Public Disclosure Authorized
Public Disclosure Authorized
Public Disclosure Authorized
Public Disclosure Authorized

ISSN 0258-6770

51344

THE WORLD BANK ECONOMIC REVIEW

Volume 21 • 2007 • Number 3

VOLATILITY AND GROWTH: A SYMPOSIUM

Macroeconomic Volatility and Welfare in Developing Countries: An Introduction
Norman V. Loayza, Romain Rancière, Luis Servén, and Jaume Ventura

The Structural Determinants of External Vulnerability
Norman V. Loayza and Claudio Raddatz

Do Some Forms of Financial Flows Help Protect Against "Sudden Stops"?
Andrei A. Levchenko and Paolo Mauro

Creditor Protection and Credit Response to Shocks
Arturo José Galindo and Alejandro Micco

Crises, Volatility, and Growth
Enisse Kharroubi

Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar
Hanan G. Jacoby and Bart Minten

Land Tenure, Investment Incentives, and the Choice of Techniques: Evidence from Nicaragua
Oriana Bandiera

Earnings, Schooling, and Economic Reform: Econometric Evidence From Hungary (1986–2004)
Nauro Campos and Dean Jolliffe

www.wber.oxfordjournals.org

OXFORD JOURNALS
OXFORD UNIVERSITY PRESS

THE WORLD BANK ECONOMIC REVIEW

EDITOR
Jaime de Melo, *University of Geneva*

ASSISTANT TO THE EDITOR
Marja Kuiper

EDITORIAL BOARD

Chong-En Bai, *Tsinghua University, China*
Jean-Marie Baland, *University of Namur, Belgium*
Kaushik Basu, *Cornell University, USA*
Alok Bhargava, *Houston University, USA*
François Bourguignon, *World Bank*
Kenneth Chomitz, *World Bank*
Maureen Cropper, *University of Maryland, USA*
Jishnu Das, *World Bank*
Klaus Deininger, *World Bank*
Asli Demirgüç-Kunt, *World Bank*
Stefan Dercon, *University of Oxford, UK*
Ishac Diwan, *World Bank*
Augustin Kwasi Fosu, *United Nations University, WIDER, Finland*
Alan Harold Gelb, *World Bank*
Paul Gertler, *World Bank*
Indermit Gill, *World Bank*
Jan Willem Gunning, *Free University, The Netherlands*
Hanan Jacoby, *World Bank*
Graciela Kaminsky, *George Washington University, USA*
Peter Lanjouw, *World Bank*
Thierry Magnac, *Université de Toulouse I, France*
Jonathan Morduch, *New York University, USA*
Juan-Pablo Nicolini, *Universidad Torcuato di Tella, Argentina*
Boris Pleskovic, *World Bank*
Martin Rama, *World Bank*
Ritva Reinikka, *World Bank*
Elisabeth Sadoulet, *University of California, Berkeley, USA*
Joseph Stiglitz, *Columbia University, USA*
Jonathan Temple, *University of Bristol, UK*
L. Alan Winters, *University of Sussex, UK*

The World Bank Economic Review is a professional journal for the dissemination of World Bank–sponsored and other research that may inform policy analysis and choice. It is directed to an international readership among economists and social scientists in government, business, international agencies, universities, and development research institutions. The Review seeks to provide the most current and best research in the field of quantitative development policy analysis, emphasizing policy relevance and operational aspects of economics, rather than primarily theoretical and methodological issues. It is intended for readers familiar with economic theory and analysis but not necessarily proficient in advanced mathematical or econometric techniques. Articles illustrate how professional research can shed light on policy choices. Consistency with World Bank policy plays no role in the selection of articles.

Articles are drawn from work conducted by World Bank staff and consultants and by outside researchers. Non-Bank contributors are encouraged to submit their work.

Before being accepted for publication, articles are reviewed by three referees—one from the World Bank and two from outside the institution. Articles must also be endorsed by two members of the Editorial Board before final acceptance.

For more information, please visit the Web sites of the Economic Review at Oxford University Press at www.wber.oxfordjournals.org and at the World Bank at www.worldbank.org/research/journals.

Instructions for authors wishing to submit articles are available online at www.wber.oxfordjournals.org. Please direct all editorial correspondence to the Editor at wber@worldbank.org.

THE WORLD BANK ECONOMIC REVIEW

Volume 21 · 2007 · Number 3

VOLATILITY AND GROWTH: A SYMPOSIUM

Macroeconomic Volatility and Welfare in Developing Countries: An Introduction 343
Norman V. Loayza, Romain Rancière, Luis Servén, and Jaume Ventura

The Structural Determinants of External Vulnerability 359
Norman V. Loayza and Claudio Raddatz

Do Some Forms of Financial Flows Help Protect Against "Sudden Stops"? 389
Andrei A. Levchenko and Paolo Mauro

Creditor Protection and Credit Response to Shocks 413
Arturo José Galindo and Alejandro Micco

Crises, Volatility, and Growth 439
Enisse Kharroubi

Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar 461
Hanan G. Jacoby and Bart Minten

Land Tenure, Investment Incentives, and the Choice of Techniques: Evidence from Nicaragua 487
Oriana Bandiera

Earnings, Schooling, and Economic Reform: Econometric Evidence From Hungary (1986–2004) 509
Nauro Campos and Dean Jolliffe

SUBSCRIPTIONS: A subscription to *The World Bank Economic Review* (ISSN 0258-6770) comprises 3 issues. Prices include postage; for subscribers outside the Americas, issues are sent air freight.

Annual Subscription Rate (Volume 21, 3 Issues, 2007): *Academic libraries*—Print edition and site-wide online access: US$158/£99/€149, Print edition only: US$150/£94/€141, Site-wide online access only: US$150/£94/€141; *Corporate*—Print edition and site-wide online access: US$237/£148/€222, Print edition only: US$226/£141/€212, Site-wide online access only: US$226/£141/€212; *Personal*—Print edition and individual online access: US$56/£35/€53. Please note: US$ rate applies to US & Canada, Euros€ applies to Europe, UK£ applies to UK and Rest of World. There may be other subscription rates available; for a complete listing, please visit www.wber.oxfordjournals.org/subscriptions. *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.*

Full pre-payment in the correct currency is required for all orders. Payment should be in US dollars for orders being delivered to the USA or Canada; Euros for orders being delivered within Europe (excluding the UK); GBP sterling for orders being delivered elsewhere (i.e. not being delivered to USA, Canada, or Europe). All orders should be accompanied by full payment and sent to your nearest Oxford Journals office. Subscriptions are accepted for complete volumes only. Orders are regarded as firm, and payments are not refundable. Our prices include Standard Air as postage outside of the UK. Claims must be notified within four months of despatch/order date (whichever is later). Subscriptions in the EEC 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. Subscribers in Canada, please add GST to the prices quoted. Personal rate subscriptions are only available if payment is made by personal cheque or credit card, delivery is to a private address, and is for personal use only.

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, OxfordOX2 6DP, UK. E-mail: jnls.cust.serv@oxfordjournals.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@oxfordjournals.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 Economic Review* (ISSN 0258-6770) is published by Oxford University Press for the International Bank for Reconstruction and Development/THE WORLD BANK. Send address changes to *The World Bank Economic Review*, 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 Economic Review*, The World Bank, 3, Chemin Louis Dunant, CP66 1211 Geneva 20, Switzerland.

OXFORD JOURNALS ENVIRONMENTAL AND ETHICAL POLICIES: Oxford Journals is committed to working with the global community to bring the highest quality research to the widest possible audience. Oxford Journals will protect the environment by implementing environmentally friendly policies and practices wherever possible. Please see http://www.oxfordjournals.org/ethicalpolicies.html for further information on Oxford Journals' environmental and ethical policies.

DIGITAL OBJECT IDENTIFIERS: For information on dois and to resolve them, please visit www.doi.org.

PERMISSIONS: For information on how to request permissions to reproduce articles or information from this journal, please visit www.oxfordjournals.org/jnls/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: +44 (0)1235 201904. Fax: +44 (0)8704 296864.

DISCLAIMER: Statements of fact and opinion in the articles in The World Bank Economic Review 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 Economic Review* 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 Economic Review* is indexed and/or abstracted by *CAB Abstracts, Current Contents/Social and Behavioral Sciences, Journal of Economic Literature/EconLit, PAIS International, RePEc (Research in Economic Papers)*, and *Social Services Citation Index*.

COPYRIGHT © The International Bank for Reconstruction and Development/THE WORLD BANK 2007
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.

Macroeconomic Volatility and Welfare in Developing Countries: An Introduction

Norman V. Loayza, Romain Rancière, Luis Servén, and Jaume Ventura

Macroeconomic volatility, both a source and a reflection of underdevelopment, is a fundamental concern for developing countries. Their high aggregate instability results from a combination of large external shocks, volatile macroeconomic policies, microeconomic rigidities, and weak institutions. Volatility entails a direct welfare cost for risk-averse individuals, as well as an indirect one through its adverse effect on income growth and development. This article provides a brief overview of the recent literature on macroeconomic volatility in developing countries, highlighting its causes, consequences, and possible remedies. It then introduces the contributions of a recent conference on the subject, sponsored by the World Bank and Pompeu Fabra University, Barcelona.

On almost any standard measure of macroeconomic volatility, developing countries have topped the charts over the last four decades. Among the most volatile are not just small economies (Dominican Republic and Togo) but also large ones (China and Argentina). Many are predominantly commodity exporters (Ecuador and Nigeria), but some are also rapidly industrializing economies (Indonesia and Peru). The empirical connection between macroeconomic volatility and lack of development is undeniable, making volatility a fundamental development concern. What is behind this relationship? Is volatility a source or a reflection of underdevelopment? What precise underdevelopment characteristics put poor countries more at risk? Through what mechanisms does volatility affect welfare?

Norman V. Loayza (corresponding author) is a lead economist at the World Bank; his email address is nloayza@worldbank.org. Romain Rancière is an economist at the International Monetary Fund; his email address is rranciere@imf.org. Luis Servén is a research manager at the World Bank; his email address is lserven@worldbank.org. Jaume Ventura is a researcher at the Centre de Recerca en Economia Internacional (CREI) and professor of economics at Universitat Pompeu Fabra; his email address is jaume.ventura@upf.edu. For useful comments and suggestions the authors are grateful to Eduardo Cavallo, Jim de Melo, Andrei Levchenko, Claudio Raddatz, and participants in the conference "The Growth and Welfare Effects of Macroeconomic Volatility" (Barcelona, 17–18 March 2006), sponsored by the World Bank and Pompeu Fabra University.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 343–357 doi:10.1093/wber/lhm017
Advance Access Publication 4 October 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

To help answer these questions, the Development Economics Vice-Presidency of the World Bank and the Center for International Economic Research of Pompeu Fabra University, Barcelona, organized the conference "The Growth and Welfare Effects of Macroeconomic Volatility." Taking place in Barcelona on 17–18 March 2006, it gathered researchers and policymakers from around the world to discuss more than a dozen original papers on the topic. A selection of those papers is published in this issue of the *World Bank Economic Review*.[1] This short introduction reviews the literature on macroeconomic volatility and welfare in developing countries and highlights the contributions of the Barcelona conference.

I. Why Do We Care about Macroeconomic Volatility in Developing Countries?

The welfare costs of macroeconomic volatility in developing countries are particularly large. They come, first, from the direct welfare loss of deviating from a smooth path of consumption, optimal for most people, who are naturally risk averse. Macroeconomic volatility, summarized by output volatility, is reflected disproportionately in consumption volatility for developing countries (figure 1).[2] The welfare gains from reducing consumption volatility can be substantial. Based on the approach of Athanasoulis and van Wincoop (2000), the World Bank (2000) estimates potential welfare gains of up to 5–10 percent of consumption in various Latin American countries, while these gains seldom reach 1 percent in developed economies.

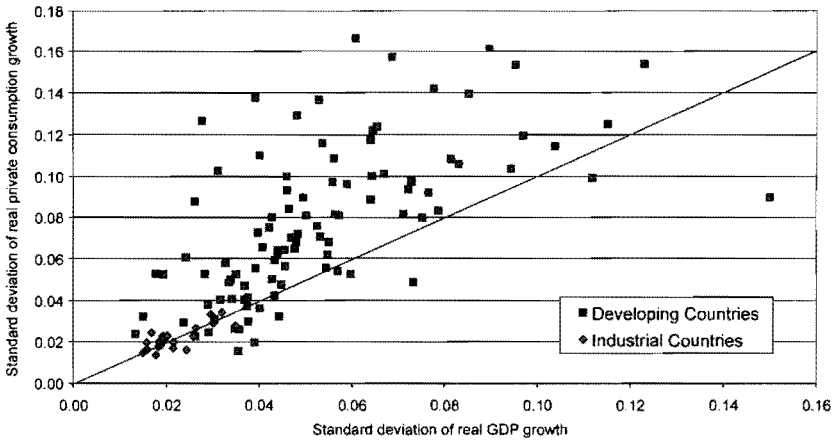
No less important, macroeconomic volatility has a negative impact on output growth and thus on future consumption (see figure 2 for a simple illustration). Volatility has this negative effect through its links with various forms of uncertainty (economic, political, and policy-related) and with the tightening of binding investment constraints (when volatility reflects large negative fluctuations). Aizenman and Pinto (2005) and Wolf (2005) review these mechanisms and the related literature.

The negative volatility–growth link was first documented empirically in Ramey and Ramey's seminal paper (1995) and further analyzed in Fatás (2002), Acemoglu and others (2003), and Hnatkovska and Loayza (2005). These studies show that volatility's indirect welfare cost through reduced economic growth is magnified in countries that are poor, financially and institutionally underdeveloped, or unable to conduct countercyclical fiscal policies. Hnatkovska and Loayza (2005) estimate that a one-standard-deviation increase in macroeconomic volatility (the difference between the output-gap variance of

1. All the papers are available on the conference website, www.cepr.org/meets/wkcn/1/1638/papers/

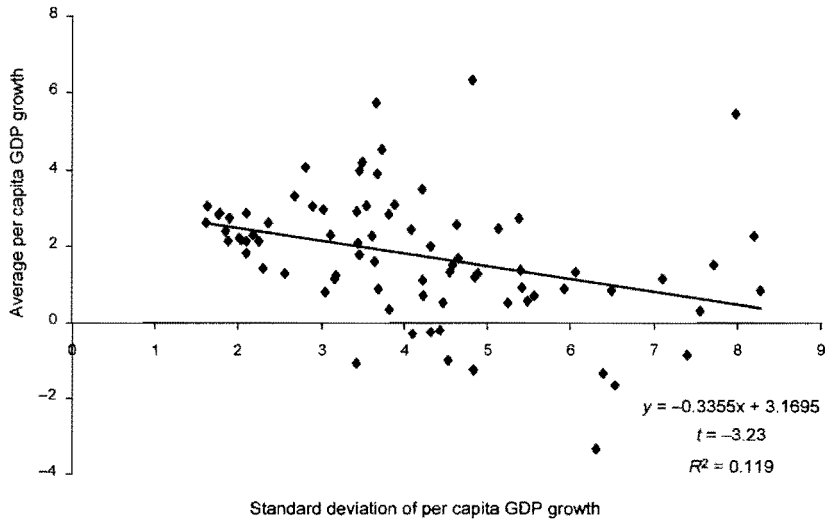
2. The factors behind this seeming "excess volatility" of consumption in developing countries are examined by Aguiar and Gopinath (2007).

FIGURE 1. Output Volatility and Consumption Volatility



Source: Authors' analysis using World Development Indicators data, cross-country sample, 1970–2001.

FIGURE 2. Macroeconomic Volatility and Economic Growth



Source: Authors' analysis using World Development Indicators data, cross-country sample, 1960–2000.

Indonesia and the United Kingdom) results in an average loss of 1.28 percentage points in annual per capita GDP growth.[3]

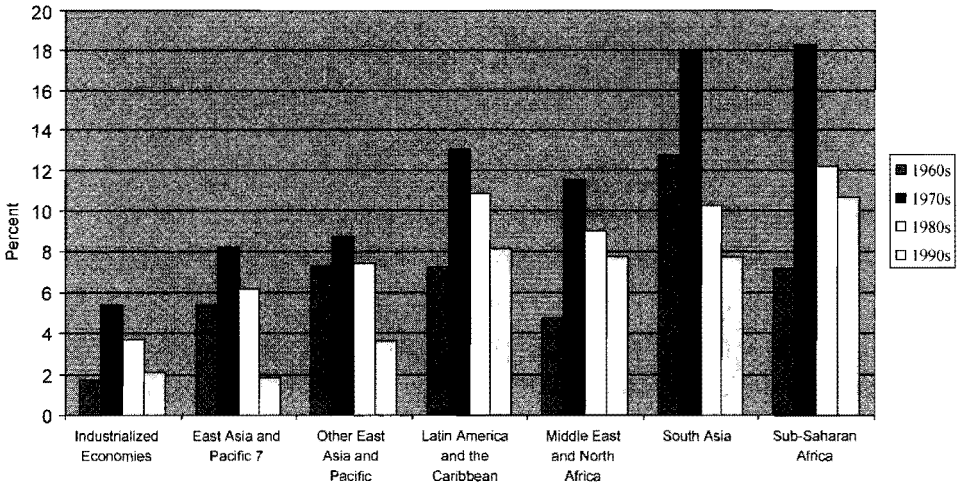
3. This estimate of the growth effect of volatility is derived from a regression model that exhibits conditional convergence: that is, as the level of per capita GDP increases, its growth rate declines, and as the level of GDP per capita decreases, its growth rate increases. So the negative effect of volatility on growth will gradually fade away as per capita GDP declines.

II. Why Are Developing Countries More Volatile?

Not only are the effects of volatility larger in developing countries but these countries also face more macroeconomic volatility than do industrial countries (see figure 1). This seems to stem from three sources. First, developing countries receive bigger exogenous shocks. These may come from financial markets in the form of "sudden stops" of capital inflows, for instance. Or they may come from goods markets, especially from abrupt and large changes in the international terms of trade. Industrial economies have consistently experienced smaller shocks in terms of trade growth (calculated as the standard deviation of the logarithmic change) over each of the four decades in 1960–2000, while developing countries in all regions except East Asia have encountered terms of trade volatility at least three times as large (figure 3).

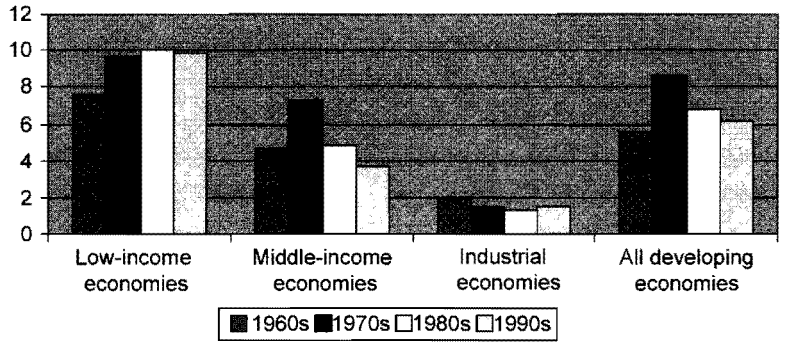
Second, developing countries seem to experience more domestic shocks, generated by the intrinsic instability of the development process and self-inflicted policy mistakes. This intrinsic instability has been studied in connection with the development of financial systems and the risk associated with new projects (Gaytán and Rancière 2006; Kharroubi 2007). It has also been studied in connection with the structure of production. Comparative advantage leads developing countries to specialize in industries that use traditional technologies operated by unskilled workers. Kraay and Ventura (2007) argue that these industries are more volatile and that this pattern of specialization can explain a substantial fraction of the difference in volatility between developed and developing countries.

FIGURE 3. Volatility of Terms of Trade Growth (regional medians)



Source: Authors' analysis using World Development Indicators data.

FIGURE 4. Volatility of Public Consumption Growth (medians by group)

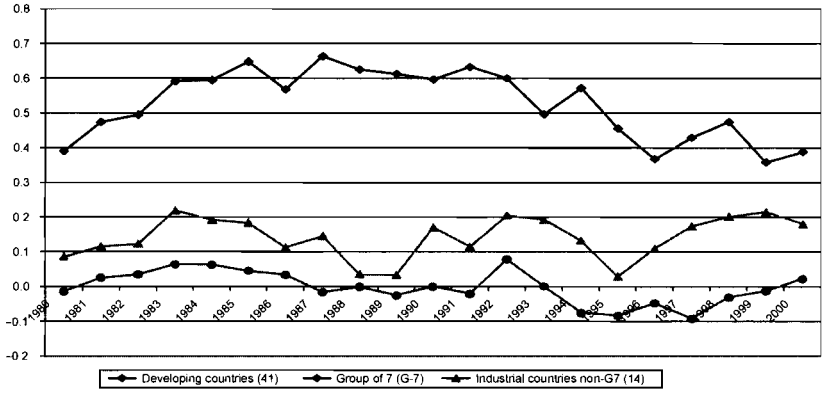


Source: Montiel and Servén 2005.

Domestic shocks also come from self-inflicted policy mistakes. Governments often instigate macroeconomic volatility by conducting erratic fiscal policy and, even worse, by financing it at times through similarly volatile inflationary monetary policy. The volatility of public consumption growth for countries at different income levels suggests that developing countries conduct more volatile fiscal policy (figure 4). Using more formal analysis, Fatás and Mihov (2006*) arrive at the same conclusion, establishing a negative connection between fiscal volatility and economic growth. More generally, Raddatz (2007) finds that in low-income countries domestically induced shocks—related to social conflict, economic mismanagement, and political instability—account for the bulk of fluctuations in GDP per capita. For this group of countries, external shocks linked to terms of trade, foreign aid, international finance, and climatic conditions contribute a significant but small portion of their overall macroeconomic volatility.

Third, developing countries have weaker "shock absorbers," so external fluctuations have larger effects on their macroeconomic volatility. The literature has traditionally identified two elements as shock absorbers: financial markets to diversify macroeconomic risk and stabilization policies to counter aggregate shocks. Both are deficient in developing countries, where financial markets are shallow, drying up in moments of crisis when they would be most useful and failing to provide adequate instruments to diversify away the risk of external shocks (World Bank 2000). And macroeconomic policies, far from providing a stabilizing force, often amplify volatility in developing countries. Fiscal policy is generally procyclical, expanding in booms and contracting in recessions (Gavin and Perotti 1997). For the typical developing country the correlation between public consumption growth and GDP growth is around 0.5, but for the Group of Seven countries it fluctuates around 0 (figure 5).

FIGURE 5. Fiscal Procyclicality: Procyclicality of Public Consumption (15-year rolling windows, group medians)



Source: Montiel and Servén 2005.

Analysis of shock absorption has traditionally focused on macroeconomic policy. More recently, however, microeconomic policy has also been found important (figure 6). The heavy microeconomic regulation in developing countries hampers adjustment to shocks by restricting the economy's ability to reallocate resources in response. (For an analysis of these mechanisms see Caballero and others 2004; Bergoeing, Loayza, and Repetto 2004). There is mounting empirical evidence that tighter barriers to microeconomic reallocation and firm dynamics boost aggregate volatility (see Loayza, Oviedo, and Servén 2005).[4]

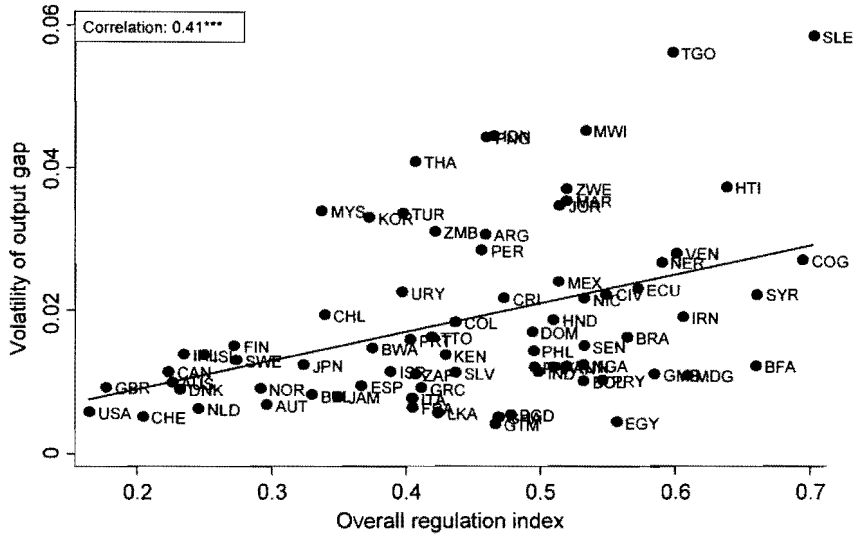
III. VOLATILITY AND CRISIS

Does the negative impact of volatility reflect the harmful effect of sharp negative fluctuations ("crisis" volatility) rather than the impact of repeated but small cyclical movements ("normal" volatility)? The literature on irreversible investment and incomplete financial markets under imperfect competition emphasizes the nonlinear effects of uncertainty and volatility on economic outcomes. Large adverse shocks contract investment, make liquidity constraints binding, and eventually lead to asset destruction (Caballero 1991; Caballero and Hammour 1994).

Hnatkovska and Loayza (2005) study the different impacts of normal and crisis volatility on economic growth. They divide the standard deviation of each country's per capita GDP growth (total volatility) into fluctuations within a

4. The overall regulation index in figure 6 encompasses a broad array of regulatory dimensions relevant to firms' economic activity: firm entry, trade, finance, contract enforcement, bankruptcy, labor, and taxation. Except for taxation, they are all highly correlated and show a similar link with macroeconomic volatility.

FIGURE 6. Microeconomic Regulation and Macroeconomic Volatility



Source: Loayza, Oviedo, and Servén 2005; cross-country sample, 1990–2000.

specified band (normal volatility) and outside it (extreme volatility).[5] Crisis volatility is the extreme volatility that corresponds to large negative fluctuations. Figure 7 illustrates this decomposition for Argentina in 1960–2005. What harms the economy's long-run performance is not the volatility due to normal fluctuations but the volatility due to crises. The effect of a one-standard-deviation increase in crisis volatility is almost twice as large as that of one in total volatility—a loss of 2.15 percentage points of per capita GDP growth.

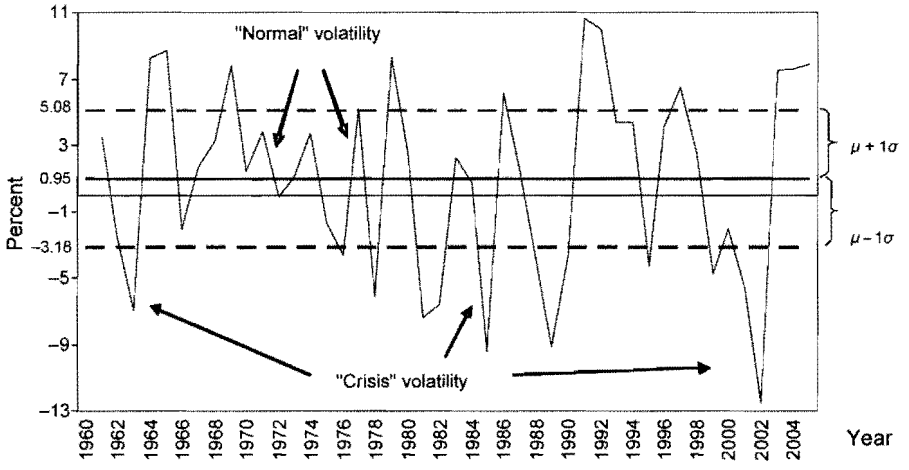
This distinction is important for macroeconomic management, particularly in developing countries where high volatility largely reflects extreme adverse outcomes. Although a majority of developing countries saw a decline in total volatility in the 1990s, Montiel and Servén (2005) report the worrisome trend that crisis volatility increased in the 1980s and further in the 1990s (figure 8). The high incidence of extreme events across the developing world in the 1990s—growth collapses, sudden capital stops, banking crises, exchange rate crashes—was doubtless behind this trend.

IV. MANAGING MACROECONOMIC VOLATILITY

The three main sources of macroeconomic volatility just outlined suggest the need for a three-part strategy to manage it. The first part of such a strategy is

5. The band is the country's mean GDP growth rate plus or minus the world mean of standard deviations of GDP growth. Thus the width of the band is common to all countries, which promotes cross-country comparability. The results are robust to changes in the common width of the band.

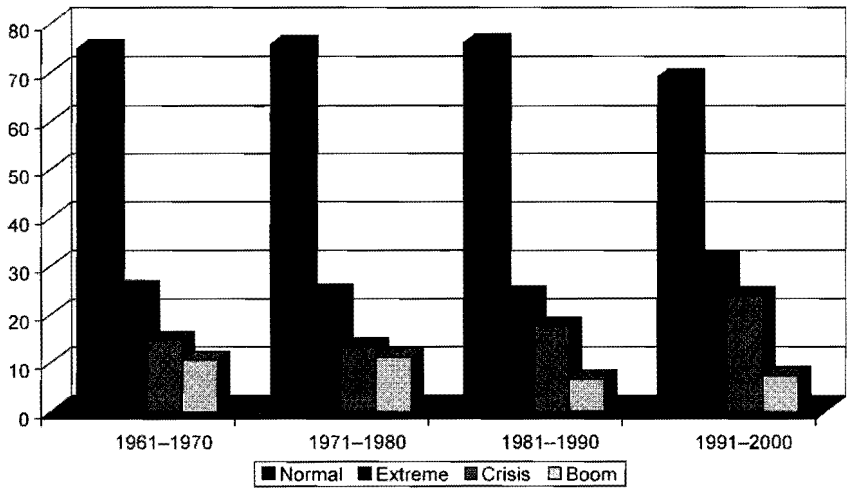
FIGURE 7. Normal and Crisis Volatility: Argentina, 1960–2005 (GDP per capita growth rate)



Note: where σ is the worldwide average of standard deviations of per capita GDP growth rates.

Source: Hnatkovska and Loayza 2005.

FIGURE 8. Normal and Extreme GDP Growth Volatility (percentage of total volatility, average of 77 developing countries)



Source: Montiel and Servén 2005.

to reduce domestic policy-induced macroeconomic volatility by controlling the level and variability of fiscal expenditures, by keeping inflation low and stable, and by avoiding price rigidity (including that of the exchange rate), which eventually leads to drastic adjustments. The best way to ensure these outcomes is to develop institutions that can support them. An autonomous central bank

has proved very successful in managing monetary policy, controlling inflation, and inducing fiscal discipline; indeed, many countries around the world have adopted one for these purposes. Similarly, some countries are implementing fiscal rules and programs that tie fiscal policy more to the country's long-run needs and reduce the scope for discretionary policy, a major source of aggregate volatility (Fatás and Mihov 2006*).

The second part of the strategy is to strengthen the economy's shock absorbers. The ability to conduct countercyclical fiscal policies is crucial, and it depends largely on the ability of the authorities to reduce public indebtedness to internationally acceptable levels, establish a record of saving in good times to provide for bad times, and develop credibility that forestalls perceptions of wasteful spending and default risk. But the financial sector has the greatest potential as a shock absorber. To enhance its effectiveness, both its volume of intermediation and variety of risk-diversification instruments must expand significantly. A precondition for financial depth is reducing intrinsic fragilities in the financial system, particularly those from mismatches in banking assets and liabilities.

