assumes that the policymakers follow through on their commitment to reward schools on the basis of parental choices. In other words, it does not address issues related to interest group influence, which of course do not disappear in a voucher system.

5. The use of a poor measure of effort and the exclusion of observable, exogenous correlates from the contract both raise the expected variance with which effort will be measured. The higher the variance, the higher the implicit costs of contracting (Holmstrom 1979).

6. This bias on the part of parents is rational if enrolling a child in a school with advantaged peers helps the child learn—if there are peer effects—or if enrolling in such a school is construed as a sign of high achievement by employers and higher level schools—if there are signaling effects.

7. With a risk-neutral principal and a risk-averse agent, a fee schedule in which the agent bears all the risk is never pareto optimal (Shavell 1979), but a small degree of risk aversion in a linear compensation contract will permit a solution close to the first best (Holmstrom and Milgrom 1987).

8. For a formal presentation of this point, see Hsieh and Urquiola (2002).

9. Holmstrom and Milgrom (1987) argue that if two of an agent's activities can be separately observed, the weight to attach to each in the optimal compensation scheme depends not only on the costs and benefits of the activities but on their variances. The higher the variance, the lower is the weight attached to the activity.

10. For a summary of research findings on vouchers in the United States, as well as on charter schools, see Gill and others (2001). That volume argues that differences in academic achievement between conventional public and charter schools in Arizona, Michigan, and Texas are relatively small and mixed in direction, though that might be a consequence of the relative youth of charter schools. Hoxby (2001) argues that areas with greater competition from charter schools exhibit higher achievement. Other reviews include Ladd (2002) and Neal (2002).

References

Aedo, C., and O. Larrañaga. 1994. "Sistemas de Entrega de los Servicios Sociales: La Experiencia Chilena." In C. Aedo and O. Larrañaga, eds., *Sistema de Entrega de los Servicios Sociales: Una Agenda Para la Reforma*. Washington, D.C.: Banco Interamericano de Desarrollo.

Angrist, J. D., E. Bettinger, E. Bloom, E. King, and M. Kremer. 2001. "Vouchers for Private Schooling in Colombia: Evidence from a Randomized Natural Experiment." NBER Working Paper 8343. National Bureau for Economic Research, Cambridge, Mass.

Ball, S., and C. Vincent. 1998. "'I Heard it on the Grapevine': 'Hot' Knowledge and School Choice." *British Journal of Sociology of Education* 19(3):377–400.

Bradley, S., and J. Taylor. 2002. "The Effect of the Quasi-Market on the Efficiency-Equity Trade-off in the Secondary School Sector." *Bulletin of Economic Research* 54(3):295–314.

Calderón, A. 1996. "Voucher Programs for Secondary Schools: The Colombian Experience." Human Capital Development and Operations Policy Working Paper. World Bank, Washington, D.C.

Daun, H. 2003. "Markets Forces and Decentralization in Sweden: Impetus for School Development or Threat to Comprehensiveness and Equity?" In D. Plank and G. Sykes, eds., *Choosing Choice: School Choice Policies in International Perspective*. New York: Teachers College Press.

Espínola, V. 1995. "The Decentralization of the Educational System in Chile." CIDE Working Paper. Center for Research and Teaching Economics, Mexico City.

Filer, R., and D. Munich. 2003. "Public Support for Private Schools in Post-Communist Central Europe: Czech and Hungarian Experiences." In D. Plank, and G. Sykes, eds., *Choosing Choice: School Choice Policies in International Perspective*. New York: Teachers College Press.

Fiske, E., and H. Ladd. 2000. *When Schools Compete: A Cautionary Tale*. Washington, D.C.: Brookings Institution Press.

———. 2003. "School Choice in New Zealand: A Cautionary Tale." In D. Plank and G. Sykes, eds., *Choosing Choice: School Choice Policies in International Perspective*. New York: Teachers College Press.

Gauri, V. 1998. *School Choice in Chile: Two Decades of Educational Reform*. Pittsburgh, Pa.: University of Pittsburgh Press.

Gewirtz, S., S. J. Ball, and R. Bowe. 1995. *Markets, Choice and Equity in Education*. Buckingham, UK: Open University Press.

Gibson, A., and S. Asthana. 2000. "What's in a Number? Commentary on Gorard and Fitz's 'Investigating the Determinants of Segregation between Schools.'" *Research Papers in Education* 15(2):133–53.

Gill, B., P. Timpane, K. Ross, and D. Brewer. 2001. *Rhetoric versus Reality: What We Know and What We Need to Know about Vouchers and Charter Schools.* Santa Monica, Calif.: Rand Education.

Gorard, S., and J. Fitz. 2000. "Investigating the Determinants of Segregation between Schools." *Research Papers in Education* 15(2):115–32.