Governments can reduce financial fragilities and deepen financial markets by eliminating implicit insurance schemes (such as fixed exchange rate regimes) and credit restrictions that distort the valuation of financial assets and liabilities. They can also protect creditor and shareholder rights in the law and its judicial implementation. Firms and other microeconomic agents should have the flexibility to adjust to shocks through reallocating resources across production plants, geographic areas, and economic sectors. Competition and trade provide the incentives and mechanisms for such reallocations. And governments can facilitate reallocation by reducing the burden of regulations, limiting bureaucratic requirements, and streamlining its own operations.

The third part of the strategy is to manage external shocks. Following Ehrlich–Becker's (1972) classic "comprehensive insurance" framework, three possible options can be identified:

- Self-protection (reducing the exposure to risk through, for instance, limited trade and financial openness).
- Self-insurance (transferring resources across time through, for example, accumulating foreign reserves during tranquil times).
- Full hedging and insurance (transferring resources across "states of nature" through, say, securing contingent credit lines or trading commodity-linked options).

Self-protection has potentially large efficiency costs because it may prevent the economy from accruing the static and dynamic advantages of global integration. Moreover, closing the economy to external trade or financial flows may increase the likelihood of policy-induced distortions that eventually result in large domestic shocks.

Self-insurance seems the most popular option among developing countries. Many have simple commodity-stabilization funds and are accumulating massive foreign reserves to smooth terms-of-trade shocks and reversals (sudden stops) in capital-account flows. Indeed, the ratio of foreign reserves to imports has more than doubled in emerging market economies over the last 15 years. Self-insurance is certainly better than the extremes of isolation or no protection, and it seems to reduce the economy's vulnerability to external disturbances (see Aizenman 2006; García and Soto 2006). But liquidity hoarding, with its large opportunity cost in forgone investment, is clearly less effective than hedging through contingent financial instruments. In the world's current state of financial development perfect hedging is not available to developing countries. Financial markets do, however, provide some hedging opportunities preferable to self-insurance. For sudden capital stops, Caballero and Panageas (2006) show that using derivatives linked to the volatility of mature stock markets or to commodity prices can be a big improvement over accumulating foreign reserves.

V. Lessons from the 2006 Barcelona Conference

The papers for the conference cover a broad range of issues related to volatility, growth, and welfare. This section reviews their contributions to the four questions just discussed.

The Welfare and Growth Costs of Fluctuations

In an influential set of lectures Lucas (1987) argued that the costs of fluctuations are small. An important strand of the literature has questioned this finding, however, and Reis (2006*) adds to this discussion more refined calculations of these costs.[6] Lucas's calculations assume that consumption shocks are serially uncorrelated, a convenient but empirically untenable assumption: in the United States lagged consumption shocks account for 84 percent of the variability of current consumption. Reis shows that taking this high persistence into account can bring the welfare costs of fluctuations up to 5 percent of per capita consumption, or about 100 times more than the estimates of Lucas (1987).[7] Using a consumption and savings model, Reis also points out that an increase in precautionary savings and a reduction in risky investment provide supplemental channels for fluctuations to reduce welfare. Although Reis's model has been calibrated using the U.S. economy, it seems likely that the welfare costs of fluctuations will be even larger in developing economies where shocks, according to Calderon and Fuentes (2006*), are much more persistent.

Reis's calculations might even underestimate the welfare costs of volatility, because they consider only the effects of aggregate volatility, assuming no

6. The asterisk (*) indicates papers associated with the Barcelona conference.

7. See also van Wincoop (1999) for an analysis of the role of persistence in this context.

idiosyncratic (individual or household) volatility, which has also increased substantially in the United States in the last decade. Primiceri and van Rens (2006*) explore the source of this increase by examining the consumption behavior of a large panel of individuals, finding that their behavior is consistent with an increase in the persistence of individual income shocks. When hit by a shock, individuals understand that it is likely to be permanent and so adjust their consumption.

An important related issue is the connection between aggregate and idiosyncratic volatility. Comin and Mulani (2006*) analyze the effects of firm volatility on aggregate volatility and the converse. Somewhat surprisingly, they show that increases in firm volatility are positively associated with research and development spending and that increases in that spending reduce aggregate volatility.

Why Are Developing Countries More Volatile?

Loayza and Raddatz (2007*) analyze how financial openness and trade openness, as well as product-market flexibility, factor-market flexibility, and domestic financial development, influence the impact of terms of trade shocks on output. Using semistructural vector autoregressions on a panel of countries, they find that financial openness and labor market flexibility appear to mitigate the consequences of external shocks. In contrast, they find that trade openness magnifies the output consequences of terms-of-trade shocks, particularly when domestic financial markets are not well developed. These findings are consistent with the theoretical results of Broner and Ventura (2006*), who, in a model of endogenously incomplete markets, study how trade integration can lead to financial instability. They show that trade integration can have different effects depending on domestic financial markets. If those markets are deep, trade integration allows for better risk-sharing, thus raising welfare. If they are thin, trade integration destroys risk-sharing and lowers welfare.

Tackling this issue empirically, Giovanni and Levchenko (2006*) find that countries more open to trade tend to be more volatile. They argue that this is the outcome of counteracting forces. Two mechanisms lead to a positive relationship: traded sectors are more volatile than nontraded ones, and trade leads to specialization in fewer sectors. But traded sectors are less correlated with the rest of the economy and so can act as hedging activities.

The arguments and evidence in the foregoing papers might seem to contradict the notion of trade openness as shock absorber, as proposed by Martin and Rey (2006) and Cavallo and Frankel (2004) for financial shocks. The issue is not settled, awaiting more research on the role of openness in macroeconomic volatility.

Two additional papers provide further insight into the relationship between development and volatility. Koren and Tenreyro (2006*) argue with substantial empirical evidence that as development proceeds, countries choose technologies that are more resilient to shocks and thus allow for lower aggregate volatility.

Kharroubi (2007*) proposes an explanation for the negative relationship between growth and volatility observed in developing countries based on the shortcomings of their financial systems. Moral hazard generates a bias toward short-term debt contracts, increasing the risk of liquidity crises and macroeconomic volatility. Kharroubi develops a theoretical model and provides some empirical evidence supporting his proposed mechanism.

Volatility and Crises

Gaytán and Rancière (2006*) propose a theoretical explanation for the more frequent banking crises in middle-income countries, along with larger benefits from financial intermediation. Banks choose to be either covered from or exposed to crises. Covered banks tend to hold excess liquidity but are crisis proof, while exposed banks are less constrained in their investments but can face severe losses in crises. The conclusion of the paper is that banks in middle-income countries have more incentives than those in low- and high-income countries to remain exposed to crises. So the higher propensity for crises in developing countries may reflect an optimal development strategy.

Lorenzoni (2006*) develops a theory of credit booms and financial fragility in credit-constrained economies, with two useful conclusions. First, as in Gaytán and Rancière (2006*), some degree of financial fragility can be optimal and should not be avoided. Second, agents in general do not fully internalize the aggregate consequences of excessive borrowing, and this creates room for welfare-improving prudential regulation.

Managing Macroeconomic Volatility

Fatás and Mihov (2006*) show that policy volatility exerts a first-order negative impact on long-term economic growth, even controlling for the institutional framework. To obtain their measure of policy volatility, the authors construct a measure of exogenous policy decisions unrelated to the state of the economy and take the standard deviation of this measure as a proxy for policy volatility.

One limitation in Fatás and Mihov (2006*) analysis is that their estimates are reduced form, so the transmission mechanisms from volatility to growth remain unspecified. In contrast, the other papers reviewed here focus on specific interactions between institutions, policies, volatility, and growth. Galindo and Micco (2007*) find that bankruptcy law is an important determinant of credit access and macroeconomic volatility. They find that higher legal protection for creditors significantly reduces credit volatility and the potential impact of exogenous shocks. Aghion and others (2006*) offer empirical evidence that exchange rate volatility generally reduces growth for countries with relatively low financial development but that there is no significant effect for financially advanced countries. Therefore, growth considerations are largely irrelevant for the choice of an exchange rate regime for financially developed economies but quite important for developing countries.

Prati and Tressel (2006*) present evidence that foreign aid volatility increases trade balance volatility and depresses exports through a Dutch-disease mechanism. They argue that these effects could be mitigated by actively managing the central bank's net domestic assets. Levchenko and Mauro (2007*), concerned with the detrimental effects of sudden stops, show that countries with a more diversified portfolio of foreign liabilities and a higher share of foreign direct investment tend to fare better during capital-flow reversals.

To conclude, a comprehensive theoretical and empirical analysis of the intricate connection between volatility and welfare tailored to all the key features of developing countries is still missing. Even so, the literature and the lessons from the Barcelona conference reviewed here can provide some elements of sensible policy recommendations and identify areas where research is especially needed.

Funding

This paper was funded in part by the Development Economics Vice-presidency of the World Bank.

References

Acemoglu, D., S. Johnson, J.A. Robinson, and Y. Thaicharoen. 2003. "Institutional Causes, Macroeconomics Symptoms: Volatility, Crises, and Growth." *Journal of Monetary Economics* 50(1):49–122.

Aghion, P., P. Bacchetta, R. Ranciere, and K. Rogoff. 2006. "Exchange Rate Volatility and Productivity Growth: The Role of Financial Development." Discussion Paper 5629. Centre for Economic Policy Research, London, United Kingdom.

Aguiar, G., and M. Gopinath. 2007. "Emerging Market Business Cycles: The Cycle is the Trend." *Journal of Political Economy* 115(1):69–102.

Aizenman, J. 2006. "International Reserves Management and the Current Account." University of California, Santa Cruz, Department of Economics. Santa Cruz, Calif.

Aizenman, J., and B. Pinto. 2005. "Overview" In J. Aizenmann and B. Pinto, eds., *Managing Economic Volatility and Crises*. Cambridge, United Kingdom: Cambridge University Press.

Athanasoulis, S., and E. van Wincoop. 2000. "Growth Uncertainty and Risk-Sharing." *Journal of Monetary Economics* 45(3):477–505.

Bergoeing, R., N. Loayza, and A. Repetto. 2004. "Slow Recoveries." *Journal of Development Economics* 75(2):403–506.

Broner, F., and J. Ventura. 2006. "Globalization and Risk Sharing." Discussion Paper 5820. Centre for Economic Policy Research, London, United Kingdom.

Caballero, R. 1991. "On the Sign of the Investment-Uncertainty Relationship." *American Economic Review* 81(1):279–88.

Caballero, R., K. Cowan, E. Engel, and A. Micco. 2004. *Effective Labor Regulation and Microeconomic Flexibility*. Working Paper 10744. Cambridge, Mass.: National Bureau of Economic Research.

Caballero, R., and M. Hammour. 1994. "The Cleansing Effect of Recessions." *American Economic Review* 84(5):1350–68.

Caballero, R., and S. Panageas. August 4, 2006. "Hedging Sudden Stops and Precautionary Contractions." *Journal of Development Economics*, doi:10.1016/j.jdeveco.2006.05.010.

Calderón, C., and R. Fuentes. 2006. "Characterizing the Business Cycles of Emerging Economies." Centre for Economic Policy Research, London, United Kingdom.

Cavallo, E., and J. Frankel. 2004. *Does Openness to Trade Make Countries More Vulnerable to Sudden Stops, or Less?* Working Paper 10957. Cambridge, Mass.: National Bureau of Economic Research.

Comin, D., and S. Mulani. 2006. "A Theory of Growth and Volatility at the Aggregate and Firm Level." New York University, Department of Economics. New York, New York.

Ehrlich, I., and G. Becker. 1972. "Market Insurance, Self-Insurance, and Self-Protection." *Journal of Political Economy* 80:623–48.

Fatás, A. 2002. "The Effects of Business Cycles on Growth." In N. Loayza and R. Soto, eds., *Economic Growth: Sources, Trends, and Cycles.* Santiago, Chile: Central Bank of Chile.

Fatás, A., and I. Mihov. 2006. "Policy Volatility, Institutions and Economic Growth." INSEAD. Singapore and Fontainebleau, France.

Galindo, A., and A. Micco. Forthcoming. "Creditor Protection and Credit Volatility." *World Bank Economic Review*, doi:10.1093/wber/lhm016.

García, P., and C. Soto. 2006. "Large Hoardings of International Reserves: Are They Worth It?" In R. Caballero, C. Caldern, and L. F. Cspedes eds. *External Vulnerability and Preventive Policies.* Santiago, Chile: Central Bank of Chile.

Gavin, M., and R. Perotti. 1997. "Fiscal Policy in Latin America." In NBER Macroeconomics Annual. Cambridge, Mass.: MIT Press.

Gaytán, A., and R. Rancire. 2006. "Banks, Liquidity Crises, and Economic Growth." International Monetary Fund, Washington, D.C.

Giovanni, J., and A. Levchenko. 2006. "Openness, Volatility and the Risk Content of Exports." International Monetary Fund, Washington, D.C.

Hnatkovska, V., and N. Loayza. 2005. "Volatility and Growth." In J. Aizenmann and B. Pinto, eds., *Managing Economic Volatility and Crises.* Cambridge, United Kingdom: Cambridge University Press.

Kharroubi, E. Forthcoming. "Illiquidity, Financial Development and the Growth-Volatility Relationship." *World Bank Economic Review*, doi:10.1093/wber/lhm015.

Koren, M., and S. Tenreyro. 2006. "Technological Diversification." London School of Economics and Political Science, London, United Kingdom.

Kraay, A., and J. Ventura. 2007. "Comparative Advantage and the Cross-Section of Business Cycles." *Journal of the European Economic Association* 5(6).

Levchenko, A., and P. Mauro. September 17, 2007. "Do Some Forms of Financial Flows Help Protect against Sudden Stops." *World Bank Economic Review*, doi:10.1093/wber/lhm014.

Loayza, N., A.M. Oviedo, and L. Serven. 2005. "Regulation and Macroeconomic Performance." Policy Research Working Paper 3469. World Bank, Washington, D.C.

Loayza, N., and C. Raddatz. Forthcoming. "The Structural Determinants of External Vulnerability." *World Bank Economic Review*, doi:10.1093/wber/lhm018.

Lorenzoni, G. 2006. "Inefficient Credit Booms." Massachusetts Institute of Technology, Cambridge, Mass.

Lucas, R. E., Jr. 1987. *Models of Business Cycles.* New York: Basil Blackwell.

Martin, P., and H. Rey. 2006. "Globalization and Emerging Markets: With or Without Crash?" *American Economic Review* 96(5):1631–51.

Montiel, P., and L. Servn. 2005. "Macroeconomic Stability: The More, the Better?" In *Economic Growth in the 1990s: Lessons from a Decade of Reform.* Washington, D.C.: World Bank.

Prati, A., and T. Tressel. 2006. "Aid Volatility and Dutch Disease: Is There a Role for Macroeconomic Policies?" International Monetary Fund, Washington, D.C.

Primiceri, G., and T. Rens. 2006. "Predictable Life-Cycle Shocks, Income Risk and Consumption Inequality." Universitat Pompeu Fabra, Barcelona, Spain.

Raddatz, C. 2007. "Are External Shocks Responsible for the Instability of Output in Low-Income Countries?" *Journal of Development Economics* 84(1):155–87.

Ramey, G., and V. Ramey. 1995. "Cross Country Evidence on the Link between Volatility and Growth." *American Economic Review* 85(5):1138–51.

Reis, R. 2006. "The Time-series Properties of Aggregate Consumption: Implications for the Costs of Fluctuations." Princeton University, Department of Economics, Princeton, New Jersey.

Van Wincoop, E. 1999. "How Big are the Potential Welfare Gains from International Risk Sharing?" *Journal of International Economics* 47(1):109–35.

World Bank. 2000. *Securing Our Future in a Global Economy.* Washington, D.C.

———. various years. World Development Indicators Database. Washington, D.C. (www.worldbank.org/data).

Wolf, H. 2005. "Volatility: Definitions and Consequences." In J. Aizenman and B. Pinto, eds. *Managing Economic Volatility and Crises.* Cambridge, Mass.: Cambridge University Press.

The Structural Determinants of External Vulnerability

Norman V. Loayza and Claudio Raddatz

This article examines empirically how domestic structural characteristics related to openness and product- and factor-market flexibility influence the impact of terms of trade shocks on aggregate output. Applying semistructural vector autoregressions to a panel of 88 countries with annual observations for the period 1974–2000, the analysis isolates and standardizes the shocks, estimates their impact on GDP, and examines how this impact depends on the domestic conditions outlined above. The article finds that greater trade openness magnifies the output impact of terms of trade shocks, particularly negative ones, while financial openness reduces their impact. Flexibility of labor and firm-entry are beneficial, with labor flexibility dampening the impact of negative shocks and ease of firm-entry magnifying positive ones only. Domestic financial depth has a more nuanced role in stabilizing the economy. Analysis of interactions across structural determinants reveals complementarities among macroeconomic conditions (trade and financial openness and depth) and, separately, among microeconomic conditions (flexibility of labor markets and ease of firm-entry). Variables across these groups tend to behave as substitutes for each other. JEL codes: F36, F41, F43.

Macroeconomic volatility is not only a source of business cycle uncertainty but also a major cause of low economic growth. Ramey and Ramey (1995) were the first to document this finding for a cross-section of countries. Fatás (2002) and Hnatkovska and Loayza (2005) show that macroeconomic volatility is particularly harmful for developing countries, where volatility is higher and its impact more pronounced.

Among the causes of macroeconomic volatility, fluctuations in the terms of trade are important sources of external shocks. Across countries about 10

Norman V. Loayza (corresponding author) is a lead economist at the World Bank; his email address is nloayza@worldbank.org. Claudio Raddatz is an economist at the World Bank; his email address is craddatz@worldbank.org. The paper on which this article was based was prepared for the conference "The Growth and Welfare Effects of Macroeconomic Volatility" (Barcelona, 17–18 March 2006), sponsored by the World Bank and Pompeu Fabra University, Barcelona. The authors thank Paolo Mauro (discussant); Luis Servén; Romain Ranciere and Jaume Ventura (conference organizers); other conference participants; the journal editor; and three anonymous referees for useful comments. They are grateful to Koichi Kume and Naotaka Sugawara for editorial assistance.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 359–387 doi:10.1093/wber/lhm018
Advance Access Publication 4 October 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

percent of the variation in GDP growth and about 25 percent of the variation in growth volatility can be explained by observed differences in the volatility of terms of trade changes (see Easterly and others 1993; Hnatkovska and Loayza 2005). Terms of trade shocks have also been documented to have a significant impact on GDP within countries (see Ahmed 2003; Raddatz 2007), although their preeminence over domestic shocks is subject to debate.[1]

Going beyond the average impact of external shocks, there is a rich literature suggesting that the impact of an external shock on the real side of the economy may be determined by domestic conditions interacting with the shock to produce macroeconomic stability or volatility. Traditional analysis of the domestic sources of vulnerability has stressed macroeconomic policy responses in monetary, foreign exchange, and fiscal areas. A recent example is Broda (2001), who compares the stabilizing properties of different exchange rate regimes in the face of terms of trade shocks. New developments in the study of vulnerability have concentrated on the role of structural characteristics related to the functioning of markets and institutions. Some studies stress the role of factor and product market rigidities in amplifying shocks at the macroeconomic level (see, for example, Kiyotaki and Moore 1997; Bernanke and Gertler 1989; Caballero and Hamour 1994, 1996, 1998; Caballero and Krishnamurty 2001). Others, such as Acemoglu and others (2003) and Rodrik (1999), point to the relevance of institutional development in the control of crises and management of shocks.[2]

Notwithstanding these contributions, the extent to which domestic structural characteristics can account for the relative instability of aggregate output remains an open question. This article contributes to this literature by examining how certain domestic structural characteristics influence the impact that external shocks may have on aggregate output. The broad issue is whether a country's vulnerability to shocks is not purely random but linked to structural characteristics that are at least partially policy driven: trade openness, financial depth, capital account openness, labor market flexibility, and ease of firm-entry. Not deep institutional variables, these are outcomes through which fundamentals operate. The purpose in using structural outcome variables is to separate and elucidate the mechanisms that drive external vulnerability.

For analysis two aspects of output vulnerability to external shocks can be distinguished: the frequency and strength of shocks affecting a country and the effect that a shock of a given size and frequency can have on the country's output. This article examines the second aspect, applying an econometric method that, using a panel sample of 88 countries and annual observations for 1974–2000, isolates

1. Mendoza (1995) and Kose and Riezman (2001), using calibrated small open economy models, find terms of trade shocks to account for almost half of economic fluctuations. Hoffmaister, Roldós, and Wickham (1998), Ahmed (2003), and Raddatz (2007), among others, using time-series analysis, find that external shocks explain a much smaller fraction of output volatility (around 20 percent).

2. Another strand of the literature takes one step back and focuses on explaining the business-cycle behavior of the terms of trade. For instance, Kraay and Ventura (forthcoming) link movements in the terms of trade to countries' endowments and resulting industrial structure.

and standardizes the shocks, estimates their impact on GDP, and examines how this impact depends on the domestic conditions outlined above.[3]

From an empirical perspective, the relevant question is whether the differential impact of a given external shock is related to country characteristics. Controlling for the size of the shocks is not easy. Most of the recent literature has relied on either indirect evidence from difference-in-difference estimation (see, for example, Braun and Larrain 2005; Caballero and others 2005; Raddatz 2006) or calibrated macroeconomic models developed to match certain moments of developing countries' economic performance (for a survey, see Arellano and Mendoza 2002).

This article takes a different approach and directly estimates the output impact of external shocks using semistructural vector autoregression analysis, as applied to panel data (cross-country, time-series) of aggregate variables. This method requires the identification assumption that the relevant external variable—the change in the terms of trade—does not respond to domestic output changes or the variables that account for the country's structural characteristics. In practice, this rather uncontroversial assumption amounts to a small open economy condition for the countries included in the analysis. Similar applications of this methodology can be found in Broda (2004), Ahmed (2003), Uribe and Yue (2003), and Raddatz (2007). Controlling for the size of the shock, the analysis accounts for its interaction with the set of country characteristics under analysis and estimates its conditional output impact.

Section I presents the econometric method in detail and the specification tests. Section II introduces the data, the variable definitions and sources, and the sample of countries and years under analysis. Section III presents the empirical results, including the discussion of symmetric and asymmetric effects, the potential interaction between structural characteristics, and a set of robustness checks.

I. Methodology

The impact of exogenous shocks on a country's economic performance and its relation to the country's structural characteristics are estimated using a panel vector autoregression. To minimize the need for identification assumptions (see below), the focus is exclusively on terms of trade shocks. Therefore, for a given country i the semistructural model corresponds to:

$$A_{i,0}x_{i,t} = \sum_{j=1}^{q} A_{i,j}x_{i,t-j} + \varepsilon_{it} \quad (1)$$

3. An analogy illustrates these ideas. How vulnerable people are to disease depends on the seriousness of the disease itself (first aspect) and how well prepared they are to bear a given disease (second aspect). Analyzing the second aspect requires examining how people facing the same disease (in type and strength) react, to shed light on why some people suffer so much from an attack of, say, the flu, while others remain unscathed.

where $x_{i,t} = (\Delta tt_{i,t}, \Delta y_{i,t})'$ is a vector that contains the first difference of the log of terms of trade index ($\Delta tt_{i,t}$) and the log of real GDP per capita ($\Delta y_{i,t}$), both as deviations from their country-specific means.[4] The matrices $A_{i,j}$ contain the structural coefficients for the different lags incorporated in the model (including the contemporaneous one). The structural errors $\varepsilon_{i,t}$ are independent and identically distributed, with zero mean and a diagonal variance–covariance matrix Σ.

The identification assumption applied is that terms of trade changes are strictly exogenous for a given country—$\Delta\ tt_{i,t}$ does not respond to $\Delta y_{i,t}$ at any lags. This assumption is equivalent to imposing the following triangular structure on all the A matrices:

$$A_{i,j} = \begin{bmatrix} a^{i,j}{}_{11} & 0 \\ a^{i,j}{}_{21} & a^{i,j}{}_{22} \end{bmatrix}. \tag{2}$$

For the developing and small developed countries in this study this assumption should be uncontroversial. In fact, for the sample of countries included in this study a standard Granger causality test cannot reject the hypothesis that output fluctuations do not Granger-cause terms of trade fluctuations.[5]

The relatively weak assumption required to identify the impact of terms of trade shock is the reason for focusing exclusively on these shocks. It is preferable to focus on a reduced set of shocks that can be clearly identified than on a broader set of shocks that would require strong and controversial identification assumptions. This means, however, that the results have to be interpreted with caution. Since the model does not account for all exogenous sources of fluctuations, it is semistructural. The terms of trade variable captures all strictly exogenous variables whose fluctuations are correlated with those of the terms of trade. Therefore, statements on the effects of different structural characteristics on the amplification or dampening of shocks apply directly to terms of trade shocks and indirectly to other exogenous contingencies that are correlated with these shocks, such as the world business cycle.

The baseline model corresponds to a panel vector autoregression in which part of the coefficients in the A matrices are assumed to be common across cross-sectional units. Of interest is testing how different structural characteristics of a country affect the impact of terms of trade shocks on output, as captured by the $a^{i,j}_{21}$ coefficients, so these coefficients are permitted to vary across countries according to the specific characteristics whose role is to be determined.

4. Of course, this is equivalent to including a country fixed effect in the vector autoregression.

5. When performed on a country by country basis, the test cannot reject the null hypothesis in 72 of the 88 cases. The results are not materially affected by excluding the 16 countries in which the hypothesis is rejected that terms of trade are not Granger-caused by output. The countries are Canada, Chile, Greece, India, Ireland, Jamaica, Kenya, Lesotho, Mali, Malaysia, Niger, Papua New Guinea, Senegal, Singapore, Togo, and Thailand.

In particular, it is assumed that

$$a_{21}^{i,j} = \beta_0^j + \beta_1^j \times \text{OPEN}_i + \beta_2^j \times \text{FDEV}_i + \beta_3^j \times \text{CAOPEN}_i + \beta_4^j \times \text{LABOR}_i + \beta_5^j \times \text{ENTRY}_i \quad (3)$$

where OPEN_i, FDEV_i, CAOPEN_i, LABOR_i, and ENTRY_i are measures of trade openness, financial development, capital account openness, labor flexibility, and ease of firm-entry for country i, respectively (described below). The analysis will also allow for the possibility that the influence of these characteristics on the transmission of terms of trade shocks may differ for increases and decreases in log terms of trade (with respect to the mean change). For the notation above, this corresponds to allowing the β^j coefficients to vary with the state of the terms of trade in the following way:

$$\beta = \begin{cases} \beta^+ & \text{if } \Delta tt_{i,t} > 0 \\ \beta^- & \text{otherwise} \end{cases}$$

where $\beta = (\beta^0, \ldots, \beta^j, \ldots, \beta^q)$, $\beta^j = (\beta_0^j, \ldots, \beta_5^j)$, and β^+ and β^- are similarly defined. The remaining of the coefficients that capture the dynamics of the terms of trade ($a_{11}^{i,j}$) and the lagged effect of output on itself ($a_{22}^{i,j}$) are restricted to be the same for all countries.

The use of panel vector autoregressions, with the corresponding restrictions on the parameters, is common in the recent literature estimating the impact of exogenous shocks on macroeconomic variables (Broda 2004; Ahmed 2003; Uribe and Yue 2003), because the limited length of the time-series dimension of the data (around 25 annual observations) makes it difficult to estimate country-specific dynamics. Using a panel vector autoregression approach increases the degrees of freedom of the estimation, and if the common parameter restrictions are correct, provides more efficient estimators. Of course, the obvious disadvantage is that the model is incorrectly specified if these restrictions are not valid.

A concern with this approach, as Pesaran and Smith (1995) note, is that assuming common coefficients may yield parameters that underestimate the short-run impact of exogenous variables (and overestimate the long-run impact) if the dynamics differ substantially across countries. However, as Pakes and Griliches (1984) demonstrate, if differences in slope coefficients are uncorrelated with the exogenous variables, the estimated parameters would be consistent estimators of the average coefficients. This is an important result for the analysis here as there is no obvious reason why the marginal effect of terms of trade in a country should be determined by the terms of trade itself. Nevertheless, in an additional exercise (and at the cost of reduced precision of the estimates) the vector autoregression is also estimated on a country by country basis, without imposing any restriction on the dynamics. The estimated country-specific effects of the shocks are then related to the structural

TABLE 1. Unit Root Test

Variable	Augmented Dickey–Fuller by country (cannot reject unit root, percent)	Augmented Dickey–Fuller by country (cannot reject unit root, percent)	Levin–Lin–Chu *p*-value
	(1)	(2)	(3)
Log GDP per capita	72	86	0.987
Log terms of trade index	60	83	0.994

Note: Column 1 reports the percentage of the 88 countries in the sample for which the Augmented Dickey–Fuller test cannot reject the null hypothesis of a unit root when the number of lags augmenting the test is country specific, as determined by performing the Hall (1990) procedure on a country by country basis. Column 2 reports the percentage for the case where for all countries the model is augmented using the median number of lags (two) across countries. Column 3 shows the *p*-value of the Levin–Lin–Chu (2002) test for panel unit roots for the case in which the panel is augmented by two lags.

Source: Authors' analysis based on data described in text.

characteristics under study. The results prove to be very similar to those obtained with the panel methodology.

As mentioned, the variables in the vector autoregression are the first differences of the log terms of trade and output per capita. The relevant series is modeled as difference–stationary for two reasons. First, standard tests suggest the presence of a unit root in the levels of both series. Columns 1 and 2 of table 1 show the results of the Augmented Dickey–Fuller tests performed on a country by country basis for country-specific and common lag structures.[6] In most cases the test cannot reject the null hypothesis of a unit root for both series (about 85 percent of the time for both series when the median number of lags is used for all countries). The panel-based unit-root test suggested by Levin, Lin, and Chu (2002), augmented by the median number of lags across countries (two), reaches a similar conclusion: the null hypothesis of a unit root cannot be rejected. The second reason for modeling the relevant series as difference–stationary is that previous empirical papers in this literature (for example, Ahmed 2003 and Broda 2004) have done so, giving this specification the advantage of being more directly comparable with previous results.[7]

The vector autoregression specification uses two annual lags in the benchmark specification. This lag structure was determined using standard lag selection tests (Akaike information criterion, Schwartz information criterion, and Hannan–Quinn criterion).

6. The number of lags for each country was determined using the methodology of Hall (1990). The common number of lags used in column 2 corresponds to the median across countries (two lags).

7. A Pedroni (1999) panel cointegration test, not reported, does not reject the null hypothesis of no cointegration between log terms of trade and output. The different statistics derived by Pedroni tend to give different results, but most of them cannot reject the null hypothesis of no cointegration. Because the power and size tradeoff of the different tests varies with the cross-sectional and time-series dimension of the panel (see Pedroni 2004), statistics with the largest size (that tend to overreject) and highest power at short time dimensions were emphasized. Those tests, corresponding to the panel and group *t*-statistics derived by Pedroni (1999), clearly do not reject the null hypothesis of no cointegration.

Under the identification assumptions described above, the parameters of the model are estimated using a two-step procedure: the reduced-form coefficients are first estimated equation by equation by ordinary least squares (OLS); then the impulse-response functions (IRFs) are computed for each of the structural shocks (using the reduced-form coefficients and the variance–covariance matrices of the reduced-form errors derived from these coefficients). The confidence bands for the IRFs are estimated by parametric bootstrapping, assuming normally distributed reduced-form errors.[8]

II. Data

The following are the main variables used in the analysis. *Real GDP per capita*, in constant 2000 U.S. dollars was obtained from the World Development Indicators Database (World Bank 2005) This series was used instead of GDP adjusted for purchasing power parity (PPP), despite reduced international comparability, because it has more recent coverage than the measures from the Penn World Tables (Heston, Summers, and Aten 2002) and longer coverage than the PPP series produced by the World Bank.[9] The *terms of trade index* is the ratio of export prices to import prices using the current and constant price values of exports and imports from the national accounts component of the Penn World Tables version 6.1 and updated using the terms of trade data from the World Development Indicators Database (World Bank 2005).[10] To reduce concerns about structural breaks, data are for the post Bretton-Woods period, 1974–2000.

The structural characteristics of countries are captured in the following variables. *Trade openness* is measured as the log of the ratio of total trade to GDP. *Financial development* is the log of the ratio of private credit provided by banks and other financial institutions to GDP, obtained from Beck,

8. The procedure can be briefly described as follows. The estimated variance–covariance matrix of the reduced form errors is used to simulate a random realization of the perturbations. The initial values of the different variables, the baseline coefficients, and the simulated perturbations are used to simulate a new set of observations for the variables in the vector autoregression. These simulated observations are used to estimate a new set of coefficients. This exercise is repeated 500 times. The IRF is computed for each set of coefficients obtained from the bootstrapping. A 90 percent confidence interval is built for the IRF by taking the 5th and 95th percentile of the empirical distribution of the IRF on a point by point basis.

9. In a robustness check presented below using PPP-adjusted GDP, the results remain basically the same.

10. This index is used instead of the more traditional net barter index because of its broader coverage. However, this index includes the service export sector (tourism and financial services), whose prices are not measured as precisely as those of merchandise trade and are much less likely to be exogenous to domestic conditions (the main identification assumption). This is unlikely to be a problem for the average country because of the typically small relevance of the export service sector, but to address any potential concern the index was replaced by the net barter terms of trade index in cases where the correlation between these two indexes (based on the post-1980 data in which both are available) was smaller than 0.5, taken as an indication of the importance of the export service sector (21 cases, or 25 percent of the sample).

Demirgüç-Kunt, and Levine (2000) or, if unavailable from that source, from the World Development Indicators Database. *Openness* in capital account transactions is captured by the Chinn–Ito index (Chinn and Ito 2002), with a higher value indicating a higher degree of openness.[11] The *index of labor market flexibility*, calculated from data in World Bank (2003), is a weighted average of three indicators (flexibility of hiring, conditions of employment, and flexibility of firing) as in Botero and others (2004). The original index was rescaled to range from 0 to 1, with higher values indicating more flexible labor markets. Finally, the *index of ease of firm entry*, calculated from data in World Bank (2003) and O'Driscoll, Feulner, and O'Grady (2003), is a weighted average of four indicators (registration procedures, cost to register, days to register, and burden of entry regulations) as in Chang, Kaltani, and Loayza (2005). This index also ranges from 0 to 1, with higher values indicating fewer restrictions.

The sample includes 88 countries representing different regions and income levels (see appendix). Sub-Saharan Africa has the largest share in the sample, at 30 countries, followed by Latin America at 20, East Asia and Pacific at 11, the Middle East and North Africa and Western Europe at 10 each, South Asia at 4, Eastern and Central Europe at 2, and North America at 1. There are 35 low-income countries, 35 middle-income countries, and 18 high-income countries. The sample includes all countries for which measures of the structural characteristics described above and at least 15 continuous observations of both terms of trade and output per capita were available during 1974–2000. The six large industrial countries (the United States, Japan, Germany, United Kingdom, France, and Italy) are excluded because of the possible endogeneity of their terms of trade, as are five developing countries whose terms of trade data exhibited long flat periods (Cape Verde, Grenada, Nepal, St. Lucia, St. Kitts, and Nevis).

Summary statistics for these variables for each country are in the appendix. Cross-sectional univariate summary statistics and bivariate correlations for these variables are presented in tables 2 and 3, respectively. Table 3 displays the well documented positive correlations between structural characteristics and output growth and negative correlations between measures of volatility and growth. It also shows that the structural characteristics are positively correlated with each other, although the magnitudes of the correlations are not particularly large, except between financial development and ease of firm-entry, which reaches 66 percent. These relatively low correlations suggest the possibility of sorting out the role of different structural characteristics in the transmission of shocks.

11. The Chinn–Ito index corresponds to the first principal components of the following four binary variables reported in the International Monetary Fund's *Annual Report on Exchange Arrangements and Exchange Restrictions* (various issues): existence of multiple exchange rates, restrictions on current account, capital account transactions, and the existence of requirements to surrender export proceedings.

TABLE 2. Descriptive Statistics of Country Averages, 1974–2000: Univariate (variables reported in appendix)

Variable	Mean	Standard deviation	Minimum	Maximum
Average output growth (percent)	1.17	1.94	−3.35	7.35
Average terms of trade growth (percent)	−0.75	1.55	−5.99	2.57
Standard deviation output growth	4.19	1.98	1.21	10.06
Standard deviation terms of trade growth	11.82	7.57	1.00	34.08
Trade openness	3.79	0.54	2.57	5.67
Financial depth	−1.43	0.91	−4.31	0.39
Financial openness	−0.16	1.15	−1.64	2.68
Labor market flexibility	0.47	0.14	0.21	0.80
Ease of firm entry	0.65	0.15	0.22	0.94

Note: Variables are measured over the period 1974–2000. Average output growth is growth of real GDP per capita. Average terms of trade growth is the average growth of the terms of trade index. Standard deviation output growth is the standard deviation of the growth rates of real GDP per capita. Trade openness = Log (Exports + Imports)/GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0 − 1index obtained from de jure labor regulation. Ease of firm-entry is a 0 − 1 index combining information on number of procedures, monetary cost, and time to open a new firm.

Source: Authors' analysis based on data described in text.

III. RESULTS

The basic results are derived from estimating the cumulative output effect of a one standard deviation shock to the terms of trade at different levels of a particular structural characteristic. As explained, this estimation is conducted in the context of a panel (cross-country, time-series) vector autoregression with (demeaned log) GDP changes as the dependent variable and (demeaned log) terms of trade changes as the exogenous variable. The output effect of terms of trade shocks are allowed to vary with five country structural characteristics: trade openness, financial depth, financial (or capital-account) openness, labor market flexibility, and ease of firm-entry. To get a sense of how much a given structural factor contributes to amplifying or dampening the external shock, the shock's cumulative output impacts are compared at relatively low (25th) and high (75th) percentiles of the world distribution of each structural characteristic.

The cumulative effect of a one standard deviation shock in the terms of trade on the level of GDP per capita for low and high levels of each country characteristic is displayed in figure 1 and table 4. To indicate the accuracy of the estimated impacts, figure 1 also presents their 90 percent confidence bands and table 4 the corresponding (empirical) standard errors.[12] To provide a

12. Critical values and corresponding confidence intervals are obtained from the empirical distribution derived through the parametric bootstrapping procedure already described.

TABLE 3. Descriptive Statistics of Country Averages, 1974–2000: Bivariate Correlations (cross-sectional correlations between the different variables reported in appendix)

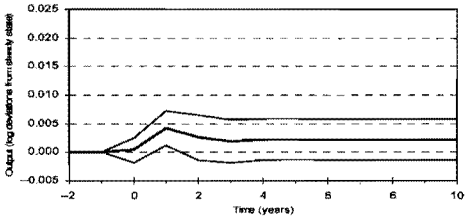
Variable	Output growth	Terms of trade growth	Standard deviation output growth	Standard deviation terms of trade growth	Trade openness	Financial depth	Financial openness	Labor market flexibility	Ease of firm-entry
Output growth	1.00								
Terms of trade growth	0.20	1.00							
Standard deviation output growth	−0.41	−0.13	1.00						
Standard deviation terms of trade growth	−0.57	−0.12	0.55	1.00					
Trade openness	0.25	−0.03	−0.13	−0.29	1.00				
Financial depth	0.52	0.30	−0.49	−0.65	0.32	1.00			
Financial openness	0.25	0.27	−0.33	−0.47	0.35	0.56	1.00		
Labor market flexibility	0.31	0.09	−0.32	−0.29	0.45	0.31	0.28	1.00	
Ease of firm entry	0.45	0.28	−0.46	−0.60	0.40	0.66	0.51	0.56	1.00

Note: Variables are measured over the period 1974–2000. Average output growth is growth of real GDP per capita. Average terms of trade growth is the average growth of the terms of trade index. Standard deviation output growth is the standard deviation of the growth rates of real GDP per capita. Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0 − 1index obtained from de jure labor regulation. Ease of firm-entry is a 0 − 1 index combining information on number of procedures, monetary cost, and time to open a new firm.

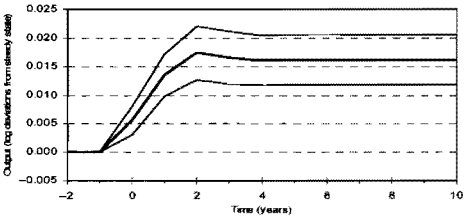
Source: Authors' analysis based on data described in text.

FIGURE 1. Cumulative Output Impact of Terms of Trade Shock: Symmetric Case

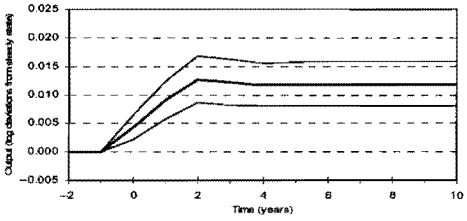
Low trade openness



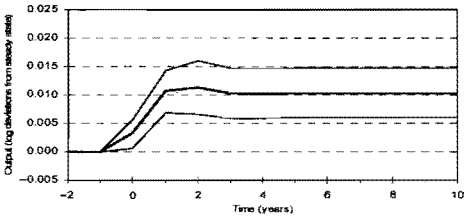
High trade openness



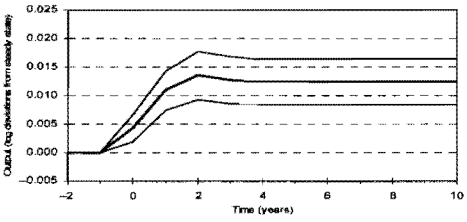
Low financial depth



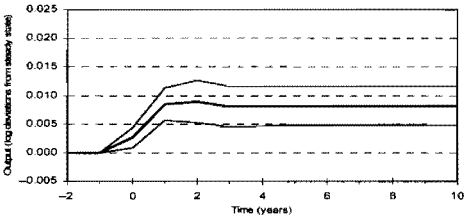
High financial depth



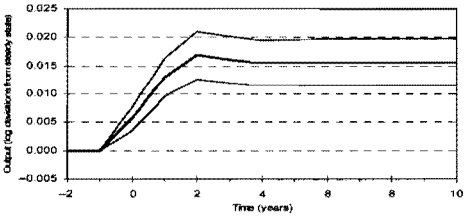
Low financial openness



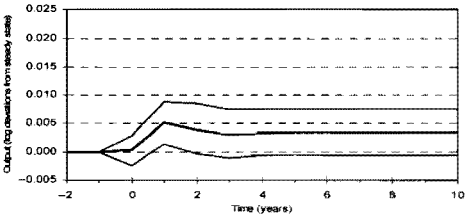
High financial openness



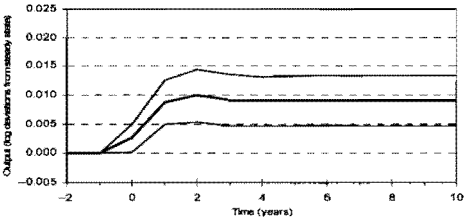
Low labor market flexibility



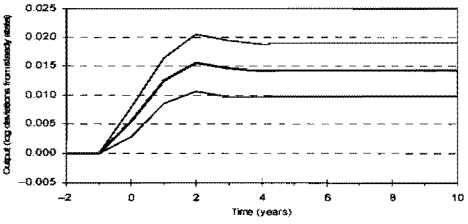
High labor market flexibility



Low ease of firm entry



High ease of firm entry



Note: See table 2 for definitions of variables. Bands are 90 percent confidence intervals.
Source: Author's analysis based on data described in text.

TABLE 4. Basic Results under Symmetric Analysis: Cumulative Output Impact of a One Standard Deviation Terms of Trade Shock for Low and High Values of Five Structural Characteristics (percent of GDP)

	Trade openness	Financial depth	Financial openness	Labor market flexibility	Ease of firm-entry
Low value	0.227	1.178	1.250	1.569	0.908
(25th percentile)[a]	(0.222)	(0.234)	(0.244)	(0.240)	(0.262)
High value	1.609	1.032	0.819	0.338	1.430
(75th percentile)[a]	(0.266)	(0.265)	(0.207)	(0.260)	(0.281)
Difference	1.382	−0.147	−0.430	−1.231	0.523
	(0.308)	(0.312)	(0.236)	(0.297)	(0.373)
Test Ho:Diff. = 0 (one-tail)	**		**	**	*

*Significant at the 10 percent level; **significant at the 5 percent level.

Note: Numbers is parentheses are standard errors. Critical values are obtained from empirical distribution (which may have non-Gaussian properties). Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0−1index obtained from de jure labor regulation. Ease of firm entry is a 0 − 1 index combining information on number of procedures, monetary cost, and time to open a new firm.

[a]Percentiles of the world distribution of the respective structural characteristics.

Source: Authors' analysis based on data described in text.

benchmark for quantitative comparison, the median cumulative output impact of a one standard deviation terms of trade shock (the impact calculated at the median of all structural characteristics) was estimated. It was approximately 1 percent of GDP. As noted, the size of the shock is made the same for all countries in order to focus on the variation in responsiveness to a uniform shock.

The most noticeable result is that the cumulative output impact of terms of trade shocks rises with greater trade openness. This is likely to be a size effect in the sense that a higher volume of trade implies a larger share of economic activities that the terms of trade, as relative prices, can influence. This effect should not be confused with a purely mechanical effect, which applies to the relation between trade prices and nominal GDP (or the price of GDP in terms of importable goods). Since the analysis is based on real GDP, mechanical price effects should not be present.[13] The effect of openness is large and significant: the output impact of the shock is 1.4 percentage points higher at the third quartile of trade openness than at the first quartile. The vulnerability of open economies should not have a normative implication; it merely reflects the extent of real resource shifts in the presence of price signals and, from a

13. Unless output deflators are incorrectly or inconsistently measured, an issue considered in the discussion of robustness.

methodological perspective, highlights the need to control for openness in assessing the impact of other structural characteristics.

Conversely, greater financial depth seems to have no effect on the impact of terms of trade shocks. This is surprising, considering that financial depth is usually considered an antidote to external vulnerability. This important issue will be revisited, particularly in the analysis of asymmetric effects of positive and negative shocks and complementary interactions with other structural characteristics.

An increase in financial openness reduces the effect of terms of trade shock, significantly but by a moderate margin: the difference in the cumulative output impact between the 25th and 75th percentiles of financial openness is −0.43 percentage point. That access to international financial markets has a stabilizing effect while domestic financial depth does not is puzzling (a possible interaction between these two financial aspects is considered later).

Easing firm-entry significantly though moderately amplifies terms of trade shocks: the output impact of the shock is 0.52 percentage point higher at the 75th percentile than at the 25th percentile of ease of firm-entry. Entry of new firms is only one side of the firm-dynamics process; firm exit can also be a reaction to external shocks. Moreover, firm dynamics may have different characteristics under negative and positive shocks. The shock-amplifying effect of ease of firm-entry is reconsidered in the analysis of asymmetric effects.

Finally, of all structural characteristics considered here, improvement in labor market flexibility has the strongest effect on reducing the impact of terms of trade shocks on per capita GDP. The difference in the shock's cumulative output impact between the 25th and 75th percentiles of labor market flexibility is −1.23 percentage points, in absolute value almost as large as that of trade openness. The ability of firms to adjust their activities on the labor margin seems crucial for an economy's ability to accommodate the shock.

Robustness

This section examines the robustness of the basic results to changes in measurement of the terms of trade shock, in the sample of countries, the application of a longer lag structure in the estimated vector autoregressions, the inclusion of the exchange rate regime as a country characteristic, and implementation of an alternative method of estimating the effects of structural characteristics. The results on several robustness checks using the panel vector autoregression methodology are presented in the rows of table 5. The robustness check on the methodology is presented in table 6.

The first concern is whether the amplifying effect of trade openness reflects mostly a mechanical effect. Two robustness checks address this issue. The first replaces the simple terms of trade index with one that weighs export and import prices by the size of export and import volumes. When the basic exercise is

TABLE 5. Robustness: Cumulative Output Impact of a One standard Deviation Terms of Trade Shock for Low and High Values of Five Structural Characteristics (percent of GDP)

Robustness test[a]	Trade openness	Financial depth	Financial openness	Labor market flexibility	Ease of firm entry	Exchange rate regime
Benchmark[b]						
Low	0.227	1.178	1.250	1.569	0.908	
High	1.609	1.032	0.819	0.338	1.430	
Difference	1.382	−0.147	−0.430	−1.231	0.523	
Trade weighted terms of trade						
Low	0.526	1.018	0.890	0.996	0.264	
High	1.470	0.522	0.435	0.290	1.571	
Difference	1.995	−0.496	−0.455	−0.706	1.307	
Purchasing power parity GDP						
Low	0.281	0.948	0.983	1.167	1.000	
High	1.308	0.906	0.821	0.539	0.779	
Difference	1.027	−0.042	−0.162	−0.627	−0.221	
Developing countries only						
Low	0.235	1.314	1.370	1.714	1.015	
High	1.793	1.138	0.935	0.415	1.569	
Difference	1.558	−0.176	−0.435	−1.299	0.553	
Excluding 10 percent largest countries						
Low	−0.014	1.185	1.133	1.427	0.841	
High	1.606	0.873	0.769	0.325	1.290	
Difference	1.620	−0.312	−0.365	−1.102	0.448	
Excluding mainly manufacturing exporters						
Low	0.207	1.273	1.275	1.638	0.935	
High	1.701	1.052	0.912	0.359	1.522	
Difference	1.494	−0.220	−0.363	−1.279	0.587	
Three lags in common lag structure						
Low	0.128	0.982	1.101	1.482	0.589	
High	1.407	0.891	0.631	0.056	1.555	
Difference	1.279	−0.092	−0.470	−1.425	0.966	
Including exchange rate regime						
Flexible	0.467	1.228	1.411	1.706	1.153	1.296
Fixed	1.794	1.342	1.100	0.651	1.562	1.224
Difference	1.327	0.114	−0.311	−1.055	0.410	−0.072

Note: Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0−1 index obtained from de jure labor regulation. Ease of firm-entry is a 0−1 index combining information on number of procedures, monetary cost, and time to open a new firm.

[a]"Low" and "High" correspond to the 25th and 75th percentiles, respectively, of the world distribution of the respective structural characteristic.

[b]Includes all countries and sets the common lag structure to two lags.

Source: Authors' analysis based on data described in text.

repeated using this trade-weighted shock, the amplifying effect of trade openness becomes even larger. This indicates that trade openness, as a mechanism for shock expansion, operates not only through trade volumes but also through domestic

TABLE 6. Shock Impact and Structural Characteristics, (Dependent variable: cumulative GDP impact of a one-standard deviation terms of trade shock)

	Ordinary least squares[a]	Weighted least squares
Constant	−0.1547 (0.2086)	−0.2350 (0.2353)
Trade openness	0.1286 (0.0502)**	0.1187 (0.0513)**
Financial depth	0.0613 (0.0508)	0.0103 (0.0374)
Financial openness	−0.0558 (0.0301)*	−0.0379 (0.0259)
Labor market flexibility	−0.6658 (0.2164)**	−0.7498 (0.2190)**
Ease of firm-entry	0.2808 (0.2176)	0.4098 (0.2463)*
R-squared	0.16	—
Number of countries	85	88

*Significant at the 10 percent level; ** significant at the 5 percent level.

Note: Numbers in parentheses are robust standard errors. The regressions are estimated using a robust procedure that reduces the influence of outliers. Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0−1 index obtained from de jure labor regulation. Ease of firm entry is a 0−1 index combining information on number of procedures, monetary cost, and time to open a new firm.

[a]Three outliers are excluded, based on the Hadi method.

Source: Authors' analysis based on data described in text.

economic activity more generally. The second robustness check addresses the potential shortcoming of GDP deflators in cleaning out (purely nominal) price effects from real GDP. This should be minimal if the GDP and terms of trade data come from the same source and GDP is adjusted for PPP. Then, at the cost of losing the most recent observations, the analysis is rerun using GDP data from the Penn World Tables. The shock-amplifying effect of trade openness remains large, although somewhat lower than in the benchmark case.

A second concern is that the results might derive only from the contrast between developing and developed countries. To consider this possibility, all high-income countries are excluded from the sample, the model is reestimated, and the impact statistics are recomputed. The results are qualitatively the same and quantitatively similar to those obtained using the full sample. This similarity indicates that the results can be compared with those of studies that focus only on developing countries.

The third concern relates to the exogeneity assumption of the terms of trade shock. Although the largest developed countries are excluded from the sample, the small-country assumption may be problematic for countries like Brazil, China, and India. Excluding the largest 10 percent of countries and repeating the exercise yields results with the same sign and quantitatively similar to those of the benchmark.[14] The exogeneity assumption may also be questionable for

14. The large countries are Australia, Brazil, Canada, China, India, Republic of Korea, Mexico, Netherlands, and Spain.

countries whose main exports are differentiated manufacturing goods with prices that are likely endogenous. To dispel this doubt, countries that are mainly manufacturing exporters are excluded (manufactured products constitute more than half of total exports).[15] Again the results are basically the same as those of the benchmark.[16]

A fourth concern pertains to the correct specification of the vector autoregression lag structure, which may be relevant in evaluating dynamic effects. To dispel doubts on whether preestimation diagnostics could have indicated a longer lag structure, the shock impacts from vector autoregressions are reestimated with three lags for all countries. Little if anything changes: the signs of the effects remain the same as the benchmark, and quantitative differences with the benchmark are mostly small and statistically insignificant, except for ease of firm-entry, whose shock-amplifying effect seems stronger.

The final robustness check concerns the exchange rate regime. This was not included in the set of structural determinants since it is generally associated with standard macroeconomic policy. However, since it has received so much attention in the stabilization literature and could in principle be related to the structural characteristics considered here, an additional exercise includes the exchange rate regime as an interaction variable. The Gosh, Gulde, and Wolf (2002) classification is used to separate country-year observations with a pegged regime from those with intermediate and floating regimes. The results are very similar to those of the benchmark. The effect of the exchange rate regime itself is quite small and statistically insignificant. This result is only tentative, however, as a complete analysis of the role of the exchange rate regime requires treatment of measurement issues that is outside the scope of this article.

As explained, an alternative to estimating the interactions model using panel data is to estimate the simple model country by country (vector autoregression of output growth on terms of trade growth with free coefficients) and then to run a cross-country regression of the resulting cumulative impacts on the five structural variables. This method allows for full country heterogeneity in (vector autoregression) parameter estimation, but at the cost of lower estimation efficiency and increased noise in the individual country impulse responses.

Table 6 presents the results using two methods that eliminate the undue influence of outlying observations. The first column shows the results of OLS estimation where three outliers are previously eliminated using the Hadi method.[17] The second column shows weighted least squares (WLS) estimation, with the weights

15. The mostly manufacturing exporting countries are Canada, China, Finland, Hong Kong, China, Hungary, Ireland, Israel, Republic of Korea, Singapore, Sweden, and Switzerland.

16. The results are also unaffected by the exclusion of the 13 countries for which the hypothesis is rejected that terms of trade fluctuations are not Granger-caused by output fluctuations.

17. The method was applied using a p-value of 0.3, which resulted in three observations being tagged as outliers.

inversely proportional to the corresponding squared residual.[18] The results are qualitatively similar to those obtained from panel vector autoregressions: the two most important country characteristics affecting the shocks' impact are trade openness (magnifying the impact) and labor market flexibility (reducing the impact). Both carry highly significant coefficients under OLS and WLS. Financial openness has negative coefficients under both methods and significantly so under OLS. Similarly, ease of firm-entry has positive coefficients under both methods and significantly so under WLS. As in the panel vector autoregression case, financial openness appears to stabilize the effect of shocks, whereas ease of firm-entry appears to enlarge them. Financial depth is not statistically significant under OLS or WLS, as was the case using the panel vector autoregression methodology.

Asymmetric Effects

The previous analysis can determine whether structural characteristics have a stabilizing (or destabilizing) effect for all shocks, whether positive or negative. In principle, however, this symmetric treatment could mask important differences in the effects of structural characteristics for positive and negative shocks. For instance, an ideal structural characteristic—one that in reality magnifies positive shocks and reduces negative ones—could be found to be ineffectual under a symmetric analysis. This section considers separately the output response to negative and positive terms of trade shocks.

The results of the asymmetric analysis are presented in table 7. The estimation of asymmetric shocks presents larger standard errors as it uses fewer observations and suffers from wide data variations associated with sign transitions. In reading the asymmetric results, for negative shocks a more negative value for the cumulative impact indicates a stronger effect, and for positive shocks a more positive value for the cumulative impact denotes a larger effect.

There is some evidence of asymmetric effects. The destabilizing effect of trade openness is strong and statistically significant only in the case of negative shocks. Financial depth has no significant effect on the impact of either positive or negative terms of trade shocks. Therefore, its lack of relevance as a shock stabilizer cannot be explained by asymmetric effects. Financial openness does not seem to have a statistically significant effect either, but for different reasons. An increase in financial openness reduces the (absolute) impact of both negative and positive shocks, and by similar magnitudes, found with symmetric effects (by around 0.4 percentage point). It is not surprising, then, that assuming symmetry in the case of financial openness produces more efficient estimates and, thus, significant effects.

An improvement in labor market flexibility dampens the effect of both negative and positive shocks in a statistically significant way. However, the stabilizing effect is substantially larger for negative shocks than for positive shocks, meaning that labor market flexibility is particularly important in the face of

18. That is, using the "rreg" command in STATA.

TABLE 7. Asymmetric Effects Cumulative Output Impact of One standard Deviation Terms of Trade Negative and Positive Shocks for Low and High Values of Five Structural Characteristics (percent of GDP)

	Trade openness		Financial depth		Financial openness		Labor market flexibility		Ease of firm entry	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
Low	−0.262	0.427	−1.598	0.853	−1.791	0.724	−2.306	0.877	−1.461	0.210
	(0.437)	(0.422)	(0.418)	(0.400)	(0.452)	(0.436)	(0.439)	(0.422)	(0.460)	(0.442)
High	−2.494	0.661	−1.697	0.386	−1.429	0.317	−0.637	0.097	−2.020	1.249
	(0.474)	(0.453)	(0.484)	(0.475)	(0.375)	(0.369)	(0.468)	(0.452)	(0.481)	(0.476)
Difference	−2.231	0.234	−0.099	−0.466	0.362	−0.407	1.669	−0.781	−0.559	1.039
	(0.523)	(0.492)	(0.509)	(0.504)	(0.373)	(0.370)	(0.481)	(0.459)	(0.557)	(0.548)
Test Ho:Diff. = 0 (one-tail)	**						**	**		**

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors of corresponding cumulative output impact. Critical values are obtained from empirical distribution (which may have non-Gaussian properties). Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0−1index obtained from de jure labor regulation. Ease of firm-entry is a 0−1 index combining information on number of procedures, monetary cost, and time to open a new firm.

Source: Authors' analysis based on data described in text.

adverse shocks. Finally, ease of firm-entry shows interesting evidence of an asymmetric effect: easing firm-entry significantly increases the consequences of positive shocks only. This provides an upbeat spin to the shock-magnifying effect found for ease of firm-entry in the benchmark case.

Interaction Effects

Up to now the output response to terms of trade shock has been allowed to vary linearly with the five structural characteristics. The relevance of each characteristic has been assessed while holding the rest constant. This section examines the output response to terms of trade shocks when the effect of each structural variable is allowed to depend on the rest. This is akin to allowing for multiplicative interactions in a regular regression context, and the focus is on interpreting the equivalent of interaction coefficients in that context. Allowing for multiplicative interactions is complex, so the analysis is restricted to the case of symmetric effects (of positive and negative shocks).

Following the presentation used previously, for a given pair of structural determinants the first is set at its 25th percentile, then the second is varied from its 25th to its 75th percentile and the difference in cumulative output impact is computed. Then the first structural determinant is set at its 75th percentile and the second is again varied from its 25th to its 75th percentile and the corresponding difference in the cumulative output impact is computed. Finally, the difference of the previously computed differences in cumulative output impacts is computed (always high minus low). This difference-in-difference value is the statistic of interest (as mentioned above, it carries analogous information to the coefficient on a regular multiplicative interaction). A negative sign for this difference-in-difference value reveals that the two structural determinants under consideration are complements in dampening the effects of terms of trade shocks: an increase in either one leads to a lower shock impact when the other one is at a high value. Conversely, a positive sign for the difference-in-difference value indicates that they are substitutes: an increase in either brings about a smaller output response to a shock when the other one is at a low value.

Table 8 summarizes the results of the interactions model, presenting only the difference-in-difference value for each pair of structural determinants, along with its standard error and its test of statistical significance. The following patterns emerge among the statistically significant results. Financial depth behaves as a complement to trade openness and financial openness. Likewise, labor market flexibility and ease of firm-entry are complements. In contrast to the basic case, the interactions model indicates a relevant though nuanced role for financial depth in affecting the impact of external shocks: deepening domestic financial markets can reduce the impact of external shocks when international trade and financial markets are open. This result is consistent with the literature that emphasizes the complementarity between reforms in domestic and international financial markets (see Caballero and Krishnamurthy 2001; Edwards 2001,

TABLE 8. Complementarities among Structural Characteristics: Differential Cumulative Output Impact of a One Standard Deviation Terms of Trade Shock for Low and High Values Between Pairs of Structural Characteristics (percent of GDP)

	Trade openness	Financial depth	Financial openness	Labor Market flexibility	Ease of firm-entry
Trade openness					
Difference-in-difference	—	−1.679 (0.383)	−0.489 (0.409)	−0.468 (0.388)	−0.074 (0.548)
Test Ho = Diff-diff = 0		**	—	—	—
Financial depth					
Difference-in-difference		—	−1.820 (0.474)	0.245 (0.455)	1.353 (0.558)
Test Ho = Diff-diff = 0			**	—	**
Financial openness					
Difference-in-difference			—	0.993 (0.452)	0.936 (0.436)
Test Ho = Diff-diff = 0				**	**
Labor market flexibility					
Difference-in-difference				—	−2.518 (0.644)
Test Ho = Diff-diff = 0					**
Ease of firm entry					
Difference-in-difference					—
Test Ho = Diff-diff = 0					

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard deviations of corresponding output impact. Impacts are given in percentage points of GDP. They are the difference between a given pair of structural characteristics of the difference in the cumulative output impact of their corresponding low and high values. This is analogous to the effect of an interaction between a pair of variables. Critical values are obtained from empirical distribution (which may have non-Gaussian properties). Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0−1index obtained from de jure labor regulation. Ease of firm-entry is a 0−1 index combining information on number of procedures, monetary cost, and time to open a new firm.