Greene, J. 2001. "An Evaluation of the Florida A-Plus Accountability and School Choice Program." Center for Civic Innovation at the Manhattan Institute, New York.

Greene, J., P. Peterson, and J. Du. 1997. "Effectiveness of School Choice: The Milwaukee Experiment." Harvard University Program in Education Policy and Governance, Cambridge, Mass.

———. 1998. "School Choice in Milwaukee: A Randomized Experiment." In Paul E. Peterson and Bryan C. Hassel, eds., *Learning from School Choice.* Washington, D.C.: Brookings Institution Press.

Holmstrom, B. 1979. "Moral Hazard and Observability." *Bell Journal of Economics* 10:74–91.

Holmstrom, B., and P. Milgrom. 1987. "Aggregation and Linearity in Provision of Intertemporal Incentives." *Econometrica* 55(2):303–28.

Howell, W., and P. Peterson. 2002. *The Education Gap: Vouchers and Urban Schools.* Washington, D.C.: Brookings Institution Press.

Howell, W., P. Wolf, P. Peterson, and D. Campbell. 2000. "Test-Score Effects of School Vouchers in Dayton, Ohio, New York City, and Washington, D.C.: Evidence from Randomized Field Trials." Paper presented at the American Political Science Association, September, Washington, D.C.

Hoxby, C. M. 2001. "How School Affects the Achievement of Public School Students." Hoover Institution, Stanford, Calif.

Hsieh, C.-T., and M. Urquiola. 2002. "When Schools Compete, How Do They Compete? An Assessment of Chile's Nationwide School Voucher Program." Occasional Paper 43, National Center for the Study of Privatization in Education, Teachers College, Columbia University, New York.

King, E., P. Orazem, and D. Wolgemuth. 1998. "Central Mandates and Local Incentives: The Colombia Education Voucher Program." Series on Impact Evaluation of Education Reforms Working Paper 6. World Bank, Development Economics Research Group, Washington, D.C.

King, E., L. Rawlings, M. Gutierrez, C. Pardo, and C. Torres. 1997. "Colombia's Targeted Education Voucher Program: Features, Coverage and Participation." Series on Impact Evaluation of Education Reforms Working Paper 3. World Bank, Development Economics Research Group, Washington, D.C.

Krueger, A., and P. Zhu. 2002. "Another Look at the New York City School Voucher Experiment." NBER Working Paper 9418. National Bureau for Economic Research, Cambridge, Mass.

Ladd, H. 2002. "School Vouchers: A Critical View." *Journal of Economic Perspectives* 16(4):3–24.

LaRocque, N. 1999. "An Assessment of the Private Education Sector in Côte d'Ivoire." World Bank, Human Development Network, Education Group, Washington, D.C.

Le Grand, J. 1991. "Quasi-Markets and Social Policy." *Economic Journal* 101:1256–67.

Levacic, R. 2001. "An Analysis of Competition and its Impact on Secondary School Examination Performance in England." National Center for the Study of Privatization in Education, Teachers College, Columbia University, New York.

Levacic, R., and P. A. Woods. 1999. "Polarisation and Inequality between Secondary Schools in England: Effects on School Practice and Performance." Paper presented at the British Educational Research Association Annual Conference, University of Sussex.

Mayer, D., P. Peterson, D. Myers, C. Tuttle, and W. Howell. 2002. "School Choice in New York City after Three Years: An Evaluation of the School Choice Scholarship Program." Mathematica Policy Research, Washington, D.C.

McEwan, P. J. 2001. "The Effectiveness of Public, Catholic, and Non-Religious Private Schooling in Chile's Voucher System." *Education Economics* 9(2):103–28.

McEwan, P. J., and M. Carnoy. 1999. "The Impact of Competition on Public School Quality: Longitudinal Evidence from Chile's Voucher System." Stanford University, Stanford, Calif.

———. 2000. "The Effectiveness and Efficiency of Private Schools in Chile's Voucher System." *Educational Evaluation and Policy Analysis* 22(3):213–39.

Michaelowa, K. 2001. "Primary Education Quality in Francophone Sub-Saharan Africa: Determinants of Learning Achievement and Efficiency Considerations." *World Development* 29(10):1699–716.

Milgrom, P., and J. Roberts. 1992. *Economics, Organization, and Management*. Englewood Cliffs, N.J.: Prentice Hall.

Millington, J., and S. Bradley. 1998. "The Effect of Spatial Competition on Secondary School Exam Performance." CREED Discussion Paper 4/98. Collaborative Research in Economics and Development. Lancaster University, Department of Economics, Lancaster, UK.

Mizala, A., and P. Romaguera. 1998. "Desempeño Escolar y la Eleccion de Colegios: La Experiencia Chilena." University of Chile, Santiago.