Source: Authors' analysis based on data described in text.

among others).[19] In turn, labor flexibility is more effective in reducing the impact of the shock if ease of firm-entry is high, a result that highlights the importance of complementary reforms (see Eslava and others 2005).

Three other pairs of variables behave as substitutes. They are ease of firm-entry with both financial depth and financial openness, and labor market flexibility with financial openness. Thus, deepening financial markets and opening the capital account reduce the output effect of the shock, particularly when there are impediments to firm flexibility. Likewise, labor market flexibility has a larger role in reducing the impact of terms of trade shock when the capital account is closed. It is interesting to note that while ease of firm-entry and labor market flexibility are complements, they are substitutes for financial market depth and openness.

IV. Concluding Remarks

What underlies a country's vulnerability to external shocks? Why do some countries suffer so much from terms of trade shocks while others remain unscathed? This article examined how certain domestic characteristics influence the impact that terms of trade shocks can have on aggregate output. It has an empirical objective, but the analysis was motivated by the recent literature that emphasizes the role of product- and factor-market rigidities as the source of macroeconomic vulnerability.

The results indicate that the two most important country characteristics affecting the output impact of shocks are trade openness and labor market flexibility, with trade openness magnifying the impact and labor market flexibility reducing it. Financial openness also shows a significant but smaller stabilizing effect. Ease of firm-entry magnifies the shocks, but mainly the positive ones, as revealed by an examination of asymmetric effects. Financial depth does not seem to directly affect the impact of terms of trade shocks, but it affects how other structural characteristics amplify or dampen these shocks, as exposed by the analysis of interaction effects. These results are robust to checking for mechanical interpretations of the trade-related results, placing stricter restrictions to guarantee shock exogeneity, concentrating exclusively on developing countries, using a longer lag structure for the vector autoregressions, controlling in addition for the exchange rate regime and allowing full heterogeneity in the estimation of country impulse responses.

When the possibility of asymmetric effects (from negative and positive shocks) is considered, trade openness amplifies negative shocks, whereas ease of firm-entry

19. An alternative reading of the previous results may help to clarify the positive role of financial development. First, although trade openness always increases the impact of a shock, this is considerably smaller when the expansion in openness occurs in a country with well developed local financial markets. Similarly, the findings indicate that greater financial openness in an environment of underdeveloped local financial markets may result in an increase in the impact of external shocks. In contrast, when financial openness occurs in a country with well developed financial markets, the impact of the shocks is reduced.

magnifies only positive ones. Labor market flexibility dampens both shocks, but especially negative ones, and financial openness seems to reduce both shocks in a similar way. Analysis of the interactions among the structural determinants of the impacts of shocks reveals an interesting pattern. Macroeconomic outcomes (in trade and in financial openness and depth) tend to complement each other: an improvement in any of these dimensions leads to a larger reduction in the output impact of terms of trade shocks in a country that is advanced in the other related dimensions. The same happens for microeconomic conditions (in ease of firm-entry and in labor market flexibility), which also tend to be complements. However, macroeconomic and microeconomic conditions seem to behave as substitutes, compensating for each other's deficiencies.

The article opened by pointing out two aspects of output vulnerability to external shocks: the strength of the shock and the sensitivity to the shock. As the article looked only at sensitivity to the shock, it is only fair to ask whether this is indeed quantitatively relevant in assessing a country's degree of vulnerability. The empirical model can answer that question by decomposing the variance of total predicted volatility into the portion due to the countries' sensitivity to a homogeneous terms of trade shock and the fraction due to the variation of these shocks across countries. A conservative estimate of the importance of the portion due to the sensitivity to the shock is 30 percent. The estimate is conservative because it is based on homogeneous parameters across countries, as derived from the panel vector autoregression methodology.[20] A more liberal estimate—one based on country-specific vector autoregression parameter—would assign an importance more than twice as large. In any case, the relevance of domestic structural characteristics in dealing with external vulnerability cannot be ignored.

A final caveat is in order. The analysis focused on the role of structural characteristics on the amplification of terms of trade shocks only. This is a relevant exercise because of the importance typically attributed to these shocks and the advantages it offers for identification purposes. To the extent that the response to other types of external shocks is similar, the results convey information about the general influence that structural characteristics have on external vulnerability. However, the possibility that their role in the transmission of other external shocks may differ from the one documented here cannot be

20. This fraction is estimated as follows. For each country in the sample, the long-run output variance is computed in response to its own shock ($\alpha_i \sigma_i^2$), first, by estimating the response to a common shock and then by simulating the effect of its own shock. Actual values of the country's structural characteristics are used to estimate its long-run output variance in response to a common shock ($\alpha_i \sigma^2$), and the country's own data are applied to estimate the variance of its terms of trade shocks (σ_i^2). The log of the output variance [log ($\alpha_i \sigma_i^2$)] is then decomposed into the sum of the log of vulnerability [log (α_i)] and the log of terms of trade variance [log (σ_i^2)]. The cross-country variance of the log of output volatility then corresponds to the cross-country variance of the log of vulnerability, the log of terms of trade variance, and the covariance between them. The figure reported in the text corresponds to the contribution of the log of vulnerability to this variance when the covariance term is imputed in proportion to the standard deviation of each component (assuming constant correlation).

dismissed. In particular, financial development, which plays a secondary role in the results of this study, may have a more prominent job in dampening financial shocks. Since an appropriate analysis of this possibility would require more complex and controversial identification assumptions, it awaits future research.

APPENDIX

Country Sample and Summary Statistic

List of sample countries and summary statistics is given in table A-1.

TABLE A-1. List of Sample Countries and Summary Statistics

Country name	Average output growth (%) (1)	Average terms of trade growth (%) (2)	Standard deviation output growth (3)	Standard deviation terms of trade growth (4)	Trade openness (5)	Financial depth (6)	Financial openness (7)	Labor market flexibility (8)	Ease of firm-entry (9)
Algeria	0.46	−0.43	2.87	23.14	3.81	−1.12	−1.41	0.54	0.66
Angola	−2.26	−3.66	9.28	18.08	4.16	−4.31	−1.55	0.22	0.22
Argentina	0.27	−0.01	5.78	8.17	2.70	−1.78	−0.13	0.34	0.69
Australia	1.86	−0.66	1.92	5.06	3.28	−0.77	1.32	0.64	0.89
Austria	2.20	−0.31	1.56	1.34	3.97	−0.25	1.68	0.70	0.74
Bangladesh	1.62	−2.08	2.27	15.78	2.91	−1.60	−1.40	0.50	0.62
Belgium	1.95	−0.12	1.66	1.59	4.83	−0.96	1.56	0.52	0.80
Benim	0.55	−1.69	3.63	14.17	3.71	−2.37	−0.24	0.48	0.69
Bolivia	−0.11	−3.12	3.00	11.29	3.73	−1.40	0.68	0.34	0.52
Botswana	5.26	1.49	3.57	8.34	4.63	−2.06	−0.21	0.65	0.62
Brazil	1.21	−1.73	3.68	9.83	2.75	−1.30	−1.64	0.22	0.45
Burkina Faso	1.19	0.77	3.43	12.52	3.17	−2.01	−0.36	0.47	0.45
Burundi	−0.61	−2.78	5.11	33.79	3.28	−2.48	−1.09	0.38	0.25
Cameroon	0.61	0.00	7.03	22.39	3.45	−1.63	−0.47	0.56	0.59
Canada	1.76	0.18	2.28	3.05	3.90	−0.37	2.68	0.66	0.94
Central African Republic	−1.42	−1.27	4.61	16.26	3.22	−2.60	−0.66	0.38	0.25
Chad	−0.56	−2.94	9.06	13.46	3.26	−2.57	−0.76	0.34	0.41
Chile	3.18	−2.54	5.75	14.51	3.73	−0.85	−1.25	0.50	0.78
China	7.35	−0.93	3.44	5.74	3.16	−0.13	−1.24	0.53	0.61
Colombia	1.34	0.54	2.30	10.19	3.21	−1.33	−1.53	0.41	0.65
Congo, Rep.	0.37	−0.79	7.02	22.26	4.27	−2.28	−0.91	0.40	0.58
Costa Rica	1.29	0.14	3.73	9.45	4.12	−1.69	−0.56	0.37	0.64
Côte d'Ivoire	−1.14	−1.95	4.94	16.36	4.05	−1.16	−0.53	0.47	0.59
Denmark	1.65	0.40	1.93	2.43	3.97	−0.89	1.13	0.75	0.91

Dominican Republic	2.27	−2.49	3.31	11.72	4.02	−1.37	−1.46	0.51	0.60
Ecuador	0.40	−1.73	3.18	13.45	3.71	−1.53	0.04	0.45	0.51
Egypt, Arab Rep.	3.55	−2.80	2.86	11.33	3.57	−1.24	−1.05	0.41	0.59
El Salvador	0.01	0.07	4.83	17.84	3.90	−2.71	−0.64	0.31	0.59
Ethiopia	−0.09	0.29	7.67	19.72	3.02	−1.82	−1.14	0.49	0.69
Finland	2.13	−0.08	3.05	3.09	3.89	−0.55	1.54	0.45	0.85
Ghana	−0.60	−2.01	5.06	15.93	3.89	−3.26	−1.39	0.65	0.55
Greece	1.42	−1.11	2.46	4.60	3.47	−0.99	−0.54	0.33	0.63
Guatemala	0.48	−1.42	2.59	25.42	3.52	−1.90	0.63	0.35	0.56
Guinea	1.38	−3.96	1.42	8.91	3.71	−3.18	−1.07	0.40	0.56
Haiti	−1.59	−4.08	4.82	12.03	3.34	−2.2	0.44	0.40	0.32
Honduras	0.53	−0.59	3.25	13.45	4.07	−1.23	0.17	0.44	0.56
Hong Kong, China	4.56	0.38	4.50	1.75	5.22	0.39	2.68	0.73	0.94
Hungary	1.69	−0.88	3.91	3.18	4.36	−1.25	−0.68	0.46	0.76
India	3.12	1.64	2.92	10.60	2.57	−1.45	−1.03	0.49	0.56
Indonesia	3.87	1.46	4.46	10.94	3.72	−1.20	2.05	0.43	0.45
Iran, Islamic Rep.	−0.64	−1.18	7.73	24.31	3.31	−1.25	−0.90	0.48	0.63
Ireland	4.35	−0.46	3.15	2.55	4.57	−0.56	0.58	0.51	0.88
Israel	1.86	0.89	1.96	4.16	4.09	−0.65	−0.39	0.62	0.83
Jamaica	−0.21	−1.60	4.19	8.67	4.17	−1.33	−0.36	0.66	0.76
Jordan	1.73	0.68	7.52	7.06	4.31	−0.49	−0.18	0.40	0.69
Kenya	0.23	−0.44	2.33	10.48	3.80	−1.24	−0.74	0.66	0.60
Korea, Rep.	5.82	−0.73	3.79	5.29	4.03	−0.30	−0.63	0.49	0.70
Lesotho	2.85	−0.98	6.64	15.82	4.79	−2.01	−0.54	0.55	0.59
Madagascar	−1.57	0.86	3.67	11.23	3.32	−1.86	−0.92	0.39	0.65
Malawi	0.56	−2.13	5.34	10.94	3.97	−2.25	−1.03	0.48	0.63
Malaysia	3.92	−0.14	4.08	6.99	4.71	−0.29	1.63	0.75	0.77
Mali	0.65	0.01	5.93	8.07	3.64	−2.03	−0.24	0.46	0.62

(Continued)

TABLE A-1. Continued

Country name	Average output growth (%) (1)	Average terms of trade growth (%) (2)	Standard deviation output growth (3)	Standard deviation terms of trade growth (4)	Trade openness (5)	Financial depth (6)	Financial openness (7)	Labor market flexibility (8)	Ease of firm-entry (9)
Mauritania	0.10	0.46	3.36	9.42	4.29	−1.16	−1.08	0.41	0.55
Mexico	1.50	−0.38	3.74	9.90	3.28	−1.67	0.92	0.23	0.66
Morocco	1.57	1.12	4.98	9.09	3.74	−1.25	−1.26	0.49	0.82
Mozambique	0.88	−3.59	7.90	10.57	3.45	−2.19	−1.32	0.26	0.40
Namibia	−0.47	−1.94	2.72	11.23	4.58	−0.97	−1.18	0.57	0.64
Netherlands	1.83	−0.14	1.50	1.00	4.52	0.08	2.53	0.46	0.80
New Zealand	0.68	0.37	2.39	5.05	3.79	−0.64	1.70	0.68	0.93
Nicaragua	−2.91	−2.46	7.85	18.30	4.01	−1.28	0.11	0.39	0.62
Niger	−1.71	0.10	6.05	17.16	3.47	−2.13	−0.53	0.41	0.57
Nigeria	−0.96	−0.03	5.59	27.87	4.11	−2.11	−1.19	0.57	0.62
Norway	3.04	−0.48	1.76	7.94	3.95	−0.22	0.54	0.59	0.82
Pakistan	2.47	−1.26	1.93	9.80	3.39	−1.48	−1.09	0.42	0.65
Panama	1.12	−0.74	4.92	10.46	3.67	−0.59	2.68	0.21	0.78
Papua New Guinea	0.07	−1.47	5.43	12.24	4.36	−1.67	−0.23	0.74	0.67
Paraguay	1.32	1.94	4.12	17.48	3.36	−1.73	−0.70	0.27	0.50
Peru	−0.42	−1.56	6.10	12.96	3.23	−1.97	0.12	0.27	0.59
Philippines	0.72	0.04	3.76	11.79	3.86	−1.13	−0.57	0.40	0.63
Portugal	2.47	0.02	3.23	4.65	3.87	−0.32	0.09	0.21	0.65
Rwanda	0.32	1.98	10.06	30.39	3.08	−2.67	−1.00	0.40	0.55

Senegal	0.19	−0.85	4.34	6.69	3.90	−1.29	−0.24	0.46	0.62
Sierra Leone	−3.35	2.57	7.15	34.08	3.52	−3.12	−0.85	0.33	0.46
Singapore	5.32	−1.24	2.56	2.08	5.67	−0.17	2.00	0.80	0.92
South Africa	−0.38	−0.79	2.30	5.61	3.75	−0.69	−1.12	0.64	0.77
Spain	1.98	0.52	1.76	5.11	3.36	−0.24	0.36	0.30	0.68
Sri Lanka	3.48	1.15	1.21	14.27	4.02	−1.73	−0.52	0.58	0.74
Sweden	1.62	−0.47	2.00	2.82	3.94	0.01	1.58	0.58	0.84
Switzerland	0.80	1.25	2.38	3.86	3.99	0.31	2.68	0.64	0.79
Syrian Arab Republic	1.57	−3.00	6.00	13.70	3.80	−2.68	−1.64	0.55	0.65
Thailand	4.66	−1.99	4.37	5.57	3.99	−0.51	−0.04	0.39	0.75
Togo	−0.49	−2.48	7.08	23.49	4.05	−1.51	−0.87	0.43	0.44
Tunisia	2.44	−1.18	2.65	4.71	4.14	−0.53	−0.92	0.43	0.78
Turkey	1.93	−0.45	4.11	6.89	3.11	−1.86	−0.95	0.45	0.77
Uganda	2.05	−0.91	3.44	20.64	3.11	−3.69	−0.47	0.58	0.6
Uruguay	1.59	−0.26	4.89	6.40	3.35	−1.29	0.87	0.61	0.68
Venezuela	−0.94	2.30	4.53	22.09	3.71	−1.07	0.64	0.25	0.55
Zambia	−2.23	−5.99	3.98	26.15	4.08	−2.78	−0.71	0.54	0.71

Note: Variables are measured over the period 1974–2000. Average output growth is growth of real GDP per capita. Average terms of trade growth is the average growth of the terms of trade index. Standard deviation output growth is the standard deviation of the growth rates of real GDP per capita. Trade openness = Log (Exports + Imports) / GDP. Financial depth = Log (Private credit) / GDP. Financial Openness is the Chinn–Ito measure of capital account openness. Labor market flexibility is a 0 − 1index obtained from de jure labor regulation. Ease of firm-entry is a 0−1 index combining information on number of procedures, monetary cost, and time to open a new firm.

Source: Authors' analysis based on data described in text

REFERENCES

Acemoglu, D., S. Johnson, J. Robinson, and Y. Thaicharoen. 2003. "Institutional Causes, Macroeconomic Symptoms, Volatility, Crises and Growth." *Journal of Monetary Economics* 50(1):49–123.

Ahmed, S. 2003. "Sources of Macroeconomic Fluctuations in Latin America and Implications for Choice of Exchange Rate Regime." *Journal of Development Economics* 72(1):181–202.

Arellano, C., and E.G. Mendoza. 2002. "Credit Frictions and 'Sudden Stops' in Small Open Economies: An Equilibrium Business Cycle Framework for Emerging Markets Crises." NBER Working Paper 8880. Cambridge, Mass.: National Bureau of Economic Research.

Beck, T., A. Demirg-Kunt, and R. Levine. 2000. "A New Database on Financial Development and Structure." *World Bank Economic Review* 14(3):597–605.

Bernanke, B., and M. Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review* 79(1):14–31.

Botero, J., S. Djankov, R. La Porta, F. Lopez-de-Silanes, and A. Shleifer. 2004. "The Regulation of Labor." *Quarterly Journal of Economics* 119(4):1339–82.

Braun, M., and B. Larran. 2005. "Finance and the Business Cycle: International Inter-Industry Evidence." *Journal of Finance* 60(3):1097–128.

Broda, C. 2001. "Coping with Terms-of-Trade Shocks: Pegs versus Floats." *American Economic Review* 91(2):376–80.

———. 2004. "Terms-of-Trade and Exchange Rate Regimes in Developing Countries." *Journal of International Economics* 63(1):31–58.

Caballero, R.J., K. Cowan, E.M.R.A. Engel, and A. Micco. 2005. "Effective Labor Regulation and Microeconomic Flexibility." NBER Working Paper 10744. Cambridge, Mass.: National Bureau of Economic Research.

Caballero, R.J., and M.L Hammour. 1994. "The Cleansing Effect of Recessions." *American Economic Review* 84(5):1350–68.

———. 1996. "On the Timing and Efficiency of Creative Destruction." *Quarterly Journal of Economics* 111(3):805–52.

———. 1998. "The Macroeconomics of Specificity." *Journal of Political Economy* 106(4):724–67.

Caballero, R.J., and A. Krishnamurthy. 2001. "International and Domestic Collateral Constraints in a Model of Emerging Market Crises." *Journal of Monetary Economics* 48(3):513–48.

Chang, R., L. Kaltani, and N. Loayza. 2005. "Openness Can Be Good for Growth: The Role of Policy Complementarities." NBER Working Paper 11787. Cambridge, Mass.: National Bureau of Economic Research.

Chinn, M., and H. Ito. 2002. "Capital Account Liberalization, Institutions and Financial Development: Cross Country Evidence." NBER Working Paper 8697. Cambridge, Mass.: National Bureau of Economic Research.

Easterly, W., M. Kremer, L. Pritchett, and L. Summers. 1993. "Good Policy or Good Luck?: Country Growth Performance and Temporary Shocks." *Journal of Monetary Economics* 32(3):459–83.

Edwards, S. 2001. "Capital Mobility and Economic Performance: Are Emerging Economies Different?" NBER Working Paper 8076. Cambridge, Mass.: National Bureau of Economic Research.

Eslava, M., J. Haltiwanger, A. Kugler, and M. Kugler. 2005. "Factor Adjustments after Deregulation: Panel Evidence from Colombian Plants." NBER Working Paper 11656. Cambridge, Mass.: National Bureau of Economic Research.

Fats, A. 2002. "The Effects of Business Cycles on Growth." In N. Loayza and R. Soto eds., *Economic Growth: Sources, Trends, and Cycles*. Santiago, Chile: Central Bank of Chile.

Gosh, A., A.M. Gulde, and H. Wolf. 2002. *Exchange Rate Regimes: Choices and Consequences*. Cambridge, Mass.: MIT Press.

Hall, A. 1990. "Testing for A Unit Root in Time Series with Pre-test Data-based Model Selection." Working Paper. North Carolina State University, Department of Economics, Raleigh.

Heston, Alan, Robert Summers, and Bettina Aten. 2002. "Penn World Table Version 6.1." Center for International Comparisons at the University of Pennsylvania, Philadelphia.

Hnatkovska, V., and N. Loayza. 2005. "Volatility and Growth." In Joshua Aizenmann, and Brian Pinto eds., *Managing Volatility*. Cambridge, UK: Cambridge University Press.

Hoffmaister, A., J. Roldos, and P. Wickham. 1998. "Macroeconomic Fluctuations in Sub-Saharan Africa." *International Monetary Fund Staff Paper* 45(1):132–60.

International Monetary Fund. Various issues. Annual Report on Exchange Arrangements and Exchange Restrictions. Washington, D.C.

Kiyotaki, N., and J. Moore. 1997. "Credit Cycles." *Journal of Political Economy* 211–48.

Kose, M., and R. Riezman. 2001. "Trade Shocks and Macroeconomic Fluctuations in Africa." *Journal of Development Economics* 65(1):55–80.

Kraay, A., and J Ventura. Forthcoming. "Comparative Advantage and the Cross-Section of Business Cycles." *Journal of the European Economic Association.*

Levin, A., Lin, Chien-Fu, and Chu, Chia-Shang, J. 2002. "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties." *Journal of Econometrics* 108(1):1–24.

Mendoza, E.G. 1995. "The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations." *International Economic Review* 36(1):101–37.

O'Driscoll, G., E. Feulner, and M.A. O'Grady. 2003. *2003 Index of Economic Freedom*. Washington, D.C.: The Heritage Foundation and the Wall Street Journal.

Pakes, A., and Z. Griliches. 1984. "Estimating Distributed Lags in Short Panels with an Application to the Specification of Depreciation Patterns and Capital Stock Constructs." *Review of Economic Studies* 51(2):243–62.

Pedroni, P. 1999. "Critical Values for Cointegration Tests in Heterogeneous Panel with Multiple Regressors." *Oxford Bulletin of Economics and Statistics* 61(S1):653–70.

———. 2004. "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series with an Application to the PPP Hypothesis." *Econometric Theory* 20(3):597–635.

Pesaran, M., and R. Smith. 1995. "Estimating Long-run Relationships from Dynamic Heterogeneous Panels." *Journal of Econometrics* 68(1):79–113.

Raddatz, C. 2006. "Liquidity Needs and Vulnerability to Financial Underdevelopment." *Journal of Financial Economics* 80(2):677–722.

———. 2007. "Are external shocks responsible for the instability of output in low-income-countries?" *Journal of Development Economics* 84(1):155–87.

Ramey, G., and V. Ramey. 1995. "Cross-Country Evidence on the Link between Volatility and Growth." *American Economic Review* 85(5):1138–50.

Rodrik, D. 1999. "Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses." *Journal of Economic Growth* 4(4):385–412.

Uribe, M., and V. Yue. 2003. "Country Spreads and Emerging Countries: Who Drives Whom?" NBER Working Paper 10018. Cambridge, Mass.: National Bureau of Economic Research.

World Bank. 2003. *Doing Business*. Washington, D.C.: World Bank.

———. 2005. "World Development Indicators Database." World Bank, Washington, D.C.

Do Some Forms of Financial Flows Help Protect Against "Sudden Stops"?

Andrei A. Levchenko and Paolo Mauro

There is a debate on whether some forms of financial flows offer better protection against crises than others. Using a large panel data set that includes advanced, emerging, and developing economies during 1970–2003, this article analyzes the behavior of several types of flows: foreign direct investment (FDI), portfolio equity investment, portfolio debt investment, other flows to the official sector, other flows to banks, and other flows to the nonbank private sector. Differences across types of flows are limited with respect to volatility, persistence, cross-country comovement, and correlation with growth at home or in the world economy. However, consistent with conventional wisdom, FDI is the least volatile form of financial flow, when the average size of net or gross flows is taken into account. The differences are striking during "sudden stops" in financial flows (defined as drops in total net financial inflows of more than percentage points of GDP compared with the previous year). In such episodes, FDI is remarkably stable, and portfolio equity seems to play a limited role. Portfolio debt experiences a reversal, though it recovers relatively quickly, and other flows (including bank loans and trade credit) experience severe drops and often remain depressed for a few years. JEL codes: F21, F32, F36.

The composition of a country's external liabilities—the relative shares of foreign direct investment (FDI), portfolio equity, and external debt—may be an important determinant of its economic performance and vulnerability to crisis through two types of mechanisms. First, the payments associated with some types of external liabilities have more desirable cyclical properties than those associated with others (Rogoff 1999; Caballero and Cowan 2006): with equity-like forms of finance, such as portfolio equity or FDI, payments are lower

Andrei Levchenko (corresponding author) is an economist in the Strategic Issues Division of the Research Department at the International Monetary Fund; his email address is alevchenko@imf.org. Paolo Mauro is the division chief in the Strategic Issues Division of the Research Department at the International Monetary Fund; his email address is pmauro@imf.org. The authors are grateful to Martín Minnoni for research assistance and to Torbjörn Becker, Philip Lane, Enrique Mendoza, Gian Maria Milesi-Ferretti, Jonathan Ostry, the journal editor, anonymous referees, and especially André Faria and Romain Rancière for helpful suggestions. The views expressed in this paper are those of the authors and should not be attributed to the International Monetary Fund, its Executive Board, or its management.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 389–411 doi:10.1093/wber/lhm014
Advance Access Publication 17 September 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

when economic performance is worse, whereas with debt contracts the same coupon payment is envisaged regardless of the state of the economy.[1] Equity finance thus makes it possible for domestic producers to share risk with foreign investors, thereby helping to stabilize domestic consumption and improving domestic producers' ability to undertake riskier but more profitable projects. Second, some forms of flows may behave in a more desirable manner than others. For example, FDI has traditionally been viewed as more stable, and thus less likely to trigger financial crisis, than portfolio financial flows. At the same time, some empirical studies have cast doubt on the relevance of labels such as "short-term" and "long-term" flows for the volatility or predictability of financial flows (Claessens, Dooley, and Warner 1995).

While recognizing that the first mechanism—payments with desirable cyclical properties—is also of key importance, this article focuses squarely on the second one: the behavior of the various types of financial flows. The objective is to provide a detailed, comprehensive, and up-to-date analysis of their behavior—especially for instances of sudden stops (defined as reversals in total financial flows of more than 5 percentage points of GDP compared with the previous year). Several studies have already considered some of the properties of at least some types of international financial flows, and this article will relate its findings to those of other researchers.

The estimates below present a somewhat mixed picture, suggesting that some—but not all—aspects of the conventional wisdom are confirmed by systematic empirical analysis. The key results are the following:

(1) Consistent with earlier results by Claessens, Dooley, and Warner (1995), the various types of financial flows do not seem to differ significantly in persistence, procyclicality, responsiveness to U.S. interest rates and growth in G-7 countries or comovement across emerging markets.
(2) Consistent with conventional wisdom, FDI is the least volatile form of financial flows, when the average size of net or gross flows is taken into account. At the same time, changes in FDI flows account for a large portion of changes in overall flows, reflecting FDI's importance as one of the largest sources of net flows to emerging and developing economies.
(3) The various types of flows behave very differently during sudden stops. FDI remains remarkably stable and plays essentially no role in sudden stops—an especially striking result, considering that FDI represents a large share of total financial flows. Similarly, portfolio equity seems to play a limited role in sudden stops. Portfolio debt experiences a reversal, though it recovers quickly after the sudden stop. Bank lending flows and

1. Moreover, in the event of an exchange rate crisis, when output usually declines, foreign currency debt requires even greater payments in domestic currency terms. On the other hand, the burden of debt can be reduced in bad times through default or, for domestic currency debt, inflation. In principle, appropriately designed financial instruments, such as growth-indexed bonds, can increase the procyclicality of payments (Borensztein and Mauro 2004).

official flows experience severe drops and often remain depressed for several years. These differences in behavior are accounted for primarily by gross inflows rather than by gross outflows.

A few previous studies have directly analyzed some aspects of the behavior of different types of financial flows, often focusing on important episodes.[2] Claessens, Dooley, and Warner (1995), in a thorough analysis of the stylized facts in this context, fail to find significant differences across types of flows. Chuhan, Perez-Quiros, and Popper (1996) and the World Bank (1999) report evidence suggesting that FDI may be more resilient than short-term flows in response to financial disturbances; Sarno and Taylor (1999) find FDI to be more persistent than other types of flows; and Lipsey (2001) shows that FDI was relatively stable in the crises affecting Latin America in 1982, Mexico in 1994, and East Asia in 1997. This article updates and builds on such studies to gather a more comprehensive range of stylized facts, including an analysis of the behavior of financial flows in "sudden stop time," using an approach loosely analogous to that taken by event studies.

I. Data Description

This article analyzes data for 1970–2003 (chosen for data availability and quality) on the financial account and six of its components: FDI; portfolio debt investment; portfolio equity investment; other net flows to the domestic official sector, which are net flows arising from the net purchases of foreign assets by the domestic monetary authorities and general government, as well as net purchases by foreign residents of liabilities issued by the domestic monetary authorities and general government; other net flows to domestic banks, which are net flows arising from net purchases of foreign assets by domestic banks, as well as net purchases by foreign residents of liabilities issued by domestic banks; and other net flows to the nonbank private sector, such as trade credits and bank flows to the nonbank private sector. All flows exclude exceptional financing, use of International Monetary Fund (IMF) credit, and changes in reserves. Flows are net and are reported in current U.S. dollars. The data are drawn from the IMF's Balance of Payments database (Analytic Presentation, *Balance of Payments Manual*, Fifth Edition).

The six categories of flows are those adopted by the Balance of Payments database and are mutually exclusive. The distinctions between FDI, portfolio

2. Other studies have addressed complementary questions. Fernández-Arias and Hausmann (2001) consider the relationship between the composition of financial flows and the frequency of crises. They find that the share of FDI in total finance is associated with a lower frequency of crisis in developing economies, although they argue that the true underlying determinant of the likelihood of crisis is the currency denomination and maturity of liabilities. Faria and Mauro (2004) analyze the long-run determinants of the composition of countries' external liability structures and find that institutional quality tends to be positively associated with the shares of FDI, and especially portfolio equity, in total liabilities.

debt investment, portfolio equity investment, and other net flows are based on the type of flows, whereas the subcomponents of other net flows (to the domestical official sector, to domestic banks, and to the nonblank private sector) are defined by recipient, an important aspect to keep in mind when interpreting the results. For instance, a full picture of changes in the government's net position would require not only data on other net flows to the domestic official sector, but also additional information on flows to the government in the form of, say, portfolio debt investment (for example, government bonds). Another important limitation of the data is that they do not provide comprehensive information on the source of flows: it would be difficult to determine, for instance, whether inflows to the domestic official sector come from the foreign private sector or from foreign governments in the form of official assistance.

Throughout the analysis, flows are normalized by GDP in current U.S. dollars (taken primarily from the World Bank's World Development Indicators database and supplemented with data from the IMF's World Economic Outlook database). All data were checked for quality, dropping outliers, and unusable observations. The full sample includes 142 countries (table 1) for which at least 10 years of overall net financial account data are available. Many countries do not have data for some of the subcomponents. Coverage is sparsest for portfolio equity investment, where data are available for only 12 developing economies. As a result, the sample of non-FDI flows to developing economies may not be representative, so the results for that group should be treated with special caution. The summary statistics presented below are based on annual data for 1970–2003; all the main results hold for the subperiod 1990–2003. Similar patterns are also obtained using quarterly data for a smaller sample of countries (not reported for the sake of brevity).

Throughout the analysis, the focus is on net flows rather than gross flows. Sudden stops are a concept based on the net financial account, and crises and financing difficulties ultimately result from changes in net flows. Recent papers (Faucette, Rothenberg, and Warnock 2005; Rothenberg and Warnock 2006) have suggested that gross flows provide useful, policy-relevant information and have asked whether abrupt declines in net inflows are accounted for by the sudden retreat of global investors or the "sudden flight" of local investors. The standard focus on net flows is retained in this article both for consistency with the bulk of the literature on sudden stops and to investigate the behavior of different types of flow in a broad range of countries, which data constraints render difficult for gross flows. Nevertheless, the analysis of gross flows is potentially fruitful, and results on gross flows are reported where sufficient data are available. It is worth noting that the sudden stop sample used here overlaps with that of Rothenberg and Warnock (2006) for nine episodes: all of them are classified by Rothenberg and Warnock (2006) as "true sudden stops" rather than "sudden flights."

TABLE 1. Economies by Group

Advanced economies	Emerging market economies	Developing economies	
Australia	Argentina	Albania	Kuwait
Austria	Brazil	Algeria	Kyrgyz Republic
Belgium-Luxembourg	Bulgaria	Angola	Lao PDR
Canada	Chile	Antigua and Barbuda	Latvia
Cyprus	China	Armenia	Lesotho
Denmark	Colombia	Aruba	Lithuania
Finland	Côte d'Ivoire	Bahamas	Madagascar
France	Czech Republic	Bahrain	Malawi
Germany	Dominican Republic	Bangladesh	Maldives
Greece	Ecuador	Barbados	Mali
Iceland	Egypt	Belarus	Malta
Ireland	El Salvador	Belize	Mauritania
Israel	Hungary	Benin	Mauritius
Italy	India	Bolivia	Moldova
Japan	Indonesia	Botswana	Mongolia
Netherlands	Jordan	Burundi	Mozambique
New Zealand	Korea, Rep.	Cambodia	Namibia
Norway	Malaysia	Cameroon	Nepal
Portugal	Mexico	Cape Verde	Netherlands Antilles
Singapore	Morocco	Central African Rep.	Nicaragua
Spain	Nigeria	Chad	Niger
Sweden	Oman	Comoros	Papua New Guinea
Switzerland	Pakistan	Congo, Rep.	Paraguay
United Kingdom	Panama	Costa Rica	Romania
United States	Peru	Croatia	Rwanda
	Philippines	Dominica	Senegal
	Poland	Estonia	Seychelles
	Russia	Fiji	Sierra Leone
	Saudi Arabia	Gabon	Slovenia
	Slovak Republic	Gambia, The	Solomon Islands
	South Africa	Ghana	Swaziland
	Sri Lanka	Grenada	Syrian Arab Republic
	Thailand	Guatemala	Tanzania
	Tunisia	Guinea	Togo
	Turkey	Guyana	Tonga
	Ukraine	Haiti	Trinidad and Tobago
	Uruguay	Honduras	Uganda
	Venezuela, R.B.	Jamaica	Vanuatu
	Zimbabwe	Kenya	Vietnam

Note: Advanced economies are defined as in the IMF's *World Economic Outlook*, except for the Republic of Korea which for empirical analysis is classified as an emerging market economy rather than an advanced economy to capture the experience of its 1997–98 crisis. Economies are considered emerging market economies if they are included in either the (stock market-based) International Financial Corporation's Major Index (2005) or JPMorgan's EMBI Global Index (2005), which includes countries that issue bonds on international markets. The remaining economies are classified as developing economies.

II. Behavior of Different Types of Financial Flows

This section reports results on simple summary statistics for the various types of flows, including average net flows, volatility, correlations, persistence, and comovement, for three groups of economies: advanced, emerging market, and developing (table 2).

Average Net Flows

Considering the average financial account balance for each country in 1970–2003, and taking the cross-country median within each country group over the period, developing economies had the largest net inflows, followed by emerging market economies and then advanced economies (see table 2). This pattern is even more pronounced for FDI, which has not been a net source of finance for advanced economies. By contrast, emerging market economies received net FDI inflows averaging about 1.3 percentage points of GDP yearly, and developing economies received about 1.9 percentage points. The results (not reported for the sake of brevity) are similar when considering 1990–2003 only, and suggest that the relative importance of FDI as a source of net inflows for emerging market and developing economies has, if anything, increased in the last decade.

Volatility

Two measures are used to gauge volatility. The first, the standard deviation, is most relevant when addressing questions for which the size of the flow needs to play a role, such as "Which types of flow account for the overall volatility of financial flows?" The second, the coefficient of variation (the standard deviation divided by the mean), is more informative when considering the nature of different types of flows, say when computing the volatility of one dollar of a given type of flow. As shown below, several of the results hinge on the size of a given type of flow for different groups of economies.

With the standard deviation of net flows (computed for each country over 1970–2003) as a measure of volatility, financial flows are found to be substantially more volatile in emerging market and developing economies.[3] The cross-country median of the standard deviation of the financial account balance is 2.7 percentage points of GDP for advanced economies and almost twice as large for emerging market and developing economies. This result corroborates

3. Flows are normalized by GDP. The results are essentially identical when normalizing by trend GDP, suggesting that variation in flows is far greater than variation in GDP, and thus variation in the ratio of flows to GDP is accounted for primarily by variation in flows. It is also important to note that Levin, Lin, and Chu's (2002) panel stationarity tests convincingly reject the null hypothesis of a unit root, thus confirming that it is appropriate to compute the standard deviation of the flows to GDP ratios. Furthermore, the results are similar when considering the standard deviation of the change in the flows to GDP ratios.

TABLE 2. Financial Account and Subcomponents: Median Values across Economies within Each Group 1970–2003

Summary statistic and economy	Financial account	Foreign direct investment	Portfolio debt investment	Portfolio equity investment	Other flows to official sector	Other flows to banks	Other flows to nonbank private sector
Average of capital flows							
Advanced economies	1.38	−0.02	0.25	−0.34	0.02	0.42	0.04
Emerging market economies	1.89	1.30	0.17*	0.15*	0.10*	0.01*	0.04*
Developing economies	2.98	1.88	−0.10*	0.13*	0.86*	−0.13*	0.38*
Standard deviation							
Advanced economies	2.72	1.31	2.09*	1.51	0.88	2.30*	1.77
Emerging market economies	4.39	1.50	1.08	0.55*	1.89*	1.32	1.95*
Developing economies	4.86	2.08	0.95*	0.35*	2.21	1.14*	1.93
Coefficient of variation							
Advanced economies	1.37	2.20	3.07	3.18	2.66	5.54	5.39
Emerging market economies	1.88	1.00	3.51	1.98	3.16*	7.22*	3.61*
Developing Economies	1.41	0.96	2.75	2.60	2.24	3.68*	2.15*
Correlation with domestic growth							
Advanced economies	0.10	0.00	0.00	0.02	−0.01	0.18*	0.04
Emerging market economies	0.24	0.10	−0.02*	0.07	−0.002*	0.15	0.22
Developing economies	0.16	0.17	−0.08*	0.14	−0.01*	0.04*	0.14
Correlation with G-7 growth							
Advanced economies	−0.01	0.03	−0.08	0.05	−0.03	0.09	−0.06
Emerging market economies	−0.08	−0.07	−0.06	0.04	−0.01	−0.07	−0.07
Developing economies	0.01	0.04	0.01	0.24*	0.00	−0.03	0.03
Correlation with U.S. interest rate (1-year T-bill)							
Advanced economies	0.23	0.08	0.07	0.10	0.03	0.03	0.15

(Continued)

TABLE 2. Continued

Summary statistic and economy	Financial account	Foreign direct investment	Portfolio debt investment	Portfolio equity investment	Other flows to official sector	Other flows to banks	Other flows to nonbank private sector
Emerging market economies	0.07	−0.29	−0.07	−0.08*	0.27*	0.03*	0.13*
Developing economies	0.10	−0.16	0.05*	0.14*	0.20*	0.04	0.07*
Persistence (AR1 pooled)							
Advanced economies	0.68	0.33	0.35	0.37	0.40	0.37	0.41
Emerging market economies	0.52	0.51	0.02*	0.39	0.42*	0.12*	0.47
Developing economies	0.51	0.35	0.51*	0.41	0.49*	0.17*	0.37
First principal component							
Advanced economies	0.30	0.36	0.23	0.37	0.20	0.27	0.19*
Emerging market economies	0.24	0.40	0.28	0.34	0.25*	0.19*	0.21*
Developing economies	0.28	0.32	0.36	0.35	0.27	0.17*	0.18*

Note: All flows are net and normalized by total GDP for each year. Asterisks indicate statistically significant differences across types of flows compared with FDI in that country group. Numbers in bold indicate significant differences at the 10 percent level in statistics across country groups. The coefficient of variation of a series is the standard deviation divided by the mean; it is computed for each country separately, and this table reports the median across countries. The measure of persistence for each variable is the slope coefficient in a panel (fixed effects) regression of the variable of interest on its lagged value. The share of variation accounted for by the first principal component is a measure of comovement across countries within each group: it is the share of total variation in a set of series that can be explained by a common component.

Source: IMF, Balance of Payments Statistics Database (all financial flows); World Bank, World Development Indicators Database; IMF, *World Economic Outlook* (GDP). See the text for details.

findings by previous studies (Broner and Rigobon 2006; Prasad and others 2003). The ranking by standard deviation is the same for FDI and other flows to the official sector. However, portfolio debt investment is twice as volatile in advanced economies as in developing economies, and portfolio equity investment is five times as volatile, with emerging market economies somewhere in between. These differences are driven largely by the size of flows for the various country groups and are no longer significant when the coefficient of variation is used to measure volatility. Compared across flows, FDI is the least volatile type of flow in advanced economies, with the exception of other flows to the official sector. For emerging market economies, FDI is more volatile than portfolio debt

investment or portfolio equity investment. For developing economies, other net flows to the official sector are the most volatile, followed closely by FDI.

When the size of the flows is taken into account, however, the results on differences across flows for emerging market and developing economies are reversed. In fact, based on the coefficient of variation, FDI is the most stable flow to emerging market and developing economies (see also Wei 2001): the (cross-country median) coefficient of variation for FDI is close to 1 and is at least twice as large for each of the other types of flows; the difference compared with FDI is statistically significant for other flows to the official sector, other flows to banks, and other flows to the nonbank private sector.[4]

Correlations

Correlations of financial flows with domestic GDP growth, G-7 growth, and U.S. interest rates (the one year T-bill rate) are also reported (see table 2).[5] The coefficients of correlation between financial flows and these variables are quite small, except as noted below. Financial flows are mildly procyclical (with respect to domestic GDP growth) in emerging market and developing economies (see also Albuquerque, Loayza, and Servén 2005). In developing economies, FDI displays the highest correlation with domestic growth, though the coefficient is still small at 0.2. For emerging market economies the most procyclical flows are other flows to banks and other flows to the nonbank private sector. The only type of flow that exhibits significant correlation with G-7 growth is portfolio equity investment for the developing economies (0.2). The U.S. interest rate is correlated with the inflows into advanced economies, with a coefficient of 0.2, and is virtually uncorrelated with the financial account of emerging market and developing economies in the whole sample period, although correlation is large in the 1980s (a period characterized by relatively high interest rates and financing difficulties for emerging market and developing economies in the aftermath of the debt crisis).[6] FDI is negatively correlated with the U.S. interest rate, in both emerging market economies (correlation of -0.3) and developing economies (correlation of -0.2). Other studies, such as Fernández-Arias (1996)—using higher frequency data for shorter time periods— suggest that foreign interest rates do matter for financial flows. The

4. A possible problem with calculating the coefficient of variation is that average net inflows are often quite close to zero. Two alternative measures of relative volatility are used to check robustness: the coefficient of variation for gross financial inflows and the standard deviation of net flows normalized by the average of gross flows. The conclusions are virtually the same.

5. The results are virtually unchanged using an average of German, Japanese, and U.S. interest rates.

6. More generally, note that this analysis does not claim, on the basis of these simple correlations, to overturn the conventional wisdom that investors in advanced economies tend to supply more funds to emerging market and developing economies when interest rates in advanced economies are low. This article simply reports that the various types of flow do not display significantly different correlations with respect to rates in advanced economies.

present exercise finds that correlations with foreign interest rates are lower at the yearly frequency, a result also reported by Broner and Rigobon (2006).

Persistence

To investigate the persistence properties of financial flows, autoregressive coefficients were estimated on pooled data for each relevant country group, using a fixed-effects regression with the first lag on the right side.[7] The financial account balance is more persistent in advanced economies, with an autoregressive [AR(1)] coefficient of 0.7 higher than in emerging market and developing economies, where the AR(1) coefficient is estimated at 0.5. For advanced economies, the AR(1) coefficient is also similar across flows, ranging between 0.3 and 0.4. For emerging market economies the most persistent type of flow is FDI, with an AR(1) coefficient of 0.5, and the least persistent is portfolio debt investment, with a coefficient of virtually zero. For developing economies, the AR(1) coefficient for FDI is 0.35, and for portfolio debt investment, portfolio equity investment, and other flows it lies between 0.2 and 0.5. These estimates are close to those in Obstfeld and Taylor (2004) and Broner and Rigobon (2006), though Broner and Rigobon find that total financial flows are more persistent in emerging market and developing economies than in advanced economies.

Principal Components Analysis

This section analyzes the relationships of financial flows across income groups using principal components analysis, focusing on the share of variation explained by the first principal component—a standard measure of comovement—for each country group. The purpose here is to use comovement as a gauge for the relative importance of individual country factors compared with factors common to all countries in a given group. As an example, suppose that the typical international investor treats all emerging market economies as a group, but plays closer attention to individual country fundamentals in advanced economies. Then the share of variation in capital flows explained by the common factor—the first principal component—would be higher for the emerging market group than for the advanced economy group. Or suppose that portfolio flows are more prone to contagion than is FDI. In that case the first principal component would account for a larger share of variation in portfolio flows than in FDI. Put another way, principal components analysis is a parsimonious way to summarize the degree of comovement among a group of several variables, in this case capital flows to a large group of countries.

7. As an alternative, AR(1) regressions were estimated separately for each country. The disadvantage of the pooled approach is that it constrains the AR(1) coefficient to be the same within each country group. The advantage is that it allows for inclusion of countries for which only a short time series is available. The results obtained by performing the exercise country by country were similar to those reported here.

The empirical findings indicate that for total financial flows the patterns across advanced and developing economies are quite similar, with the first principal component accounting for 25–30 percent of the variation in financial flows. Comparing across flows, FDI and portfolio equity investment display the largest common component for advanced economies. For emerging market economies, FDI has the largest common component; for developing economies, FDI, portfolio debt investment, and portfolio equity investment are roughly similar in this respect. The substantial degree of comovement of FDI compared with some other types of flows across emerging market economies might be seen as somewhat surprising in light of the conventional wisdom that FDI is less likely to be affected by contagion. However, this pattern is consistent with the view that the fundamental determinants of FDI are likely to be correlated across emerging market economies, particularly at the annual frequency. On the whole, the data seem to suggest that there are no pronounced differences across types of flow in the importance of the common component.[8]

Complementarities or Substitutabilities among Different Types of Flows?

The correlation matrix among flows (table 3) permits an assessment of complementarities or substitutabilities across the various kinds of financial flows. Most types of flows are weakly negatively correlated or uncorrelated with each other. This pattern holds for all country groups and is consistent with the results obtained by Claessens, Dooley, and Warner (1995). In a number of instances, the correlations are statistically significantly negative, thus pointing to substitutability across flows. However, the evidence suggests that the correlations are rather small from an economic standpoint, as is the degree of substitutability. Moreover, it is possible that essentially the same type of flow could be classified differently from year to year. For example, if foreign investors acquired a small equity stake in a given company during year 1 and further shares giving them control over the firm during year 2, their investments would usually be classified as portfolio equity in year 1 and as FDI in year 2. Such changes in classification might lead to apparent substitutability between FDI and portfolio equity (in the example above), and might account for a small portion of the observed negative correlations in the data.

To recapitulate the evidence based on the summary statistics reported thus far, equity-like forms of finance seem relatively desirable because the payments they imply tend to be associated with the recipient country's ability to repay. In addition, although the behavior of the various types of financial flow does

8. Although Calvo, Leiderman, and Reinhart (1993) find that the first principal component can account for 60–80 percent of variation in financial flows, their use of monthly data for a shorter time span (four years) on a Latin American sample may explain the difference in results. Albuquerque, Loayza, and Servén (2005) show that the share of variation in FDI that is attributable to global factors has increased dramatically over the past two decades. The use of annual data in this article implies that the time series is too short to provide reliable information on whether comovement has increased over time or whether it is higher in periods of, say, relatively high global flows.

TABLE 3. Correlations among Flows, 1970–2003

	Foreign direct investment	Portfolio debt investment	Portfolio equity investment	Other flows to official sector	Other flows to banks
Portfolio debt investment	−0.09*				
Portfolio equity investment	−0.12*	−0.16*			
Other flows to official sector	−0.07*	−0.14*	−0.01		
Other flows to banks	−0.02	−0.25*	−0.23*	0.02	
Other flows to nonbank private sector	−0.05*	0.03	0.14*	0.001	0.02

*Statistically different from zero at the 10 percent level.

Note: This table reports the correlation matrix among the types of flows. To generate the results in this table, individual country series for each type of flow were first de-meaned by subtracting the country average for the flow, and then the correlation matrix was computed pooling the de-meaned series for all countries. The results are confirmed by computing correlation matrices for each individual country and taking the median correlations across countries.

Source: IMF, Balance of Payments Statistics Database (all financial flows); World Bank, World Development Indicators Database and IMF, *World Economic Outlook* (GDP). See the text for details.

not differ much in some important respects, FDI flows, in particular, seem relatively stable (when controlling for the size of the flows). As reported below, FDI flows are also strikingly impervious to sudden stops.

III. BEHAVIOR DURING SUDDEN STOPS IN FINANCIAL FLOWS

This section shows that differences in the behavior of the various types of financial flows become more pronounced during "sudden stop" events, with FDI flows alone being strikingly impervious to sudden stops.

Defining Sudden Stops in Financial Flows

Definitions of sudden stops generally focus on large and rapid changes in financial flows.[9] This study defines a sudden stop as a worsening in the financial account balance of more than 5 percentage points of GDP compared with the previous year. (The main results hold using alternative numerical thresholds.)

A key advantage of this definition is its simplicity. It should be noted, however, that in a few cases countries maintain a positive financial balance

9. According to an old bankers' saying, "it is not speed that kills; it is the sudden stop"; see Dornbusch, Goldfajn, and Valdés (1995).

even after a large and rapid worsening in the financial account balance. These "sudden slowdowns" in inflows are kept as part of the list of sudden stops because, like other sudden stops, they require a decumulation of reserves or a reduction in the current account deficit. Another potential caveat is that, in principle, some sudden stops in financial inflows may be viewed primarily as the mirror image of improvements in the current account balance—especially windfall gains in export revenues resulting from booms in commodity prices. Although the sample includes commodity exporters, none of the sudden stops analyzed seem to meet this description.

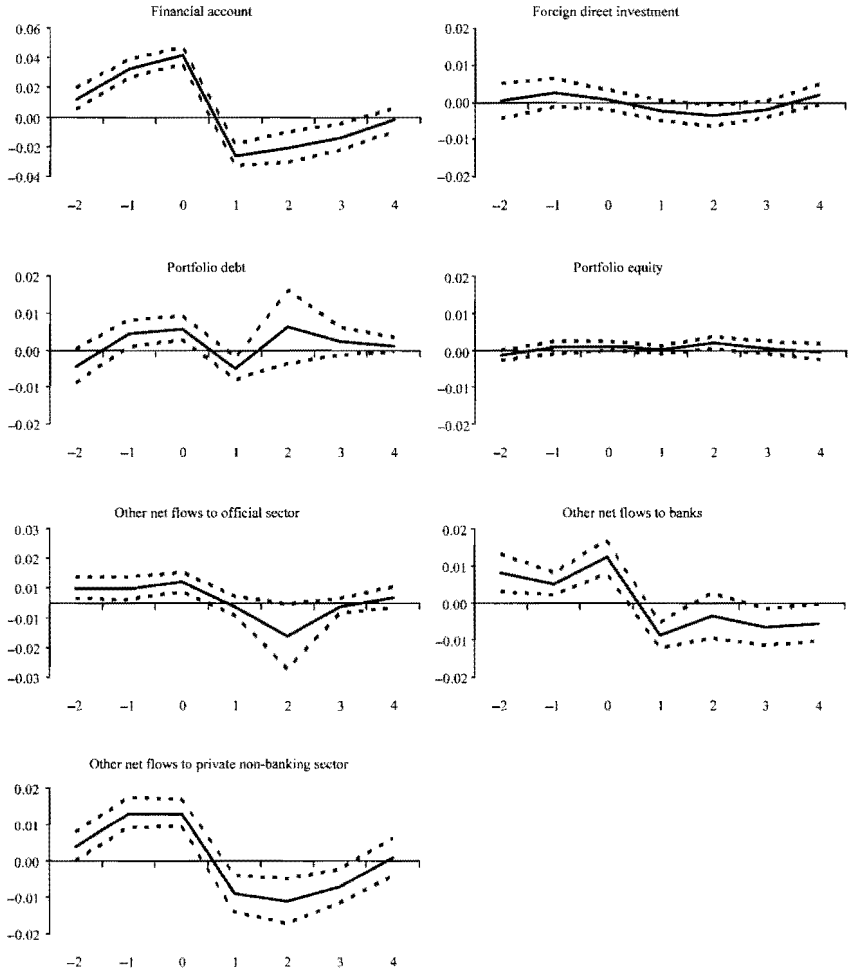
Alternative definitions of sudden stops are possible: for example, a decline in flows by more than two standard deviations, based on the individual country's distribution (Calvo, Izquierdo, and Mejia 2004). Other things equal, however, a threshold based on percentage points of GDP will identify more episodes in countries with volatile financial flows, whereas a threshold based on standard deviations will identify a considerable number of episodes even for countries whose flows are stable by international standards. To alleviate this problem, some studies use a combination of criteria, such as a 5 percentage point of GDP cutoff combined with the change being greater than one standard deviation (Guidotti, Sturzenegger, and Villar 2004). While such definitions are reasonable, this study uses the simpler definition outlined above. The results are robust to changes in the definition.

More generally, regardless of the exact definition, the interpretation of the results will depend on the direction of causality. Arguably, an intuitive and interesting question is which types of financial flows account for a sudden stop prompted by an exogenous fall in the supply to emerging markets, rather than a sudden stop caused by worsening expectations of a country's economic performance. While causality cannot be established definitively, inspection of growth forecast data since 1990 suggests that the list of sudden stops in this article does not include any obvious instances in which the stop was triggered by worsening growth expectations—as shown below.

Behavior of Different Types of Financial Flows around Sudden Stops

The types of financial flows display striking differences in behavior in "sudden stop time," as is evident in the sample of 33 sudden stop episodes in 1980–2002 for which all six subcomponents of the financial account are available for at least a 5-year period around the sudden stop year (figure 1). For each episode, the data are converted to sudden stop time, with $t = 1$ being the year in which the sudden stop occurred. For each type of financial flow, the cross-episode average (solid line) and standard error (the standard deviation divided by the number of episodes—dotted lines) are computed. (The data are first regressed on country and year dummy variables to remove country-specific means and global developments from the data. The main results are largely unaffected by this procedure.)

FIGURE 1. Composition of Financial Flows around All Sudden Stops, 1980–2004 (Percent of GDP)



Note: The behavior of different types of flows is illustrated in "sudden stop" time, with $t = 1$ the year the sudden stop occurred. The solid line represents the average across episodes for each type of financial flow. The dotted lines are one-standard-error bands for the cross-country distribution for the given year (in event time) and type of flow. Sudden stops are reversals in the financial account by more than 5 percentage points of GDP. The sample is restricted to instances in which all six subcomponents of the financial account are available for at least a 5-year period around the sudden stop year. The sample consists of 33 episodes: Argentina (2001); Barbados (1992, 2002); Brazil (1983); Chile (1991); Côte d'Ivoire (1983, 1996); Croatia (1998); Czech Republic (1996); Estonia (1998); Republic of Korea (1997); Latvia (2000); Lithuania (1999); Mauritius (2001); Mexico (1995); Namibia (1991, 1999); Panama (2000); Peru (1998); Philippines (1997); Russian Federation (1998); Senegal (1982); Slovenia (1998); Swaziland (1993); Thailand (1982, 1997); Togo (1992); Turkey (1994, 2001); Ukraine (1998); and Venezuela (1980, 1989, 2002). For each type of capital flow, the entire available sample of countries and years is first regressed on a full set of country and year fixed effects to remove country-specific means and global developments from the data. All flows exclude exceptional financing, use of IMF credit and changes in reserves.

Source: IMF, Balance of Payments Statistics Database (analytic presentation).

FDI plays almost no role in sudden stops in financial flows: it remains strikingly stable, even though it represents a large share of total financial flows.[10] Similarly, portfolio equity seems to play a limited role in sudden stops. Portfolio debt does experience a reversal, though on average it recovers relatively quickly. Other flows to the official sector, banks, and especially the nonbank private sector experience severe drops and remain depressed for a few years after sudden stops. These differences are statistically significant. The drops in FDI and portfolio equity investment during the year of the sudden stop are significantly smaller than the drops in portfolio debt investment, other flows to banks, and other flows to the nonbank private sector. Indeed, whereas the drops in FDI and portfolio equity investment are not statistically different from zero, the drops in all of the other categories are significant.

One might wonder whether the patterns displayed in figure 1 vary depending on country characteristics such as the exchange rate regime or the degree of capital controls. For example, could floating exchange rates reduce the likelihood of excessive inflows that might subsequently be reversed in a sudden stop? Similarly, might capital controls stabilize some types of flows more effectively than others? To address these issues, the sample was split into countries with fixed exchange rate regimes and those with flexible exchange rates.[11] The results (available on request) show remarkably similar patterns for the two groups of countries. For capital controls, too few of the countries in the sudden stop sample had relatively liberal financial accounts to make a reliable comparison.

Replicating the analysis in figure 1 for gross inflows and gross outflows (analogous charts are available from the authors on request) shows that the results for gross inflows are strikingly similar to those reported in figure 1, whereas the results for gross outflows show far more limited action. In other words, the patterns displayed in the figure are accounted for by differences in the behavior of gross inflows, whereas gross outflows do not seem to play an important role in this respect. Thus, in the terminology of Faucette, Rothenberg, and Warnock (2005) and Rothenberg and Warnock (2006), this study's sample seems to consist primarily of "true sudden stops" rather than "sudden flights," and such sudden stops are accounted for mainly by non-FDI inflows.

An alternative way of gauging the role played by each type of (net) flow in sudden stops is to consider the number of instances in which a type of flow worsened by more than a given threshold (say, in percentage points of GDP) during sudden stop episodes (table 4). Considering the 85 sudden stops for which data on some type of flow are available (top panel) and the 33 sudden stops (as in figure 1) for which data on all types of flow are available (bottom

10. Whether this result could be accounted for by "fire-sale FDI" (FDI taking place in the aftermath of a crisis as cash-strapped domestic entrepreneurs sell to foreign investors who are taking advantage of the exchange rate devaluation) is discussed below.

11. Fixed exchange rate regimes were those classified as 4 and above by Reinhart and Rogoff's (2004) "fine" classification, supplemented by information drawn from the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions*.

TABLE 4. Number of Large Worsenings during Sudden Stops, by Flow Type

	Thresholds in percentage point change in GDP				
	1	2	3	4	5
In 85 sudden stops					
Foreign direct investment	33	18	13	10	8
Portfolio debt investment	21	16	10	6	5
Portfolio equity investment	7	2	1	0	0
Other investments	79	75	73	67	60
In 33 sudden stops					
Foreign direct investment	13	9	5	2	2
Portfolio debt investment	18	15	9	6	5
Portfolio equity investment	6	1	1	0	0
Other investments	29	29	26	20	15

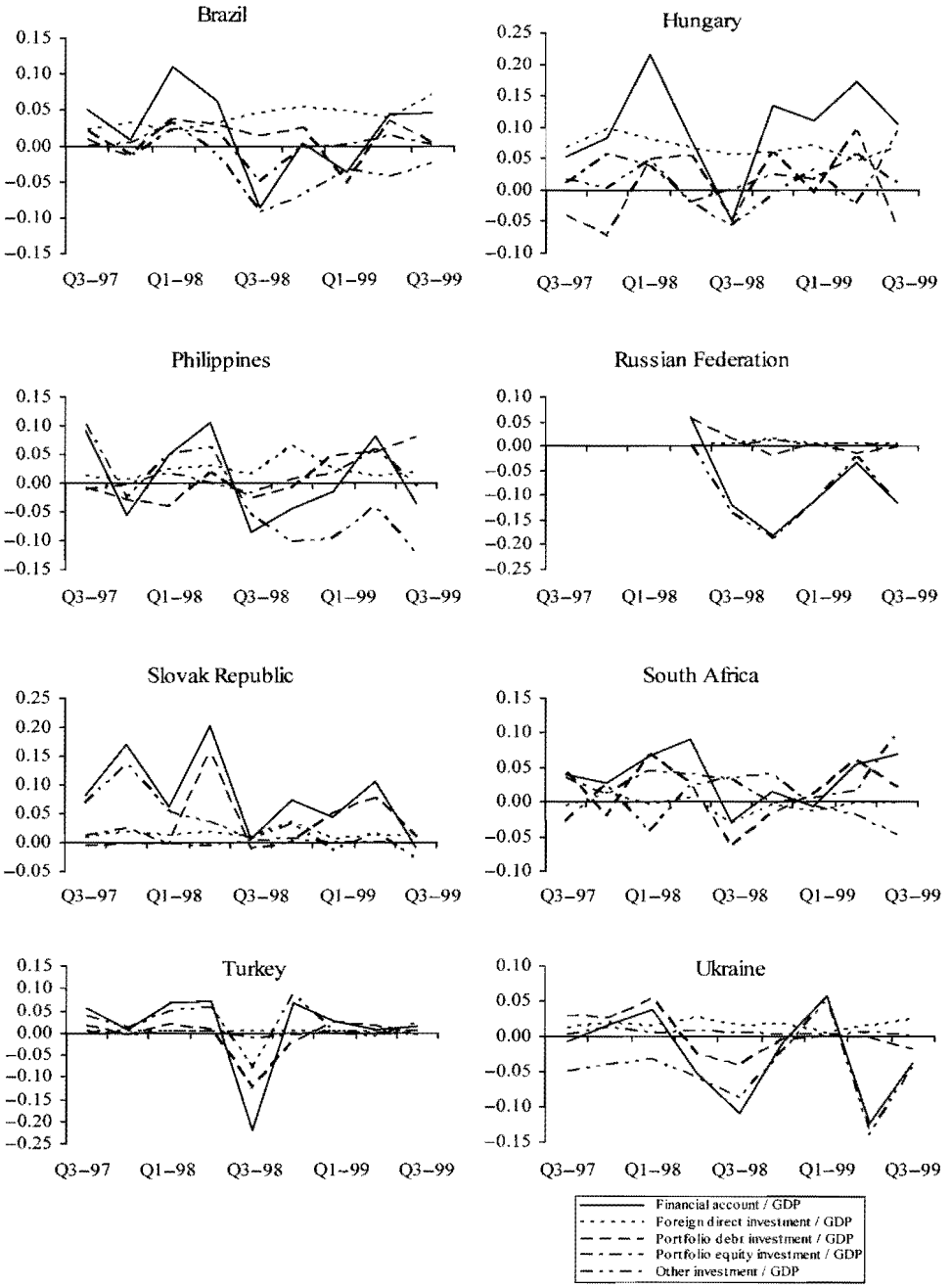
Note: Sudden stops are defined as episodes when the financial account worsens by more than 5 percentage points of GDP. The top panel considers the 85 sudden stops for which data are available for some type of flow. The bottom panel considers the 33 sudden stops for which data are available for all types of flow. The table reports the number of instances in which each flow type fell by more than the indicated number of percentage points of GDP. Thus, there will often be instances in which more than one type of investment falls by more than the indicated benchmark. For brevity, this table aggregates "other flows to official sector," "other flows to banks," and "other flows to nonbank private sector" into "other investments."