Montenegro, A. 1995. "An Incomplete Educational Reform: The Case of Colombia." Human Capital Development and Operations Policy, Working Paper 60. World Bank, Washington, D.C.

Myers, D., P. Peterson, D. Mayer, J. Chou, and W. Howell. 2000. "School Choice in New York City after Two Years: An Evaluation of the School Choice Scholarship Program." Mathematica Policy Research, Washington, D.C.

Neal, D. 2002. "How Vouchers Could Change the Market for Education." *Journal of Economic Perspectives* 16(4):25–44.

Patrinos, H. 2002a. "Private Education and Public Finance: The Netherlands as a Possible Model." Occasional Paper 59. National Center for the Study of Privatization in Education, Teachers College, Columbia University, New York.

———. 2002b. "A Review of Demand-Side Financing Initiatives in Education." World Bank, Washington, D.C.

Rodríguez, J. 1988. "School Achievement and Decentralization Policy: The Chilean Case." *Revista de Analisis Economico* 3(1):75–88.

Rouse, C. 1998. "Private School Vouchers and Student Achievement: An Evaluation of the Milwaukee Parental Choice Program." *Quarterly Journal of Economic* 113(2):553–602.

Shavell, S. 1979. "Risk Sharing and Incentives in the Principal and Agent Relationship." *Bell Journal of Economics* 10(1):55–73.

Smithfield Project. 1995. *Trading in Futures: The Nature of Choice in Educational Markets in New Zealand*. Wellington, New Zealand: Ministry of Education.

Walford, G. 1997. "Diversity, Choice and Selection in England and Wales." *Educational Administration Quarterly* 33(2):31–44.

———. 2003. "School Choice and Educational Change in England and Wales." In D. Plank and G. Sykes, eds., *Choosing Choice: School Choice Policies in International Perspective*. New York: Teachers College Press.

Witte, J. 2000. *The Market Approach to Education*. Princeton, N.J.: Princeton University Press.

World Bank. 1998. *Côte d'Ivoire: Education and Training Support Project*. Washington, D.C.

———. 2000. *Bangladesh: Education Sector Review*. Washington, D.C.

———. 2001. *Czech Republic: Enhancing the Prospects for Growth with Fiscal Stability*. Country Study. Washington, D.C.

———. 2003. *World Development Report 2004: Making Services Work for Poor People*. Washington, D.C.

Wylie, C. 1998. "Can Vouchers Deliver Better Education? A Review of the Literature, with Special Reference to New Zealand." New Zealand Council for Educational Research, Wellington.

Oxford Journals Online Collection

Are you looking to find information in your subject area quickly and easily from a wealth of different sources?

OUP publishes over 170 internationally acclaimed journal titles online in the areas of:

- HUMANITIES
- SOCIAL SCIENCES
- LAW
- ECONOMICS, BUSINESS AND FINANCE
- BIOLOGICAL SCIENCES
- MEDICINE AND HEALTH SCIENCES
- PUBLIC HEALTH AND EPIDEMIOLOGY
- MATHEMATICS, STATISTICS, COMPUTING, AND PHYSICS

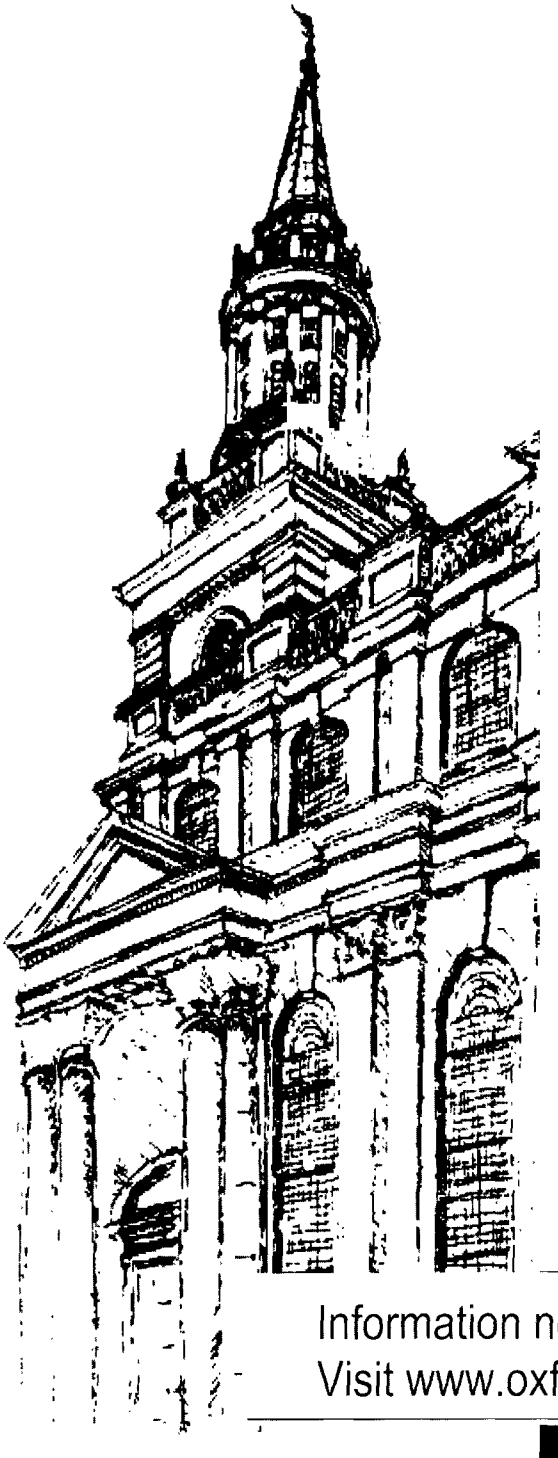
Your library can subscribe to the **whole collection**, a particular **subject area**, or a **tailor-made package** and enable you to receive full access to journal articles (full text HTML or PDF), all with advanced online functionality.