Source: IMF, Balance of Payments Statistics Database (all financial flows); World Bank, World Development Indicators Database; IMF *World Economic Outlook* (GDP). See the text for details.

panel) confirms that FDI plays a limited role in sudden stops, whereas "other flows" display more frequent large worsenings. Additionally, portfolio debt displays relatively frequent large drops, especially considering its relatively small size in normal times.

A similar message emerges when considering the response of different components of financial flows at the quarterly frequency around the Russia/Long-Term Capital Management crisis of August 1998, for all emerging market economies (figure 2, which—for the sake of brevity—reports data only for countries whose financial account balance was most affected by the crisis.) Again, FDI (the dotted line) remains remarkably stable in all countries, despite major worsening of the financial account balance (the solid line) and net flows of portfolio debt, portfolio equity, and other flows. The advantages of analyzing the Russia/Long-Term Capital Management crisis and its aftermath are that it may be viewed as a genuinely exogenous sudden stop (an unexpected event, unlikely to have been triggered by simultaneously worsening expectations of growth or other fundamentals in many emerging market economies) and that its consequences may be tracked for all emerging market economies,

FIGURE 2. Composition of Financial Flows around the August 1998 Russian/Long-term Capital Management Crisis (Percent of GDP)[a]



a. "Other investment" includes bilateral official flows but not multilateral official flows.
Source: IMF, Balance of Payments Statistics Database (analytic presentation).

without imposing any numerical cutoff on the size of the financial account reversal. A disadvantage is that the initial nature of the shock, a default on debt contracts, may have made it more likely to affect portfolio debt than other types of liabilities.

Interpretation

Causality and timing. As mentioned, the interpretation of the results regarding which components of financial flows account for sudden stops depends on the ultimate source of the sudden stop. If the sudden stop itself was driven by worsening expectations of economic growth, and if some types of flows were more closely related to growth prospects than others, then differences in resilience across types of flows in the face of sudden stops would arise naturally. If, instead, it was difficult to attribute sudden stops to changes in fundamentals in the affected countries, then one might be more willing to view some types of flows as more prone to reversals, regardless of the ultimate source of the shock.

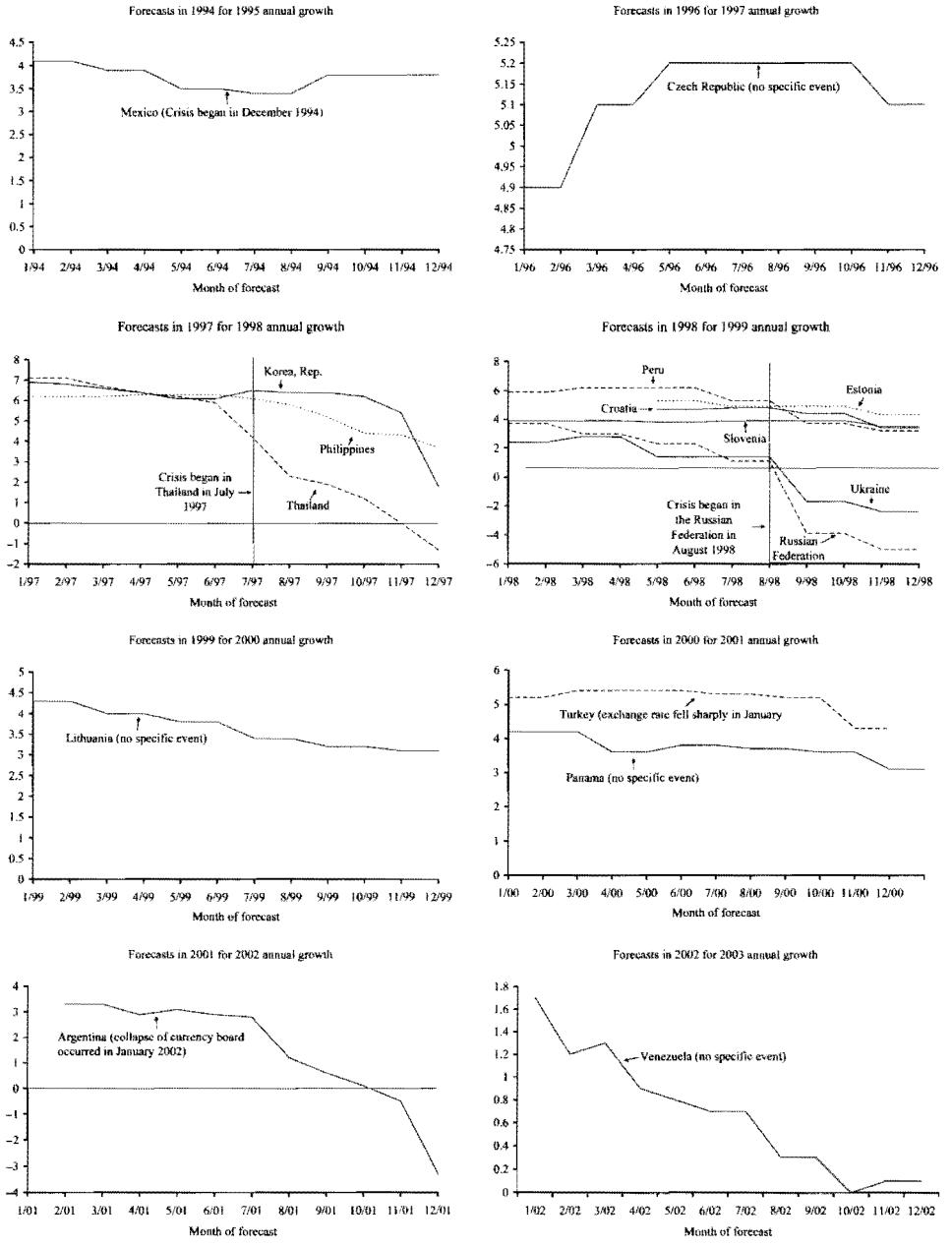
While causality cannot be conclusively established, this section shows that, for most sudden stop episodes in the sample, there is no evidence that they were preceded by a worsening of expectations for economic growth. Beginning with the 33 sudden stop episodes listed in figure 1, the analysis includes all 16 sudden stops for which monthly *Consensus Forecasts* (Consensus Economics, Inc., various years) of economic growth are available. Specifically, for each month of the year in which the sudden stop occurs, the *Consensus Forecast* of economic growth for the following year is considered. This is taken to be a reliable, summary measure of investors' expectations regarding economic fundamentals and prospects in the country in question.

For all sudden stop episodes, expectations of economic growth were buoyant or at least fairly positive at the beginning of the year in which the sudden stop eventually occurred (figure 3). Thus, a few months ahead of the sudden stop, expectations regarding economic fundamentals were usually strong. In general, it seems that expectations regarding economic fundamentals typically evolve gradually and are unlikely to plummet abruptly in the absence of a shock—which seems to take the form of a sudden stop in financial flows in the cases depicted in figure 3.

The monthly profile of how the forecasts change during the year of the sudden stop is also consistent with the view that the sudden stop triggered the decline in forecast growth, rather than the other way around. In most cases where—based on information about financial flows or asset prices—the onset of the sudden stop in capital flows can be dated, there was no worsening in expected growth prior to the month when the sudden stop began.[12] Indeed, in

12. For all sudden stop episodes in countries for which quarterly data are available, the results are confirmed by analyzing quarterly data on financial flows—specifically, by identifying the quarter in which the sudden stop began and checking that the preceding issue of the IMF's *World Economic Outlook* did not forecast a slowdown in economic growth for the country in question.

FIGURE 3. Consensus Forecasts for Economic Growth for the Following Year (Percent Growth)[a]



Source: Consensus Forecasts (Consensus Economics, Inc., various years).

most cases where the sudden stop was associated with an abrupt crisis reflected in the exchange rate or other asset prices, the *Consensus Forecast* growth began falling visibly no earlier than the month during which the crisis erupted (see figure 3).

In several cases, forecast growth declined only months after the exchange rate or other asset prices dropped. For the countries affected by the Asian financial crisis, forecast growth declined after the beginning of the crisis in Thailand (July 1997), that is, after the onset of the sudden stop. Similarly, for the countries affected by the Russian crisis, forecast growth declined only after the August 1998 crisis. (In Russia and Ukraine the worsening began a few months earlier.) In Mexico, forecast growth was strong and stable until the crisis struck (December 1994), and the same is largely the case for Turkey (where the exchange rate fell sharply in January 2001). In Argentina, where the sudden stop occurred in 2001 and 2002, forecast growth began to decline in the summer of 2001, about halfway through the first year of the sudden stop, though clearly prior to the full-blown crisis (December 2001–January 2002). For the remaining cases for which it is difficult to associate the sudden stop with an easy-to-date crisis (Croatia, Czech Republic, Lithuania, Panama, and Venezuela), growth expectations remained strong throughout the year of the sudden stop, except in Venezuela, for which the growth was forecast at about 2 percent at the beginning of the year of the sudden stop but then declined rapidly during the year. On the whole, with the notable exception of Argentina, it appears unlikely that sudden stops were caused by worsening country-specific fundamentals.

Fire-Sale FDI

Another potential concern is that a large portion of the resilience of FDI in the face of sudden stops might be accounted for by an increase in fire-sale FDI. Fire-sale FDI takes place following a crisis (typically involving a sharp currency depreciation), when foreign investors purchase cash-strapped domestic firms at prices below those based on long-run fundamentals. The evidence for such sales is based on firm-level data regressions for a small set of Asian countries in the context of the 1997–98 crisis (Aguiar and Gopinath 2005).

While it is difficult to gauge the exact macroeconomic relevance of fire-sale FDI, two considerations are in order. First, FDI rose after sudden stops in two Asian countries (the Republic of Korea and Thailand) where growth expectations improved rapidly soon after the crisis. In the rest of the sample, FDI remained strikingly stable. Occam's razor suggests that it would be unlikely for fire-sale FDI to match any decline in FDI so as to yield such exact stability in so many countries. Thus, it is an open question whether fire-sale FDI is a phenomenon of macroeconomic relevance in countries other than Korea and Thailand. Second, and more important, one might wonder whether FDI is failing to provide protection from sudden stops when domestic agents take a capital loss and then sell FDI in a fire-sale to foreign investors who buy cheap

assets in the aftermath of the crisis. Although it is true that domestic agents incur a capital loss in this case, a similar loss affects foreign investors who held FDI prior to the crisis. Moreover, as stated in the introduction, this article focuses on the behavior of various types of flow, leaving the cyclical pattern of returns on the resulting stocks as a topic for further investigation.

IV. Conclusions and Possible Extensions

There has been considerable interest in whether some forms of external financing help protect emerging markets against volatility and, in particular, render sudden stops in external financial flows less likely or less damaging. Previous studies have drawn on important episodes or provided partial analysis of stylized facts. This article has systematically documented a thorough list of stylized facts on the behavior of various types of financial flows and focused on times of sudden stop, considering a large panel of advanced, emerging, and developing economies for 1970–2003. The evidence suggests that differences across types of flows are limited with respect to volatility, persistence, cross-country comovement, and correlation with growth at home and in the world economy. However, consistent with conventional wisdom, FDI is the least volatile form of financial flow when the average size of net or gross flows is taken into account. The differences become striking during episodes of sudden stops, when equity-like forms of financial flow and FDI in particular are very stable. Other flows, including portfolio debt flows and, to a greater extent, bank flows and trade credits, account for the sudden stops.

Although causal relationships in this context are difficult to establish, this analysis has addressed issues of possible reverse causality that might affect the interpretation of the results and has focused on the impact of sudden stops that were not clearly triggered by worsening expectations of economic performance in the countries under consideration. It has shown that in most cases the sudden stops considered here were not preceded by expectations of low or worsening growth. Moreover, the results hold when considering the response of different components of financial flows at the quarterly frequency around the Russian crisis of August 1998—an event that can be viewed as clearly exogenous to country-specific variables for most emerging markets.

While many possible extensions to the analysis could be considered, three are worth highlighting. First, the analysis could be repeated controlling for potential determinants of financial flows, thus focusing on the residuals from panel regressions using alternative sets of potential explanatory variables (macroeconomic variables or, as a summary measure of fundamentals, just growth forecasts). However, it seems unlikely that the main results would change, because fundamentals have limited explanatory power for financial flows, particularly at short frequencies (Broner and Rigobon 2006). Second, the behavior of returns on the various types of flows could be explored, showing that returns on equity-like forms of external liabilities (FDI and portfolio equity) are far lower than on

debt-like liabilities in times of sudden stops. This would make it possible to measure the extent to which equity-like types of finance allow domestic producers to share risk with foreign investors. Third, the analysis could explore the consequences of financial flows, looking at whether sudden stops in financial flows (and, more specifically, in non-FDI flows) have a large adverse impact on the deviation of output from forecast output—suggestive evidence that the causal relationship goes from capital flows to output, rather than the other way around.

References

Aguiar, Mark, and Gita Gopinath. 2005. "Fire-Sale Foreign Direct Investment and Liquidity Crises." *The Review of Economics and Statistics* 87(3):439–52.

Albuquerque, Rui, Norman Loayza, and Luis Servén. 2005. "World Market Integration through the Lens of Foreign Direct Investors." *Journal of International Economics* 66(2):267–95.

Borensztein, Eduardo, and Paolo Mauro. 2004. "The Case for GDP-Indexed Bonds." *Economic Policy* 38(April):165–216.

Broner, Fernando, and Roberto Rigobon. 2006. "Why Are Capital Flows So Much More Volatile in Emerging than in Developed Countries?" In R. Caballero, C. Calderón, and L. Céspedes, eds., *External Vulnerability and Preventive Policies*. Santiago, Chile: Banco Central de Chile.

Caballero, Ricardo J., and Kevin Cowan. 2006. "Financial Integration without the Volatility." Massachusetts Institute of Technology, Cambridge, MA.

Calvo, Guillermo, Alejandro Izquierdo, and Luis-Fernando Mejia. 2004. "On the Empirics of Sudden Stops: The Relevance of Balance-Sheet Effects." NBER Working Paper 10520. National Bureau of Economics Research, Cambridge, MA.

Calvo, Guillermo, Leonardo Leiderman, and Carmen Reinhart. 1993. "Capital Inflows and the Real Exchange Rate Appreciation in Latin America." *IMF Staff Papers* 40(1):108–51.

Chuhan, Punam, Gabriel Perez-Quiros, and Helen Popper. 1996. "International Capital Flows: Do Short-Term Investment and Direct Investment Differ?" Policy Research Working Paper 1669. World Bank, Washington, D.C.

Claessens, Stijn, Michael P. Dooley, and Andrew Warner. 1995. "Portfolio Capital Flows: Hot or Cold?" *The World Bank Economic Review* 9(1):153–74.

Consensus Economics, Inc. Various years. *Consensus Forecasts*. London.

Dornbusch, Rudiger, Ilan Goldfajn, and Rodrigo O. Valdes. 1995. "Currency Crises and Collapses." *Brookings Papers on Economic Activity* 1995(2):219–70.

Faria, André, and Paolo Mauro. 2004. "Institutions and the External Capital Structure of Countries." IMF Working Paper 04/236. International Monetary Fund, Washington, D.C.

Faucette, Juillian E., Alexander D. Rothenberg, and Francis E. Warnock. 2005. "Outflows-Induced Sudden Stops." *The Journal of Policy Reform* 8(2):119–29.

Fernández-Arias, Eduardo. 1996. "The New Wave of Private Capital Flows: Push or Pull?" *Journal of Development Economics* 48(2):389–418.

Fernández-Arias, Eduardo, and Ricardo Hausmann. 2001. "Is Foreign Direct Investment a Safer Form of Financing?" *Emerging Markets Review* 2(1):34–49.

Guidotti, Pablo, Federico Sturzenegger, and Agustin Villar. 2004. "On the Consequences of Sudden Stops," *Economía* 4(2):171–203.

IMF (International Monetary Fund). 2007a. "Balance of Payments Statistics Database." Washington, D.C.

———. 2007b. "World Economic Outlook Database." Washington, D.C.

———. Various years "Annual Report on Exchange Arrangements and Exchange Restrictions." Washington, D.C.

Levin, Andrew, Chien-Fu Lin, and Chia-Shang Chu. 2002. "Unit Roots in Panel Data: Asymptotic and Finite-Sample Properties." *Journal of Econometrics* 108(1):1–24.

Lipsey, Robert E. 2001. "Foreign Direct Investors in Three Financial Crises." NBER Working Paper 8084. National Bureau of Economics Research, Cambridge, MA.

Obstfeld, Maurice, and Alan M. Taylor. 2004. *Global Capital Markets: Integration, Crisis, and Growth.* Cambridge: Cambridge University Press.

Prasad, Eswar S., Kenneth Rogoff, Shang-Wei Jin, and Ayhan Kose. 2003. "Effects of Financial Globalization on Developing Countries: Some Empirical Evidence." IMF Occasional Paper 220. International Monetary Fund, Washington, D.C.

Reinhart, Carmen M., and Kenneth S. Rogoff. 2004. "The Modern History of Exchange Rate Arrangements: A Reinterpretation." *Quarterly Journal of Economics* 119(1):1–48.

Rogoff, Kenneth. 1999. "International Institutions for Reducing Global Financial Instability." *Journal of Economic Perspectives* 13(4):21–42.

Rothenberg, Alexander D., and Francis E. Warnock. 2006. "Sudden Flight and True Sudden Stops." NBER Working Paper 12726. National Bureau of Economics Research, Cambridge, MA.

Sarno, Lucio, and Mark P. Taylor. 1999. "Hot Money, Accounting Labels and the Permanence of Capital Flows to Developing Countries: An Empirical Investigation." *Journal of Development Economics* 59(2):337–64.

Wei, Shang-Jin. 2001. "Domestic Crony Capitalism and International Fickle Capital: Is There a Connection?" *International Finance* 4(1):15–45.

World Bank. 1999. *Global Development Finance.* Washington, D.C.

Creditor Protection and Credit Response to Shocks

Arturo José Galindo and Alejandro Micco

This article studies the relationship between creditor protection and credit responses to macroeconomic shocks. Using a data set on legal determinants of finance in a panel of data on aggregate credit growth for 79 countries during 1990–2004, it is shown that credit is more responsive to external shocks in countries with weak legal creditor protection and weak enforcement. The results are statistically and economically significant and robust to alternative measures of creditor protection, to the inclusion of variables that reflect different stages of economic development, to the restriction of the sample to only developing economies, to the controls for systemic crises, to alternative shock measures, and to vector autoregressive specifications. JEL codes: G31, G33, K2.

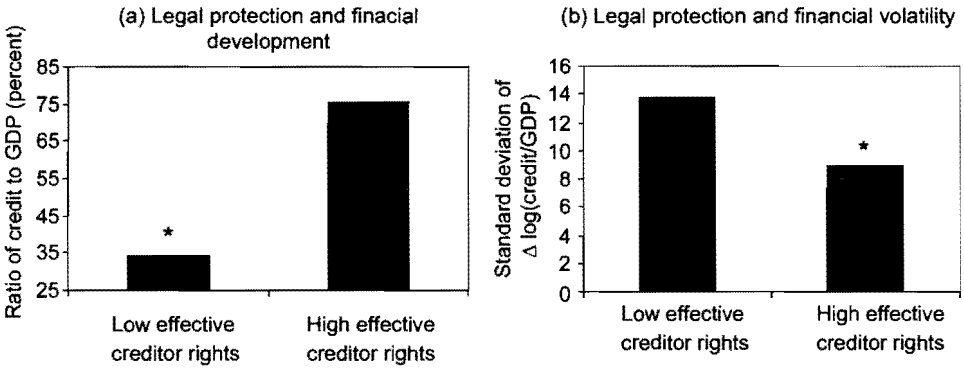
A well-documented feature in recent literature on law and finance is that strong institutions foster the development of financial markets. One strand of the literature has shown that an institutional setup that adequately protects creditor rights (CR) can align the incentives of debtors and lenders, increase the expected payoffs of lending, and deepen financial markets.[1] Less documented

Arturo José Galindo (corresponding author) is the Economic Advisor of the Banking Association of Colombia and Associate Professor at Universidad de los Andes; his email address is ajgalindo@gmail.com. Alejandro Micco is Capital Markets Director at the Ministry of Finance of Chile; his email address is amicco@hacienda.gov.cl. For useful comments and suggestions the authors are grateful to Kevin Cowan, Paolo Mauro, Danielken Molina, Brian Pinto, and Florencio Lopez-de-Silanes; to participants at the Inter-American Development Bank brown bag seminar, the Development Seminar at the University of Illinois at Urbana-Champaign, the Sextas Jornadas de Economía Monetaria e Internacional at Universidad de la Plata, Latin American and Caribbean Economic Association meetings, the Latin American Meeting of the Econometric Society, the Growth and Welfare Effects of Macroeconomic Volatility conference at Universidad Pompeu Fabra, and to three anonymous referees. They are also grateful to Inessa Love for sharing her STATA code for estimating panel vector autoregressions. They also thank César Serra for valuable research assistance and the Inter-American Development Bank for support.

1. This idea has been formalized by Townsend (1979), Aghion and Bolton (1992), and Hart and Moore (1994, 1998). Recent papers by La Porta *et al.* (1997 and 1998) and Djankov, McLiesh, and Shleifer (2007) have provided new data allowing the authors to identify empirically the importance of institutions for the development of private financial markets.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 413–438 doi:10.1093/wber/lhm016
Advance Access Publication 4 October 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

FIGURE 1. Financial Markets and Creditor Protection



*Difference significant at the 5 percent level.
Source: Authors' analysis is based on the data noted in table A-1.

is that the institutional setup can also affect the volatility of credit or the way financial markets respond to shocks.[2] Documenting and explaining this feature is the main purpose of this article.

A long tradition in macroeconomics, beginning with Fisher and Keynes, emphasizes credit markets in the propagation of cyclical fluctuations. But there has been little research on the role of CR in propagating or dispensing shocks in financial markets.[3] This article closes some of the gap by exploring empirically the relationship between creditor protections and the credit cycle.

Figure 1 summarizes some basic findings of previous research on CR and financial markets, motivating this research. Panel a shows how the development of credit markets (as measured by the ratio of credit to the private sector supplied by the financial sector to GDP) is strongly related to a measure of legal protection to creditors: an index of effective creditor rights (ECR) protection that combines legal protection to creditors and their enforcement (higher values indicate stronger protection). (The index is described in more detail below). Countries in the sample are split between those above and below the median ECR index. On average, the size of credit markets is twice as large in countries with stronger CR protection.[4] The figure also shows that institutions protecting CR—besides being important in explaining the size of credit markets—are also important in explaining the volatility of credit. Panel b of figure 1 shows that the volatility of credit—measured as the standard deviation of the annual real growth rate of the ratio of credit to GDP—is significantly

2. An exception is Johnson *et al.* (2000), who show that institutions explain a good part of the currency depreciations and stock market declines during the Asian crisis.

3. See Braun and Larrain (2005) for a discussion.

4. Similar findings appear when analyzing the median country rather than the average.

smaller in countries with stronger creditor protection. In the average country with poor CR protection, the standard deviation of the annual real growth rate of credit to GDP is 14 percent, significantly higher than in countries with strong CR protection (8 percent).

The empirical analysis corroborates this stylized fact. Panel data on aggregate credit growth for 79 countries during 1990–2004 support the claim that better legal protections significantly reduce the sensitivity of credit to shocks. Indeed, the impact of exogenous shocks to credit markets is larger in countries with low creditor protection. In common law (CL) countries, characterized by high creditor protection and good contract enforcement, the elasticity of credit to external shocks is half that elsewhere. An improvement of one standard deviation in either CR or contract enforcement substantially reduces the sensitivity of credit to external shocks. These results are robust to alternative measures of creditor protection, to the inclusion of variables that reflect different stages of economic development, to the restriction of the sample to only developing economies, to alternative definitions of shocks, to additional controls, and to different dynamic specifications.

I. Related Literature and Motivation

This article is a natural extension of previous work on creditor protection and financial development. According to that literature, the quality of institutions supporting financial contracts is a crucial determinant of the amount of credit that the financial system extends to firms and individuals. Rules and regulations that protect CR in financial contracts—for example, regulations that clearly state the right of creditors to seize collateral in a timely manner if a debtor defaults—and that are properly and efficiently enforced increase the power of creditors and the size of credit markets. Townsend (1979) formalized this idea using a costly state verification model, and Aghion and Bolton (1992) and Hart and Moore (1994, 1998) using an incomplete contract approach.

La Porta *et al.* (1997 and 1998), Beck, Demirgüç-Kunt, and Levine, (2003), and Djankov, McLiesh, and Shleifer (2007) test this idea studying the cross-country correlation between creditor protection and the size of credit markets proxied by the amount of credit to the private sector as a share of GDP. Using a different empirical approach, Demirgüç-Kunt and Maksimovic (1998), Beck, Demirgüç-Kunt, and Maksimovic (2003, 2005), and Galindo and Micco (2004) test this idea studying the firm cross-section implication of creditor protection. Weak creditor power has a larger detrimental effect on firms more likely to be credit-constrained by financial frictions, such as small firms.

This article moves ahead, focusing on the effect of creditor protection, not on credit access (first moment), but on second moments; the way aggregate credit responds to external shocks. There has been little research on the role of creditor protection in propagating shocks into credit markets. The few

empirical papers that study related issues focus on the effect of financial imperfections on either investment or output. For example, using data on large listed firms around the world, Love (2003) shows that firm investment in countries with low creditor protection reacts more to cash flows.[5]

Using a difference-in-difference approach and data from several manufacturing industries in countries around the world, Braun and Larrain (2005) and Raddatz (2006) show that the output volatility is higher in industries that are more dependent on external finance. The observed difference in the behavior of industries is bigger when financial friction is more prevalent (for example, a lack of accounting standards). These findings suggest that stronger financial systems contribute to diminished output volatility. Kroszner, Laeven, and Klingebiel (2007) find, in 19 countries, that industry growth in countries with shallower financial systems is less affected by financial crises than in countries with deeper financial systems.[6]

Their results cannot be easily extrapolated to the whole economy either because of data limitations (large listed firms in Love 2003) or because of the methodology, a difference-in-difference approach in Braun and Larrain (2005) and Raddatz (2006).[7]

This article complements this research by going one step back in the chain of events. Rather than exploring the impact of shocks on output under different scenarios of financial development, it explores the impact of shocks on financial markets, under different institutional setups.

In a related paper, Johnson *et al.* (2000) present evidence that the weakness of legal institutions is important in explaining the extent of depreciation and stock market decline in the Asian crisis (1997–98). Even though their work mainly focuses on minority shareholder expropriation by managers, not on private credit, their study is similar to this one because it suggests that corporate governance matters for the extent of macro variable fluctuation during a shock. This article can be viewed as a complement to the work of Johnson *et al.* (2000), but has a larger country coverage and focuses on credit markets rather than on equity markets.

This article is also closely related to the literature on credit channels, which shows the financial sector, due to financial friction, to be a propagation mechanism of primitive shocks, such as monetary disturbances, preferences, or terms of trade shocks. Kiyotaki and Moore (1997) study how credit constraints interact with aggregate economic activity over the business cycle. Using a dynamic setup in which lenders cannot force borrowers to repay unless their debts are secured, they find that the interaction between credit limits (collateral) and asset prices turns out

5. In a similar fashion Laeven (2003) shows that financial constraints are eased in countries with more liberal financial markets.

6. The rationale for this finding is that when credit markets are developed, firms depend more on credit in normal times and thus suffer more when credit is interrupted.

7. A difference-in-difference approach allows studying the sectors or firms that are more affected by a given factor, a cross-derivate effect, but it does not allow determining, without strong assumptions, the main effect (aggregate impact).

to be an important transmission and amplifier mechanism for exogenous shocks to credit and output.[8]

Using a different approach, Bernanke, Gertler, and Gilchrist (1999) develop a dynamic general equilibrium model, which exhibits a financial accelerator. In their setup entrepreneurs are financially constrained and have to borrow from a financial intermediary. To motivate a nontrivial role for the financial sector, they assume a costly state verification approach. This auditing cost, proportional to debt, is paid only in a default and thus is interpretable as a bankruptcy cost. The paper finds that bankruptcy costs amplify the effect of exogenous shocks on both investment and output. An improvement in legal and effective protection can be thought of as a reduction in bankruptcy costs, which would lead to the conclusion that better creditor protection reduces the impact of exogenous shocks.[9]

In seminal papers focusing on credit markets, Holmstrom and Tirole (1997 and 1998) develop incentive models of financial intermediation in which, due to moral hazards, both firms and banks are capital-constrained. In these models, firm and bank wealth determines their debt capacity. The novelty is that in a simple framework, they can study demand factors (changes in the collateral of firms) and supply factors (changes in bank capital). So they can separate a balance sheet channel and a lending channel, with credit proportional to the net worth of entrepreneurs.