Your librarian can control your online subscriptions quickly and easily and can review your institution's usage statistics, 24 hours a day.

Pass this information to your librarian and encourage them to visit **www.oupjournals.org/librarians**

www.oupjournals.org

OXFORD
UNIVERSITY PRESS



Oxford Journals Advertising

For information on advertising in this journal please contact:

Helen Pearson
Oxford Journals Advertising
PO Box 347
Abingdon
OX14 1GJ, UK

Tel/Fax
+44 (0) 1235 201904

e-mail
helen@oxfordads.com

Information now available online.
Visit www.oxfordads.com

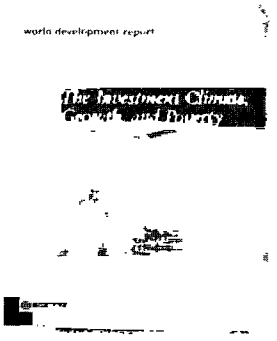
New from OXFORD

HUMAN DEVELOPMENT REPORT 2004

Cultural Liberty in Today's Diverse World

United Nations Development Programme

The *Human Development Report 2004* debunks myths that regard diversity as a threat to nations and states, the source of inevitable clashes, and an obstacle to development. Opening with an analysis of the vital links between human development and cultural liberty by Nobel Laureate Amartya Sen, it examines issues that the dynamics of globalization have brought to the forefront of policy agendas in rich and poor countries alike. These include migration, predatory extremism, and the expansion of cultural diversity. Drawing on data from national and local governments around the world, the *Report* proposes evidence-based constitutional, juridical, and socioeconomic policy options to promote cultural liberty and multicultural democracy in the context of universally accepted human rights.



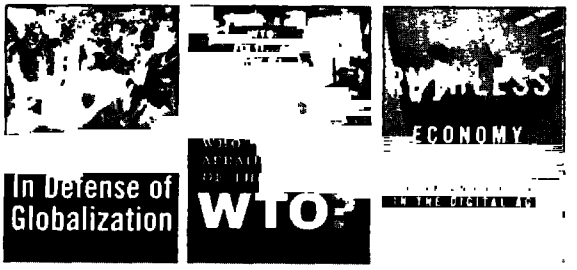
WORLD DEVELOPMENT REPORT 2005

The Investment Climate, Growth, and Poverty

World Bank

The *World Development Report 2005* provides policymakers, business developers, economic advisers, and academics with an in-depth understanding of the dynamics that shape government policies and [illegible] the investment climate. It examines what governments can do to improve the investment climates of their countries, spur growth, and reduce poverty. The *Report* focuses on the opportunities and challenges faced by developing nations and suggests practical strategies for accelerating progress. It builds on information from past World Development Reports and draws on new sources of micro-level data, country case studies, and new research.

ALSO AVAILABLE



IN DEFENSE OF GLOBALIZATION
Jagdish Bhagwati
2004 [illegible] pp. [illegible] illus. paper

WHO'S AFRAID OF THE WTO?
Kent Jones
2003 246 pp., 10 illus. paper

THE NEW RUTHLESS ECONOMY
Work and Power in the Digital Age
Simon Head
2003 240 pp. paper

OXFORD
UNIVERSITY PRESS
HIGHER EDUCATION GROUP

To order or for more information, call 1-800-451-7556.
In Canada, call 1-800-387-8020.
Visit our website at www.oup.com/us/highered

THE WORLD BANK

1818 H Street NW
Washington DC 20433, U.S.A.
World Wide Web: http://www.worldbank.org/
E-mail: researchobserver@worldbank.org

ISBN 019-8530668