In a Holmstrom and Tirole type of setup, the impact of creditor protection on credit can be ambiguous. Better creditor protection has a stabilizing effect on credit. The expected income that can be pledged to lenders without jeopardizing the entrepreneur's incentives to work increases with stronger creditor protection. The proportionality between credit and wealth, or the "equity multiplier," increases with pledgeable income. When the economy faces a negative shock (be an increase in the probability of bankruptcy of firms), pledgeable income falls, but it falls more in countries with weak creditor protections. In response, for a given level of wealth, credit is tightened more in a weak legal environment than in a strong one. In the case of success, the firm repays its debt. But in the case of failure the creditor collects only a fraction of the residual value of the firm.

8. In this model legal creditor protections could be introduced by assuming that the fraction of the market value of assets that the entrepreneur can borrow against is an increasing function of the legal environment.

9. The empirical studies in this area are concentrated in the firm cross-sectional implications of this channel. The literature shows that shocks have a large impact on firms more likely to be credit-constrained by financial friction (such small as small firms). These studies focus mainly on the United States and a few developed economies and do not focus on legal protection. This literature shows differential effects of shocks on employment (Sharpe 1994), investment (Fazzari, Hubbard, and Petersen 1988; Oliner and Rudebusch 1996), inventories (Kashyap, Lamont, and Stein 1994), sales, and short-term debt (Bernanke, Gertler, and Gilchrist 1996; Gertler and Gilchrist 1994).

This result requires the assumption that net worth is fixed. If net worth is also affected by the shock, the total impact will depend on how it affects both net worth and the multiplier. The views on this are somewhat conflicting. Raddatz's (2006) findings suggest that external shocks have a smaller impact on output in more financially developed economies (countries with better creditor protection, following La Porta *et al.* 1997, 1998). If output is used as a proxy for wealth, this would suggest an overall negative impact of creditor protection on credit fluctuations in a Holmstrom and Tirole type of setup. But Kroszner, Laeven, and Klingebiel (2007) suggest the contrary that output fluctuations could be stronger in more financially developed economies. If so, the impact of creditor protections could be ambiguous.

Overall, the credit channel view—of Kiyotaki and Moore 1997 or Bernanke, Gertler, and Gilchrist 1996, 1999—would suggest a negative impact of creditor protection on credit fluctuations, whereas the incentive view of financial intermediation suggests an ambiguous relationship.[10] The question is thus empirical and addressed in what follows.

II. Empirical Methodology

The approach here consists of exploiting the different responses of countries with different creditor protection to external shocks that change the profitability of projects and thus the probability of bankruptcy. The dependent variable is the yearly change in real credit in each of the 79 countries in the sample, during 1990–2004.[11] Specifically, it is credit provided to the private sector by the financial system divided by nominal GDP (line 22d of International Financial Statistics of the International Monetary Fund)[12]—the first difference of the logarithm of this variable. The ratio of credit to GDP (not credit) guarantees measuring the impact of the shock on the volatility of financial markets, and not merely the impact of the shock on the volatility of credit through its impact on GDP.

The study identifies how credit responds to an exogenous shock under different institutional setups. Crucial in this is obtaining an adequate proxy for such a shock. A key characteristic of this proxy is that it should not be endogenous to the behavior of credit. This rules out such straightforward measures as GDP growth, since credit and GDP are simultaneously determined (see Beck, Levine, and Loayza 2000). To obtain an exogenous measure of shocks, we construct an external shock variable based on the GDP growth rate of the trading

10. Feijen and Perotti (2005) show that another type of volatility arises in countries with weak creditor protection. Weak creditor protection reduces the availability of refinancing opportunities for small firms. This leads to an inefficiently high number of exits of small firms when the economy faces a negative shock.

11. The sample period is restricted to the 1990s and onward, since the institutional data that will be described below, is only available for this period.

12. For countries that adopted the euro in 1999, it is the sum of line 22d.f through line 22zw.

TABLE 1. Real GDP Growth and External Shock

Dependent variable: Δ log(GDP)				
	(1)	(2)	(3)	(4)
External shock	1.798 (0.296)***	1.992 (0.388)***	2.181 (0.413)***	1.471 (0.274)***
External shock* developed	—	−0.325 (0.451)	—	—
Number of observations	1.022	1.022	678	344
Number of countries	79	79	53	26
Country-fixed effects	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes
R-squared	0.26	0.27	0.23	0.42
Sample	All	All	Developing	Developed

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data from International Monetary Fund International Financial Statistics Database.

partners of any given country, weighted by exports over the source country's GDP. Formally, the shock measure is constructed as follows,

$$ext.shock_{it} = \overline{S_i} \sum_{j=1}^{J} s_{ij,t-1} * g_{jt}$$

where $ext.shock_{it}$ is the external shock to country i at time t, $s_{ij,t-1}$ is the share of exports from country i to country j in $t-1$,[13] $\overline{S_i}$ is the average share of exports to GDP in country i during the sample period,[14] and g_{jt} is the growth rate of real GDP of country j at time t. The data source for s_{ij} is the Direction of Trade Statistics Database of the International Monetary Fund, and for $\overline{S}$ and GDP growth rates, the World Bank's World Development Indicators Database.

The relevance of the shock measure is summarized in table 1, which shows a strong correlation between the external shock and the real growth rate of GDP. Column 1 shows that, controlling for country and year fixed effects, the external shock measure is strongly and significantly correlated with the real GDP growth rate of countries in the sample. Column 2 confirms that this

13. Given j and t, the sum of $s_{ij,t-1}$ over j is equal to one.

14. Used here is the average share of exports in GDP, to avoid fluctuation in this variables related with changes in the nominal exchange rate, which is endogenous. Note that in $s_{ij,t-1}$, country i's exchange rate movements cancel out.

correlation remains significant even when controlling for the level of development, measured by a dummy indicating whether the country is a high-income country according to World Bank classification. (This classification is detailed in the appendix).[15] Columns 3 and 4 show that the correlation remains significant and that the regression coefficient remains stable when splitting the sample between developing and industrial economies. Overall, the measure of external shock appears to be a good predictor of economic activity.

Using this external shock measure, the study estimates regressions of the following type:

$$\Delta Credit_{i,t} = \beta_1 ext.shock_{i,t} + \beta_2 ext.shock_{i,t} * legal_protection_i + DT_t + \eta_i + \varepsilon_{i,t} \quad (1)$$

where DT is a year dummy variable to control for any temporal fixed effects, η_i is a country fixed effect to control for country-specific trends and ensure that pooling of time series observations for an individual country with cross-sectional observations across countries does not generate spurious statistical significance, and $legal_protection_i$ is a set of variables that proxy the legal protection of creditors and the way regulations are enforced. If $\beta_1 > 0$ and $\beta_2 < 0$ credit reacts positively to shocks, but the size of the reaction diminishes as legal protection improves. If $\beta_2 > 0$ credit reacts more to shocks in strong legal protection economies.

As a proxy for legal protection, the study uses the measure of CR constructed initially by La Porta *et al.* (1998); for contract enforcement, the rule of law (RL) and the days to enforce a credit contract (CE); and the total duration of the procedure (TD) to clear a check. It also uses two variables to proxy for de jure creditor protection and enforcement at the same time: ECR and CL legal origin. The definitions and sources of the legal protection proxies are the following.

(1) CR: The Djankov, McLiesh, and Shleifer (2007) index of CR is used here. This measure, based on La Porta *et al.* (1998), estimates the degree to which secured creditors are protected during bankruptcy procedures. The index ranges from zero to four, where a higher number indicates greater creditor protection. A score of one is assigned when each of the following rights is defined in laws and regulations: there are restrictions on debtors to file for reorganization, such as creditor consent or minimum dividends; secured creditors can seize their collateral after the reorganization petition is approved (no "automatic stay" or "asset freeze."); secured creditors are paid first out of the proceeds of liquidating a bankrupt firm; and when management does not retain administration of its property pending the resolution of the reorganization.

15. This classification is detailed in the appendix.

(2) RL: The Kaufmann, Kraay, and Mastruzzi (2005) measure of the RL is used here. RL includes several indicators that measure the extent to which agents have confidence in and abide by the rules of society. These include perceptions of the incidence of crime, the effectiveness and predictability of the judiciary, and the enforceability of contracts.
(3) CE: This measures the number of days to resolve a payment dispute through courts, according to Djankov, McLiesh, and Shleifer (2007), who analyze a standard case across several countries and study the number of calendar days required to enforce a contract of unpaid debt worth 50 percent of the country's GDP per capita.
(4) TD: This measures the number of days of a process to collect a bounced check. The source of the data is Djankov *et al.* (2003) and, as above, it is also used as a proxy of efficiency.
(5) ECR: The product of CR and RL is a summary measure for both regulations and the quality of their enforcement. It takes into account that weak law enforcement can diminish the quality of regulations. Both CR and RL are normalized between zero and one in such a way that ECR also fluctuates within this range. A higher value indicates higher creditor protection.
(6) CL: The legal origin of each country's legal code is used as a proxy, both for a better creditor protection and for greater law enforcement. CL is a dummy that takes a value of one when countries have a CL legal tradition and zero otherwise. As shown by La Porta *et al.*(1998), among many others, a CL tradition is an adequate instrument for better CR and law enforcement. As for ECR, CL also proxies simultaneously for legal protection and enforcement. The source of this data is Djankov, McLeish, and Shleifer (2007).

Appendix table A-1 reports the average values and basic descriptive statistics at an aggregate level and at a country level. Table A-2 reports the cross-correlation matrix of the institutional regressors. Table A-3 reports country-specific values of these variables. For the econometric exercises here, all variables have been demeaned.

III. Results

To test whether the institutional setup affects how aggregate credit responds to shocks, a panel is constructed gathering information between 1990 and 2004[16] for a broad set of countries across the world and to estimate equation (1).

16. The sample of countries is dictated by data availability. All specifications include year- and country-fixed effects. The dataset is restricted to the number of country–year observations, where data on all variables are available.

Benchmark Results

Table 2 reports a first set of results that include the CR measure and each of the enforcement proxies separately in each regression. Column 1 reports the result using CR as the proxy for de jure protection. The framework allows for a differential role for the impact of variables that reflect better legal protection and those measuring better enforcement. Determining whether the proxies measure exclusively one or the other is not straightforward. Even so, the impact of each is assessed separately by simultaneously including a variable exclusively related to the content of regulations (such as the CR index) and other variables that capture mostly the efficiency of the legal process (such as the duration of enforcing contracts, the duration of clearing a bounced check, and the RL). These results are reported in columns 2–4. In columns 2 and 3 the negative of the log of the number of days that the procedures last is used to maintain the same interpretation as the other indexes (that higher values mean greater creditor protection or greater efficiency in enforcing creditor protections). Column 5 reports results using the ECR index, and column 6 uses the CL legal origin dummy. The lower part of the table includes an F test to assess the joint significance of the CR measure and the enforcement measures when included jointly in the regressions.

The results in table 2 suggest that better creditor protection and better enforcement reduce the impact of shocks on credit. All regressions reported in columns 1–6 show negative and significant coefficients on the interaction of the shock measure and the creditor protection proxies. The legal measure of CR protection is significant at the 1 and 5 percent significance levels in all specifications, and it remains significant when also including enforcement variables in the specification. The enforcement measures are also significant at the 1 percent level except in column 3, where the duration of clearing a check is significant at the 5 percent level. The ECR index and the CL dummy are significant at the 1 percent level. The negative signs indicate that credit to GDP tends to react less to an external shock in countries, where both legal protection and their enforcement are stronger. The results corroborate the hypothesis that stronger creditor protection reduces the responsiveness of credit to external shocks.

These results are not only statistically significant, but their economic magnitude is also relevant. A one-standard-deviation increase in a country with a mean value of the CR index would reduce the coefficient of the external shock by nearly 60 percent.[17] Similarly, a one-standard-deviation increase in the contract enforcement measure, everything else equal, reduces the coefficient on the external shock by nearly 1.8 points (a 30 percent fall in the coefficient). If a negative shock hits the economy, the contraction of credit will be 30 percent

17. For these and similar exercises it is important that the variables have been demeaned. The descriptive statistics of the main variables are reported in appendix table A-1.

TABLE 2. Benchmark Results

Dependent variable: Δ log(Credit/GDP)						
	(1)	(2)	(3)	(4)	(5)	(6)
External shock	4.686 (1.196)***	5.910 (1.228)***	5.895 (1.289)***	5.933 (1.212)***	5.907 (1.238)***	6.117 (1.601)***
External shock* CR	−2.571 (0.774)***	−2.198 (0.749)***	−1.918 (0.792)**	−1.629 (0.786)**	—	—
External shock* CE	—	−2.391 (0.803)***	—	—	—	—
External shock* TD	—	—	−2.309 (0.959)**	—	—	—
External shock* RL	—	—	—	−2.686 (0.783)***	—	—
External shock* ECR	—	—	—	—	−0.799 (0.177)***	—
External shock* CL	—	—	—	—	—	−5.007 (1.680)***
Number of observations	1.022	1.022	1.022	1.022	1.022	1.022
Number of countries	79	79	79	79	79	79
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F test (joint significance)	—	0.00	0.00	0.00	—	—
R-squared	0.14	0.14	0.14	0.15	0.15	0.14
Sample 1990–2004						

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

lower in a country one–standard-deviation ahead of a country with average contract enforcement hit by an identical shock. Results are similar for the duration of clearing a bounced check and the RL. Similarly a one-standard-deviation increase in the ECR index reduces the impact of the external shock by nearly 3.0 points (nearly half). In countries with a CL tradition, the impact on credit growth of an external shock is about 80 percent lower than in a non-CL country, depending on the sample of countries in the regression analysis.

Robustness Exercises

One concern about these results is that they may be driven by differences in economic development and that economic development is being proxied by the legal and institutional variables considered. To account for this, economic development is controlled in two ways (tables 3 and 4).

Table 3 includes an interaction of the external shock variable with a dummy indicating high income according to the World Bank classification. Table A-3 in the appendix indicates which of these countries are in the sample. In table 3 the coefficients estimated for the interactions between the creditor protections and the shock measure capture the differential impact of regulations beyond the impact of different levels of economic development. The results are very similar to those reported in table 2. There is a loss of significance in two of the enforcement measures (CE and TD), though the RL remains significant at the 5 percent level. The significance of the CR index drops, though it remains significant across specifications. The economic impact estimated after controlling for development is reduced but still remains sizeable. And CL countries are about 50 percent less sensitive to an external shock than non-CL countries.

Another way of dealing with the concern that the results reflect levels of development rather than legal and institutional differences is to split the sample. Table 4 reports the same results as before, but restricts the sample to developing economies only. Although the individual significance of the CR index falls in one of the specifications (column 3), the joint significance of the CR measure and any of the efficiency of enforcement variables remains.[18] The significance of the ECR measure remains at the 1 percent level. The order of magnitude is slightly larger than that estimated in table 3. CL countries in this sample are about 60 percent less sensitive to the external shock than non-CL ones.

Many countries suffered from systemic banking crises in the 1990s, as shown by Caprio and Klinglebiel (2003). A crisis naturally leads to a contraction in credit regardless of the quality of the legal and enforcement system. Columns 1 and 2 of table 5 control for this by including a dummy for systemic crises based on the Caprio and Klinglebiel study. The results are qualitatively

18. Given the small number of developing economies with information for EJ, the results in column 4 are not stressed here.

TABLE 3. Controlling For Development I

Dependent variable: Δ log(Credit/GDP)

	(1)	(2)	(3)	(4)	(5)
External shock	6.512 (1.435)***	6.726 (1.452)***	5.409 (1.426)***	6.058 (1.381)***	7.309 (1.735)***
External shock* CR	−1.931 (0.774)**	−1.686 (0.799)**	−1.654 (0.779)**	—	—
External shock* CE	−1.318 (1.137)	—	—	—	—
External shock* TD	—	−1.363 (0.999)	—	—	—
External shock* RL	—	—	−3.673 (1.704)**	—	—
External shock* ECR	—	—	—	−0.729 (0.225)***	—
External shock* CL	—	—	—	—	−3.481 (1.743)**
External shock* developed	−2.523 (2.061)	−2.904 (1.573)*	2.151 (3.043)	−0.744 (1.797)	−3.798 (1.512)**
Number of observations	1.022	1.022	1.022	1.022	1.022
Number of countries	79	79	79	79	79
Country-fixed effects	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
F test (joint significance)	0.03	0.02	0.00	—	—
R-squared	0.14	0.15	0.15	0.15	0.15
Sample 1990–2004					

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

TABLE 4. Controlling For Development II

Dependent variable: Δ log(Credit/GDP)					
	(1)	(2)	(3)	(4)	(5)
External shock	7.074 (1.572)***	7.559 (1.582)***	5.668 (1.652)***	6.532 (1.452)***	8.039 (2.002)***
External shock* CR	−2.805 (1.205)**	−2.686 (1.163)**	−2.022 (1.275)	—	—
External shock* CE	−2.052 (2.181)	—	—	—	—
External shock* TD	—	−2.802 (1.217)**	—	—	—
External shock* RL	—	—	−4.355 (2.125)**	—	—
External shock* ECR	—	—	—	−1.434 (0.412)***	—
External shock* CL	—	—	—	—	−4.726 (2.507)*
Observations	678	678	678	678	678
Number of countries	53	53	53	53	53
Country-fixed effects	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes
F test (joint significance)	0.06	0.01	0.00	—	—
R-squared	0.15	0.16	0.16	0.16	0.15
Sample developing economies 1990–2004					

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

the same as those in table 3. For brevity, only the results using the ECR measure and the CL indicator are reported here.

Columns 3 and 4 of table 5 control for a measure of domestic financial liberalization constructed by Kaminsky and Schmukler (2002). The empirical literature has shown that financial liberalization has a positive impact on financial depth. But the measures of financial liberalization cover a much smaller sample, when controlling for financial liberalization, both in countries and in years. The sample falls from 1,022 observations to 309, and the country coverage falls from 79 countries to 27 making the results of this exercise incomparable with the previous ones. But for this reduced sample, the main empirical conclusion of the article remains.

Columns 5 and 6 control for a different measure of financial liberalization, using an equity market liberalization dummy, constructed by Bekaert, Harvey, and Lundbald (2005). The dummy takes the value of one when the domestic equity market has been liberalized. This dummy is available to the year 2000. When controlling for this type of liberalization the sample falls to 654 observations in 63 countries. Again, the main conclusions of the previous estimations hold. Even when controlling for financial liberalization in smaller datasets, the finding that better creditor protection reduces the impact of external shocks remains.

Table 6 presents results using alternative definitions of the external shock. To save space the table reports results using exclusively the CL dummy, which summarizes good law enforcement and high creditor protection. Column 1 uses the lagged value of a measure of fluctuation in export prices as a shock.[19] Column 2 uses the lagged value of import prices. Column 3 uses the forecast of a regression of GDP growth on export prices, import prices, and the previous real shock measure. This measure can be interpreted as the component of GDP fluctuation explained by relevant external characteristics. As before, economic development is controlled. The results are once again in line with the main finding of the article. The sign of the interactions of the alternative measures of shocks with the CL dummy is negative and significant.

Table 7 explores whether the impact of the shock varies according to its size—to check whether the way credit responds to shocks that lead to recessions is different from the way it responds to positive shocks.[20] Negative shocks are defined in two ways. In columns 1 and 2, negative shocks are considered as those in the lowest 10th percentile of the distribution of our external shock measure. Columns 3 and 4 allow for a broader set of shocks by considering those in the lowest 25th percentile of the distribution as negative. A dummy indicating negative shocks,

19. The change in export prices is defined as the log-change of export prices from the World Development Indicators multiplied by the average share of exports over GDP during the sample period (1990–2004). Here, the variable "Exports of goods and services (current US$) – WDI (2005)" is used.

20. Asymmetries in the response of credit can also be derived from the possibility that lending standards are relaxed during booms and tightened during recessions, as in Dell'Ariccia and Marquez (2007).

TABLE 5. Controlling For Systemic Banking Crises And Financial Liberalization

Dependent variable: Δ log(Credit/GDP)

	(1)	(2)	(3)	(4)	(5)	(6)
External shock	5.656 (1.395)***	6.804 (1.663)***	3.710 (1.790)**	7.040 (3.500)**	5.549 (1.711)***	7.990 (2.717)***
External shock* ECR	−0.665 (0.229)***	—	−0.517 (0.290)*	—	−0.808 (0.269)***	—
External shock* CL	—	−3.198 (1.717)*	—	−4.989 (2.990)*	—	−3.785 (2.275)*
External shock* developed	−1.035 (1.824)	−3.814 (1.534)**	5.046 (2.044)**	2.784 (1.971)	−0.093 (1.949)	−4.242 (1.803)**
Systemic crisis dummy variable	−0.062 (0.016)***	−0.062 (0.016)***	—	—	—	—
Financial liberalization 1	—	—	0.053 (0.028)*	0.054 (0.028)*	—	—
Financial liberalization 2	—	—	—	—	0.001 (0.035)	0.002 (0.035)
Number of observations	1.022	1.022	309	309	654	654
Number of countries	79	79	27	27	63	63
Country-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.16	0.16	0.23	0.23	0.17	0.17
Sample	1990–2004		1990–2001		1990–2000	

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

TABLE 6. Alternative Shock Measures

Dependent variable: Δ log(Credit/GDP)			
	(1)	(2)	(3)
Export prices shock	0.849 (0.181)***	—	—
Export prices_shock* CL	−0.692 (0.257)***	—	—
Export prices_shock* developed	−0.327 (0.313)	—	—
Import prices_shock	—	0.620 (0.192)***	—
Import prices_shock* CL	—	−0.726 (0.286)**	—
Import prices_shock* developed	—	−0.033 (0.3520	—
Composite shock	—	—	2.931 (0.563)***
Composite shock* CL	—	—	−4.206 (1.892)**
Composite shock* developed	—	—	−1.615 (1.977)
Number of observations	976	976	976
Number of countries	77	77	77
Country-fixed effects	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
R-squared	0.15	0.14	0.15
Sample 1990–2004			

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

labeled *Dum_Neg_Shock*, interacts with the external shock measure, the external shock measure multiplied by the legal protection variable, and the legal protection variable. Significant estimates of these interactions would suggest an asymmetric response of credit to negative shocks. Results show that these interactions are not significant, suggesting that there is no evidence of asymmetries in the response of credit to external shocks.

Vector Autoregression Evidence

The empirical exercise described above and its various robust extensions assume no dynamic relationship between the variables in the empirical model.[21] To circumvent this restriction, the following panel vector autoregression is estimated,

$$x_{it} = C(L)x_{it} + \eta_i + d_t + \varepsilon_{it} \quad (2)$$

21. The previous analysis assumed that the external shock measure is exogenous. As pointed out by an anonymous referee, there is a possibility of endogeneity if a credit contraction in one country (possibly associated with a financial crisis) leads to a negative shock to exports in other countries due to financial contagion, and so affects the external shock to some degree. We believe that this source of endogeneity is small, and in the vector autoregression exercises it would be accounted and controlled for.

TABLE 7. Testing For Asymmetries

Dependent variable: Δ log(Credit/GDP)

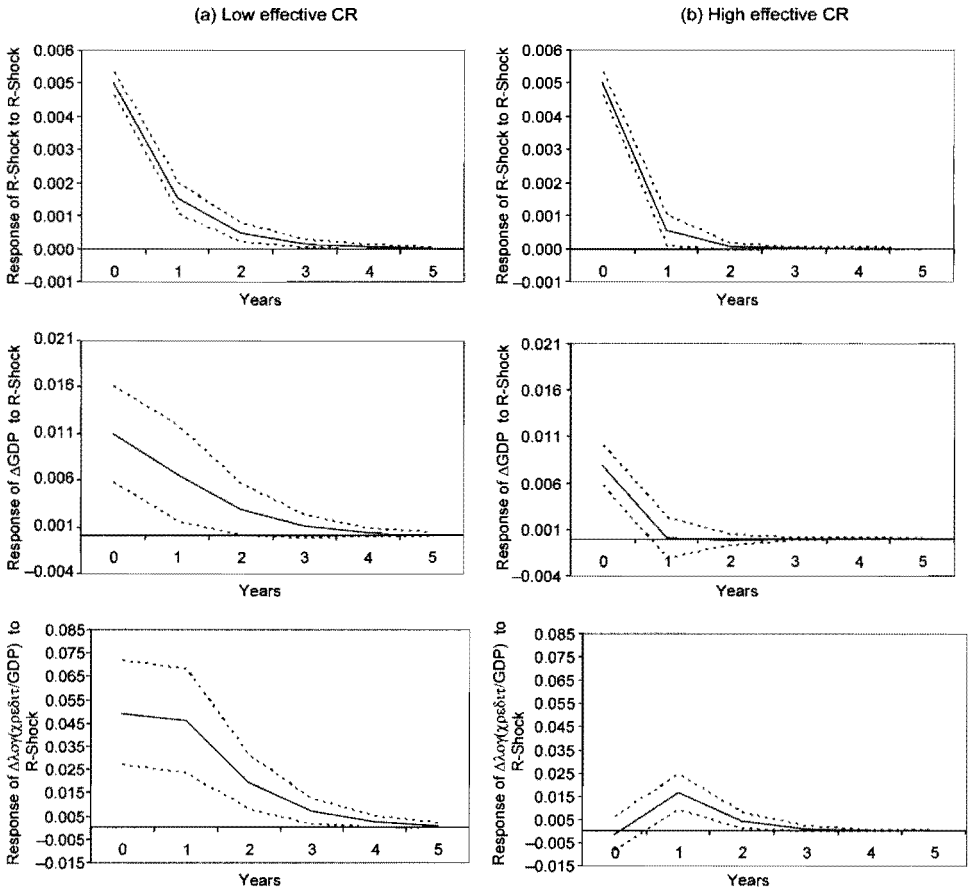
	(1)	(2)	(3)	(4)
	Dum_Size = 1 If External Shock < 10th Percentile		Dum_Size = 1 If External Shock < 25th Percentile	
	(1)	(2)	(3)	(4)
External shock	6.602 (1.672)***	6.750 (2.312)***	6.009 (1.704)***	5.448 (2.180)**
External shock* *Dum_Neg_Shock*	−2.754 (6.541)	−2.562 (8.726)	−4.324 (5.498)	−4.918 (7.281)
External shock* ECR	−0.867 (0.228)***	—	−0.742 (0.224)***	—
External shock* *Dum_Neg_Shock** ECR	−1.211 (1.328)	—	0.043 (1.030)	—
External shock* CL	—	−5.102 (2.288)**	—	−3.931 (2.265)*
External shock* *Dum_Neg_Shock** CL	—	−8.387 (11.773)	—	1.167 (10.068)
Dum_Neg_Shock	0.006 (0.017)	0.010 (0.025)	−0.000 (0.018)	−0.017 (0.021)
*Dum_Neg_Shock** ECR	−0.006 (0.004)	—	−0.000 (0.004)	—
*Dum_Neg_Shock** CL	—	−0.001 (0.034)	—	0.033 (0.037)
Number of observations	1.022	1.022	1.022	1.022
Number of countries	79	79	79	79
Country-fixed effects	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes
R-squared	0.15	0.14	0.15	0.14
Sample 1990–2004				

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: Numbers in parentheses are robust standard errors.

Source: Authors' analysis is based on the data noted in table A-1.

FIGURE 2. Impulse Response Functions, Low vs. High Effective Creditor Rights

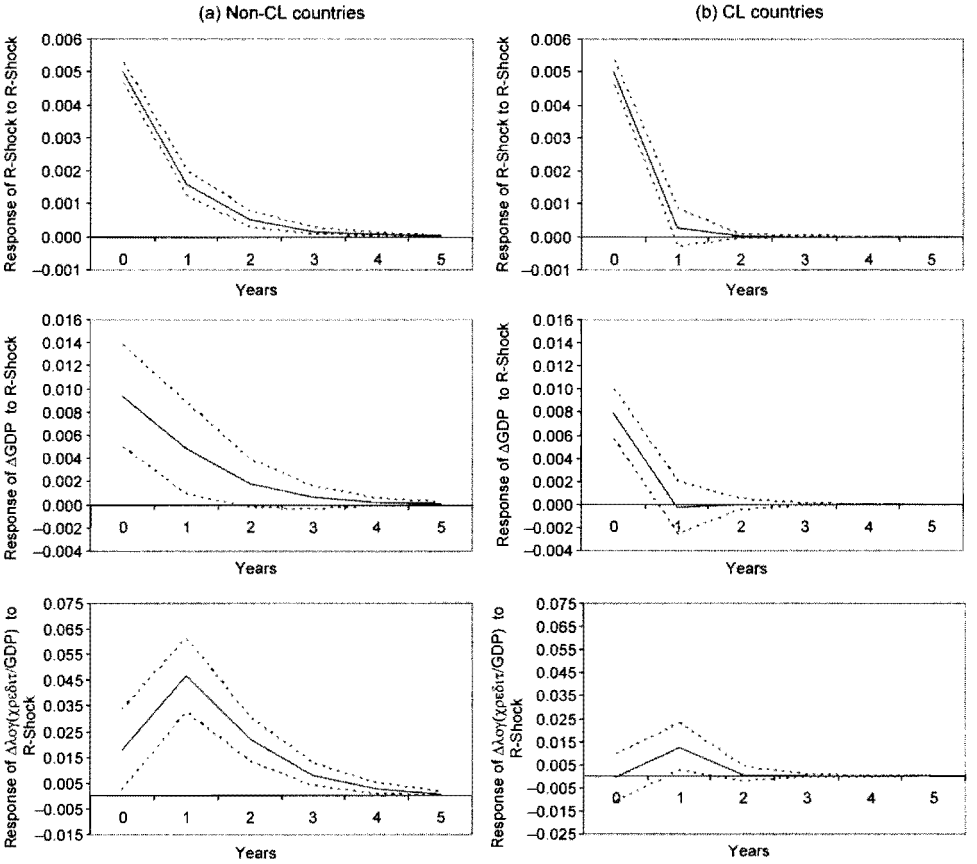


Source: Authors' analysis is based on the data noted in table A-1.

where x_{it}'= (Δlog(Credit/GDP), Δlog(GDP), R-Shock), C is a matrix of polynomials in the lag operator L, η_i is a country-specific effect, and d is a time-specific effect. This exercise identifies whether the response of credit/GDP to an external shock (R-Shock) depends on the institutional setup. As with the empirical results reported above, countries with weak institutional setups would be expected to be more responsive to a similar external shock than would countries where creditors are strongly protected.

Estimating equation (2) uses one lag of information, and imposes the restriction that R-Shock lagged is exogenous. The variables in the vector autoregression are ordered so that Δlog(Credit/GDP) is the most endogenous. To assess differences in institutional setups the sample is split according to different criteria, and the system is estimated for each subsample. After estimating the system, impulse

FIGURE 3. Impulse Response Functions, CL vs. Non-CL Countries



Source: Authors' analysis is based on the data noted in table A-1.

response functions are computed for an equal highlight to R-Shock for each subsample. Figures 2 and 3 report the impulse response functions (and their 5 percent standard deviation). Figure 2 splits the sample, taking as a threshold the sample median of effective creditor rights.[22] Figure 3 splits the sample between CL and non-CL countries.

In both figures, when hit with a shock (R-Shock) of the same size, the response of Δlog(Credit/GDP) is significantly larger in the country with low creditor protection (low ECR or non-CL country). Moreover, the duration of the shock is longer in the countries with weak creditor protection, in up to four or five periods, nearly twice that in countries with a strong institutional setup.

22. Results are very similar if the sample is split according to the average value of effective creditor rights.

IV. Conclusions

This article studies the relationship between creditor protection and the responses of credit to external shocks. It finds empirical support for the idea that weak creditor protection makes credit markets more volatile.

Theory provides conflicting views on how credit should respond to shocks under different creditor protection arrangements. The article tests these views using a data set of legal determinants of finance in a panel of aggregate credit growth data for a sample of up to 79 countries during 1990–2004. It finds support for the claim that better legal protection significantly reduces credit volatility.

The results suggest that the impact of exogenous shocks on credit markets is larger in institutional environments characterized by poor creditor protection. The results are both statistically and economically significant. For example, in CL countries, characterized by high creditor protection and good contract enforcement, the elasticity of credit to external shocks is half that in other nations. These results are robust to alternative measures of creditor protection, to the inclusion of variables that reflect different stages of economic development, to the restriction of the sample to developing economies, to controlling for systemic crises and financial liberalization, to alternative shock measures, to possible asymmetric responses, and to vector autoregression dynamic specifications.

Poor creditor protections induce an overreaction of credit markets to exogenous shocks. Overall, there is strong evidence of what explicit CR and efficient enforcement can do to promote stability in credit markets.

Appendix

Table A-1. Descriptive Statistics

Variable	Observed	Mean	Standard deviation	Minimum	Maximum
Credit/GDP (log change)	1.022	0.016	0.133	−0.93	0.92
External shock	1.022	0.010	0.012	−0.01	0.10
		Country (time invariant)			
CL	79	0.342	0.477	0	1
CR	79	0.010	1.132	−1.97	2.03
RL	79	−0.007	0.990	−1.69	1.71
CE	79	0.010	0.750	−1.62	2.37
TD	79	0.005	0.794	−1.67	3.29
ECR	79	0.004	3.820	−4.99	11.02

Source: CL, CR (average 1978–2002), and contract enforceability, Djankov, McLiesh, and Shleifer (2007); RL (average 1996–2004), Kaufmann, Kraay, and Mastruzzi (2005); total duration to collect a bounced check, Djankov *et al.* (2003).

TABLE A-2. Correlation Matrix

	CL	CR	RL	Contract enforceability	Total duration	Developed
CL	1	—	—	—	—	—
CR	0.3477 (0.0017)	1	—	—	—	—
RL	0.0083 (0.942)	0.1806 (0.1111)	1	—	—	—
Contract enforceability	0.0865 (0.4485)	0.0974 (0.3933)	0.5184 (0.0000)	1	—	—
Total duration	0.2387 (0.0341)	0.172 (0.1295)	0.2364 (0.036)	0.7397 (0.0000)	1	—
Developed	0.0065 (0.95490)	0.1777 (0.1171)	0.8416 (0.0000)	0.4811 (0.0000)	0.1917 (0.0906)	1

Note: All correlations are computed with 79 countries. Numbers in parentheses are significant level of each correlation.

Source: CL, CR (average 1978–2002), and contract enforceability, Djankov, McLiesh, and Shleifer (2007); RL (average 1996–2004), Kaufmann, Kraay, and Mastruzzi (2005); total time to collect a bounced check, Djankov *et al.* (2003); developed economies, World Bank (2006).

TABLE A-3. Country-Specific Data

Country	CL	CR	RL	CE	TD	Developed economies
Argentina	0	−0.971	−0.602	−0.588	−0.467	0
Australia	1	1.029	1.468	0.609	−0.530	1
Austria	0	1.029	1.530	−0.259	−0.836	1
Bangladesh	1	0.029	−1.158	−0.234	−0.362	0
Belgium	0	0.029	1.070	0.947	0.449	1
Bolivia	0	0.029	−0.974	−0.716	−0.903	0
Botswana	1	1.029	0.280	0.629	0.893	0
Brazil	0	−0.971	−0.634	−0.673	0.044	0
Bulgaria	0	−0.686	−0.504	−0.421	−0.780	0
Canada	1	−0.828	1.444	−0.181	−0.806	1
Chile	0	0.029	0.820	−0.055	−0.062	0
Colombia	0	−1.971	−1.086	−0.229	−1.031	0
Costa Rica	0	−0.971	0.284	−0.644	−0.677	0
Côte d'Ivoire	0	−1.971	−1.316	−0.598	0.226	0
Croatia	0	1.029	−0.482	−0.363	−0.563	0
Czech Republic	0	1.029	0.218	−0.038	−0.362	0
Denmark	0	1.029	1.534	1.247	0.818	1
Dominican Republic	0	0.029	−0.776	−0.698	−0.134	0
Ecuador	0	−1.971	−1.046	−0.296	−0.570	0
Egypt	0	0.029	−0.300	−0.351	−0.072	0
El Salvador	0	1.029	−0.798	0.049	1.142	0
Finland	0	−0.543	1.608	0.185	−0.244	1
France	0	−1.971	1.010	1.348	0.038	1
Germany	0	1.029	1.384	0.451	0.200	1
Ghana	1	−0.971	−0.544	0.367	0.737	0
Greece	0	−0.971	0.310	0.648	−0.516	1
Guatemala	0	−0.971	−1.210	−1.620	−0.157	0
Honduras	0	0.029	−1.164	−0.635	−0.180	0
Hong Kong, China	1	2.029	1.114	0.314	1.126	1
Hungary	0	−0.971	0.366	−0.234	−0.663	0
India	1	0.243	−0.354	−0.387	0.573	0
Indonesia	0	0.600	−1.240	−0.680	−0.180	0
Ireland	1	−0.971	1.316	0.286	0.369	1
Israel	1	1.457	0.572	−0.706	−0.516	1
Italy	0	0.029	0.456	−1.572	−1.233	1
Jamaica	1	0.029	−0.704	0.357	−0.072	0
Japan	0	0.529	1.148	1.571	1.142	1
Kazakhstan	0	−0.555	−1.268	−0.326	0.449	0
Kenya	1	2.029	−1.376	−0.221	−0.305	0
Kuwait	0	1.029	0.458	−0.301	−0.641	1
Latvia	0	1.029	−0.146	0.424	−0.003	0
Lithuania	0	−0.388	−0.160	0.629	0.226	0
Malawi	1	0.743	−0.808	0.041	0.554	0
Malaysia	1	1.029	0.220	−0.038	0.737	0
Mexico	0	−1.971	−0.718	−0.377	−0.409	0
Morocco	0	−0.971	−0.220	0.185	−0.021	0
Mozambique	0	0.029	−1.248	−0.698	−1.055	0
Namibia	1	0.029	0.214	0.067	0.470	0

(Continued)

TABLE A-3. Continued

Country	CL	CR	RL	CE	TD	Developed economies
Netherlands	0	1.029	1.470	1.794	1.573	1
New Zealand	1	2.029	1.574	1.753	1.142	1
Nigeria	1	2.029	−1.694	−0.928	−0.248	0
Norway	0	0.029	1.606	1.200	0.771	1
Pakistan	1	−0.971	−1.082	−0.313	−0.663	0
Panama	0	2.029	−0.404	−0.207	−0.047	0
Paraguay	0	−0.971	−1.294	0.013	−0.166	0
Peru	0	−1.971	−0.926	−0.424	−0.852	0
Philippines	0	−0.971	−0.794	−0.275	0.137	0
Poland	0	−0.971	0.120	−1.242	−1.671	0
Portugal	0	−0.971	0.814	−0.103	−0.804	1
Korea, Rep. of	0	1.029	0.326	1.348	0.919	1
Senegal	0	−1.971	−0.668	−0.519	−0.578	0
Singapore	1	1.029	1.572	1.431	1.397	1
Slovenia	0	1.029	0.430	−1.245	−1.674	0
South Africa	1	1.029	−0.174	0.041	0.806	0
Spain	0	0.029	0.808	0.536	0.246	1
Sri Lanka	1	0.029	−0.388	−0.421	−0.850	0
Sweden	0	−0.543	1.506	0.328	−0.010	1
Switzerland	0	−0.971	1.710	0.530	−0.173	1
Tanzania	1	0.029	−0.870	0.177	0.392	0
Thailand	1	0.672	−0.132	−0.301	−0.111	0
Tunisia	0	−1.971	−0.134	2.370	3.291	0
Turkey	0	0.029	−0.376	−0.134	0.583	0
Uganda	1	0.029	−1.052	0.323	0.641	0
United Kingdom	1	2.029	1.446	0.003	0.621	1
United States	1	−0.971	1.304	0.144	1.248	1
Uruguay	0	0.172	0.108	−0.764	−0.650	0
Venezuela, R. B.	0	1.029	−1.284	−0.433	−0.650	0
Zambia	1	−0.971	−0.866	0.052	0.000	0
Zimbabwe	1	2.029	−1.208	−0.192	−0.047	0

Note: All indicators have been demeaned. Contract enforceability and total duration to collect a bounced check are in logs.

Source: CL, CR (average 1978–2002), and contract enforceability, Djankov, McLiesh, and Shleifer (2007); RL (average 1996–2004), Kaufmann, Kraay, and Mastruzzi (2005); total duration to collect a bounced check, Djankov *et al.* (2003); developed economies, World Bank (2006).

REFERENCES

Aghion, Philippe, and Patrick Bolton. 1992. "An Incomplete Contracts Approach to Financial Contracting." *Review of Economic Studies* 59(3):473–94.

Beck, Thorsten, Asli Demirg-Kunt, and Ross Levine. 2003. "Law, Endowments, and Finance." *Journal of Financial Economics* 70:137–81.

Beck, Thorsten, Asli Demirg-Kunt, and Vojislav Maksimovic. 2003. "Financial and Legal Institutions and Firm Size." Policy Research Working Paper 2997. World Bank, Washington, D.C.

———. 2005. "Financial and Legal Constraints to Firm Growth: Does Firm Size Matter?" *Journal of Finance* 60:137–81.

Beck, Thorsten, Ross Levine, and Norman Loayza. 2000. "Financial Intermediation and Growth: Causality and Causes." *Journal of Monetary Economics* 46(1):31–77.

Bekaert, Greet, Campbell Harvey, and Chris Lundblad. 2005. "Does Financial Liberalization Spur Growth?" *Journal of Financial Economics* 77:3–56.

Bernanke, Ben, Mark Gertler, and Simon Gilchrist. 1996. "The Financial Accelerator and the Flight to Quality." *Review of Economics and Statistics* 78:1–15.

———. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." In *Handbook of Macroeconomics. Amsterdam.* Vol. 1C. New York and Oxford: Elsevier Science, North-Holland, 1341–93.

Braun, Matias, and Borja Larrain. 2005. "Finance and the Business Cycle: International, Inter-Industry Evidence." *The Journal of Finance* 60:1097–128.

Caprio Jr, Gerard, and Daniela Klingebiel. 2003. "Episodes of Systemic and Borderline Financial Crises." World Bank, Washington, D.C.

Dell'Ariccia, Giovanni, and Robert Marquez. 2007. "Lending Booms and Lending Standards." *Journal of Finance* 61(5):2511–46.

Demirg-Kunt, Asli, and Vojislav Maksimovic. 1998. "Law, Finance, and Firm Growth." *Journal of Finance* 53(6):2107–37.

Djankov, Simeon, Caralete McLiesh, and Andrei Shleifer. 2007. "Private Credit in 129 Countries." *Journal of Financial Economics* 84(2):299–329.

Djankov, Simeon, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer. 2003. "Courts." *Quarterly Journal of Economics* 118:453–517.

Fazzari, Steven, Glenn R. Hubbard, and Bruce C. Petersen. 1988. "Financing Constraints and Corporate Investment." Brookings Papers on Economic Activity, 1:141–95.

Feijen, Erik, and Enrico Perotti. 2005. "Lobbying on Exit: The Political Economy of Financial Fragility." American Finance Association 2006 Boston Meetings. (http://ssrn.com/abstract=686661).

Galindo, Arturo, and Alejandro Micco. 2004. "Bank Credit to Small and Medium Sized Enterprises: The Role of Creditor Protection." Inter-American Development Bank, Washington, D.C.

Gertler, Mark, and Simon Gilchrist. 1994. "Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms." *Quarterly Journal of Economics* 109:309–40.

Hart, Oliver, and John Moore. 1994. "A Theory of Debt Based on the Inalienability of Human Capital." *Quarterly Journal of Economics* 109(4):841–79.

———. 1998. "Default and Renegotiation: A Dynamic Model of Debt." *Quarterly Journal of Economics* 113(1):1–42.

Holmstrom, B., and J. Tirole. 1997. "Financial Intermediation, Loanable Funds, and the Real Sector." *Quarterly Journal of Economics* 112:663–91.

———. 1998. "Private and Public Supply of Liquidity." *Journal of Political Economy* 106(1):1–40.

Johnson, Simon, Peter Boone, Aldair Breach, and Eric Friedman. 2000. "Corporate Governance in the Asian Financial Crisis." *Journal of Financial Economics* 58(12):141–86.

Kaminsky, Graciela, and Sergio Schmukler. 2002. "Short-run Pain, Long-run Gain: The Effects of Financial Liberalization." George Washington University, Washington, D.C.

Kashyap, Anil K., Owen A. Lamont, and Jeremy Stein. 1994. "Credit Conditions and the Cyclical Behavior of Inventories." *Quarterly Journal of Economics* 109:565–92.

Kaufmann, Daniel, Art Kraay, and Massimo Mastruzzi. 2005. "Governance Matters IV: Governance Indicators for 1996–2004." World Bank, Washington, D.C.

Kiyotaki, Nobuhiro, and John Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105(2):211–48.

Kroszner, Randall, Luc Laeven, and Daniela Klingebiel. 2007. "Banking Crisis, Financial Dependence, and Growth." *Journal of Financial Economics* 84(1):187–228.

La Porta, Rafael, Florencio Lpez-de-Silanes, Andrei Shleifer, and Robert Vishny. 1997. "Legal Determinants of External Finance." *Journal of Finance* 52(3):1131–50.

———. 1998. "Law and Finance." *Journal of Political Economy* 106(6):1113–55.

Laeven, Luc. 2003. "Does Financial liberalization Reduce Financial Constraints?" *Financial Management* 32(1):15–34.

Love, Inessa. 2003. "Financial Development and Financing Constraints: International Evidence from the Structural Investment Model." *Review of Financial Studies* 16(3):765–91.

Oliner, Stephen, and Glenn Rudebusch. 1996. "Is There a Broad Credit Channel to Monetary Policy?" *Federal Reserve Bank of San Francisco Economic Review* 1:3–13.

Raddatz, Claudio. 2006. "Liquidity Needs and Vulnerability to Financial Underdevelopment." *Journal of Financial Economics* 80:677–722.

Sharpe, Steven A. 1994. "Financial Market Imperfections, Firm Leverage, and the Cyclicality of Employment." *American Economic Review* 84:1060–74.

Townsend, Robert M. 1979. "Optimal Contracts and Competitive Markets with Costly State Verification." *Journal of Economic Theory* 21(2):265–93.

World Bank. 2006. *World Development Indicators Database*. Washington, D.C.

Crises, Volatility, and Growth

Enisse Kharroubi

How do volatility and liquidity crises affect growth? When credit is constrained, a bias toward short-term debt can arise in financing long-term investments, generating maturity mismatches and leading potentially to liquidity crises. The frequency of liquidity crises ("abnormal" volatility) and the volatility of growth ("normal" volatility) are found to have independent negative effects on growth. Financial development however dampens the growth cost of volatility, but only in the case of normal volatility. The growth cost of volatility therefore depends critically on the composition of normal and abnormal volatility, the latter being more costly for growth. JEL codes: E44, G30, O16.

After the financial crises of the 1990s many voices rose to explain that the causes of these crises were new (Radelet and Sachs 1998; Corsetti, Pesenti, and Roubini 1999). Indeed, the usual features known to trigger crises (unsustainable government economic policies; Krugman 1979) were absent or could not by themselves imply such severe crises (Baig and Goldfajn 2002). Instead, new phenomena were in play, such as the large short-term debt that firms had accumulated before the crisis (table 1).

Several explanations have since been brought forward to explain this buildup in corporate imbalances—two in particular. According to the first, "crony capitalism" can explain the imbalances (Krugman 1999), because in distorting individual incentives, it encouraged firms to make inefficient decisions (about investments, risks, and so on). The implicit insurance under crony capitalism prompted agents to believe that they could benefit from the low cost of short-term debt and that the government would help them overcome potential illiquidity.

Enisse Kharroubi is an economist at the Bank of France; his email address is enisse.kharroubi@banque-france.fr. The author is grateful to Arturo Galindo, Jim de Melo, Norman Loayza, Henri Pagès, Romain Rancière, Mathias Thoenig, Thierry Tressel, Thierry Verdier, two anonymous referees for their useful comments and suggestions, as well as to the participants in the seminars at the Bank of France; the Department and Laboratory of Applied and Theoretical Economics (DELTA), École Normale Supérieure, Paris; the European Economics Association Summer Meetings; the Money Macro and Financial Research Group Conference; the International Monetary Fund–Pompeu Fabra University Conference; the Theory and Method of Macroeconomics (T2M) Conference; and the Venice University Summer School. The views are those of the author and do not necessarily reflect those of the Bank of France.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 439–460 doi:10.1093/wber/lhm015
Advance Access Publication 10 October 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

TABLE 1. Aggregate Financial Indicators for Nonfinancial Firms, 1995–96 (median)

Economy	Debt–equity ratio[a]	Current ratio[b]	Quick ratio[c]
China	0.553	1.321	0.968
Hong Kong, China	0.420	1.352	0.947
Korea, Rep. of	2.485	1.078	0.773
Malaysia	0.114	1.296	0.913
Pakistan	0.999	0.993	0.510
Philippines	0.239	1.370	0.961
Taiwan, China	0.195	1.587	1.037
Thailand	0.915	1.143	0.697
United States	0.160	2.097	1.385

[a]Ratio of total debt to the market value of the firm.

[b]Ratio of current assts to current liabilities—that is, with maturity of less than one year.

[c]Ratio of current assets minus inventories to current liabilities.

Source: Claessens, Djankov, and Nenova 2000.

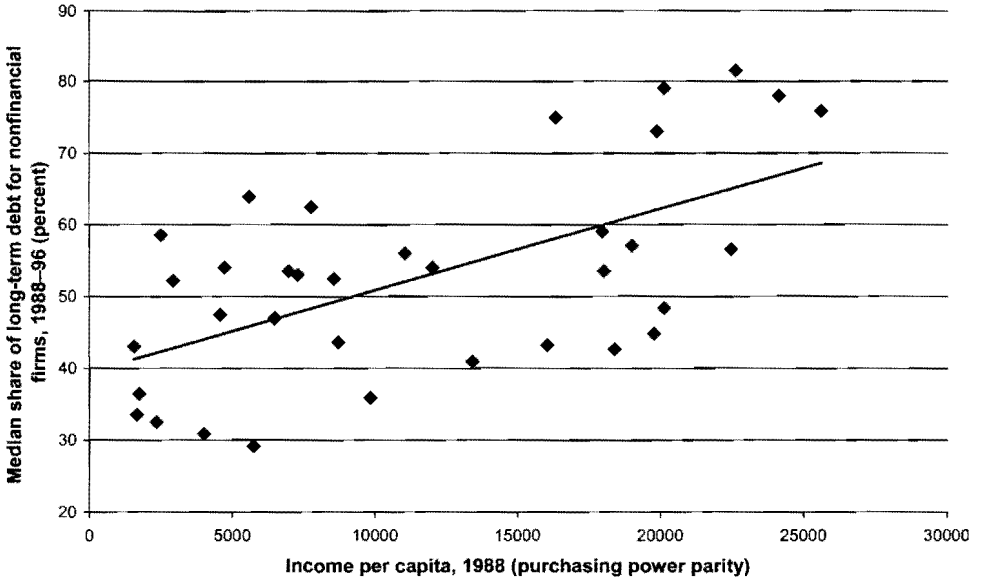
The second explanation is the "original sin" hypothesis (Eichengreen and Haussman 1999). Financial imbalances such as those displayed in table 1 are due to the inability of firms to choose their financial portfolios. Although firms know the risks, they are pushed to adopt "dangerous" financing strategies as the only way to get capital from financial markets.

Although both explanations may be reasonable and explain the vulnerability of countries to financial crashes, they are incomplete and fairly ad hoc in their foundations. In the crony capitalism explanation, the implicit insurance and the collusion links between firm managers and politicians are exogenous. There is no positive theory of crony capitalism. For original sin, what needs to be explained is why it might be relevant for developing economies but not for developed economies. For example, the share of long-term debt in total corporate debt increases with economic development (Demirgüç-Kunt and Maksimovic 1999) (figure 1).

Understanding how economic and financial development modifies financial contracts requires understanding original sin. This article has two aims. First, it uses an explicit framework to explain why private agents use risky financial strategies. Second, it explores the macroeconomic consequences of private financial strategies for growth and volatility. To do this, it studies how the maturity of firm debts is determined.

The mechanism is as follows. When contracts are imperfectly enforceable, lenders impose a bias toward short-term debt on the debt portfolio of borrowers investing in long-term activities. For lenders the problem with long-term debt lies in the freedom it leaves the borrower. In a long-term debt contract there is at least one date between the contract date and the payment date, and the borrower can choose to shirk at that interim date. In this model the borrower can decide to stop a project and reinvest the capital in a less efficient

FIGURE 1. Income Per Capita and Proportion of Long-term Debt



Note: Each point represents a country.
Source: Claessens, Djankov, and Lang 1998; Penn World Tables 6.1.

storage technology, eventually defaulting on the long-term loan. To prevent borrowers from doing so, lenders can increase the share of short-term debt in borrower debt portfolios. Lenders then have effective controlling power because they can sanction the borrowers by asking for short-term debt repayments, if the borrowers stop their project.[1] Although this mechanism solves a microeconomic incentive problem, it generates a global coordination issue when borrowers rely heavily on short-term debt. Why? if lenders agree to roll over short-term debts, borrowers are then able to carry out their long-term projects, their final return is large, and they do not have incentives to default on long-term loans. It is then rational for lenders to accept short-term debts rollover. However, if lenders refuse to roll over short-term debts, borrowers are then unable to carry out their long-term projects, their final return is low, and they have incentives to default on long-term loans. It is then rational for lenders to refuse short-term debts rollover. So both the situations where lenders agree and situations where they refuse to roll over short-term debts are equilibria, and borrowers can be forced to stop their projects because lenders are unable to coordinate to avoid inefficient runs on short-term debts.

This framework produces three results. First, the higher the probability of a run, the lower the average growth rate of the economy. This is intuitive because growth is lower when a run on short-term debts triggers liquidation of

1. This amounts to assuming that lenders can observe borrowers who stop their project.

long-term projects. Second, an increase in the volatility of long-term projects' productivity reduces growth. As the volatility of the return on entrepreneurs' projects increases their average return, it also reduces the return on lenders' technology, which always dominates at the aggregate level. Third, a reduction in credit constraints affecting entrepreneurs tends to reduce the probability of a run and thus to reduce the growth cost of volatility. On the basis of a data set for a large number of countries, the article provides empirical evidence to confirm these results.

This article relates to four strands of the literature. First, liquidity issues are studied in Diamond and Dybvig's (1983) seminal paper. Since there is a possibility of panics in the banking sector because liabilities are short term and assets are long term, banks can act as pools of liquidity to stop these panics. Closer to this article is Diamond (1991), who shows how firms' financial choices may help reduce informational asymmetries with lenders. In Diamond (1991) firms with good prospects are more likely to issue short-term debt because their probability of confronting liquidity shocks is smaller. Flannery (1986) and Kale and Noe (1990) also consider financial choices as signals of project quality. This article's approach is different, however, because firm heterogeneity plays no role. It is the nature of long-term projects (the possibility of stopping them interim) that prompts firms to borrow short term. Closest to the approach of this article is the paper by Rey and Stiglitz (1993), who show that short-term contracts give lenders the power to monitor borrowers. The argument here differs, however, by stressing the disciplining effect of short-term debt rather than its monitoring power. It then shows that the disciplining effect of short-term debt is not cost-free because it may come with multiple equilibria and inefficient project terminations due to run on the short-term liabilities of firms.

Second, this article is close to work that explains micro- or macroeconomic stylized facts using corporate financial contracts. Albuquerque and Hopenhayn (2004) study how optimal maturity debt contracts explain the dynamics of firm development. Rodrik and Velasco (1999) explain why developing economies can rationally accumulate unsustainable amounts of short-term debt. The idea is that accumulating short-term debt with illiquid projects increases the price of long-term debt because the premium on long-term debt depends positively on the amount of short-term debt.

Third, this article is related to the literature on the macroeconomic impact of capital market imperfections (Bernanke and Gertler 1989; Greenwood and Jovanovic 1990; Greenwald and Stiglitz 1993; Acemoglu and Zilibotti 1997; Kiyotaki and Moore 1997; Aghion, Banerjee, and Piketty 1999), which points out that capital market imperfections can generate or exacerbate fluctuations.

Fourth, this article is related to the literature on growth and volatility. As the common wisdom, influenced by Ramey and Ramey (1995), points to a negative relationship, some arguments support a positive relationship (Jones, Manuelli, and Sachetti 1999; Tornell, Westermann, and Martinez 2004). The

contribution here is to show that as the different sources of volatility identified all having a negative effect on growth, the growth cost of volatility depends on the composition of volatility between normal and abnormal volatility, the latter much more costly for growth.

Section I establishes the microeconomics of the capital market. Section II applies this framework to a macroeconomic model and derives the main results for growth and volatility. Section III provides empirical evidence. Section IV draws conclusions.

I. A Two-period Model of the Credit Market

Consider a risk-neutral borrower-entrepreneur with initial capital normalized to one living two periods and maximizing end-of-life consumption. In time t, the entrepreneur invests in a long-term illiquid project. Investing k_t units of capital in a long-term project at time t yields A min $(k_t; k_{t+1})$ units of capital at time $t+2$, k_{t+1} being the volume of capital still in the project at time $t+1$. The project is illiquid because extracting capital at time $t+1$ can reduce the return of the overall project

$$A = \begin{cases} \bar{R} \text{ if } \min(k_t; k_{t+1}) \geq (1-\eta)k_t \\ \underline{R} \text{ if } \min(k_t; k_{t+1}) < (1-\eta)k_t \end{cases}$$

with $0 < \eta < 1$. At time t the entrepreneur can borrow a volume of capital μ from a pool of risk-neutral investors. The share of short-term debts (which need to be repaid after one period) in total borrowing is α, and the share of long-term debts (which must be repaid after two periods) in total borrowing is $1-\alpha$. The gross interest rate on short-term debts is r_s, and the gross interest rate on long-term debts is r_l. Short-term debts are perfectly enforceable, but long-term debts are not; entrepreneurs can default on their long-term debts.[2]

In time $t+1$ the entrepreneurs can extract capital from their project. Extracting one unit of capital from the illiquid project yields one unit of capital. With that capital the entrepreneurs can pay back their short-term debts. But that can reduce the return on the illiquid project from $\bar{R}$ to $\underline{R}$.

In time $t+2$, the entrepreneurs reap the benefit of their investment and decide whether to default on their long-term debts. The marginal cost of defaulting on long-term debts is $\bar{\tau}$ if $A = \bar{R}$ and $\underline{\tau}$ if $A = \underline{R}$. The entrepreneur faces a moral hazard, $\bar{R} > \underline{R}$ but $\bar{R} - \bar{\tau} < \underline{R} - \underline{\tau}$.

At time t, the entrepreneur invests $k_t = 1 + \mu$ and pays back $\alpha\mu r_s$ at time $t+1$, so $k_{t+1} = 1 + \mu - \alpha\mu r_s$. If the entrepreneurs then pay back their

2. The difference in enforceability between short- and long-term contracts is assumed to simplify the exposition of the model. Assuming a similarly imperfect enforceability would not change the mechanism or the results of the model. It would simply add another incentive-compatibility constraint, formally very close to the illiquidity constraint.

long-term debts, they reap a profit

$$\pi = (1 + \mu - \alpha\mu r_s)\bar{R} - (1 - \alpha)\mu r_l$$

By contrast, if the entrepreneurs default on long-term liabilities, they do not pay for its long-term debts $(1 - \alpha)\mu r_l$, but they face the cost associated with default. Their profit is then

$$\pi' = (1 + \mu - \alpha\mu r_s)(R - \tau)$$

Lenders then need to propose financial contracts that preclude entrepreneurs from defaulting on their liabilities. The next proposition details these contracts.

Proposition 1

Noting that $\tau = \bar{R} - (\underline{R} - \underline{\tau})$ and assuming that $r_l > \tau r_s$, time t incentive-compatible debt portfolios (α,μ) satisfy

$$\frac{1 + \mu}{\mu} \geq (1 - \alpha)\frac{r_l}{\tau} + \alpha r_s \tag{1}$$

If an entrepreneur satisfies at time $t + 1$ the illiquidity constraint $\min(k_t;k_{t+1}) \geq (1 - \eta)k_t$, lenders can reduce the share of short-term debts from α to β with

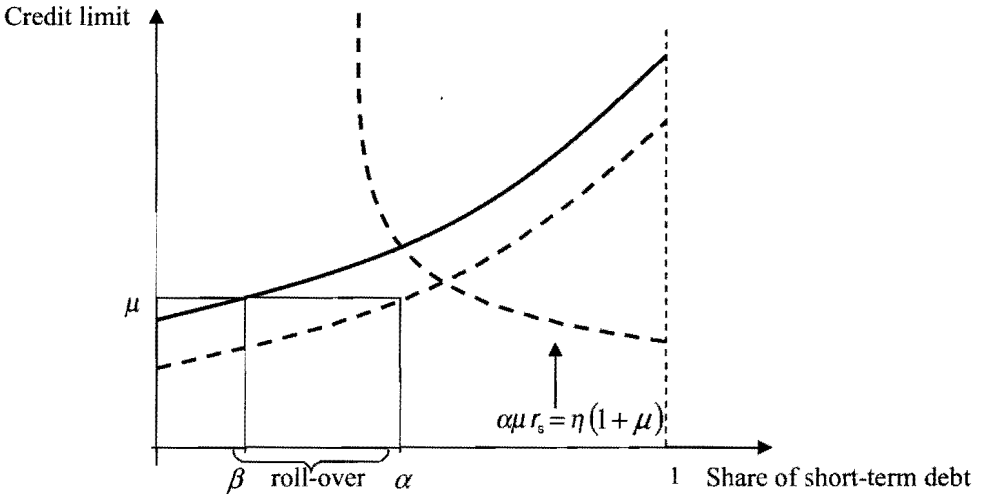
$$\beta \geq \frac{1}{r_l - \bar{\tau}r_s}\left[r_l - \bar{\tau}\frac{1 + \mu}{\mu}\right]^+ \tag{2}$$

Proof: See the appendix.

This framework produces three remarks. First, as long as the illiquidity constraint is satisfied, a higher share of short-term debt α raises the entrepreneur's borrowing capacity μ. Second, a "larger" moral hazard, in the sense of a lower $\underline{\tau}$, reduces the entrepreneur's borrowing capacity. This implies that an entrepreneur with a given volume of borrowing μ has to bear a higher proportion of short-term debt under a larger moral hazard. Lenders therefore impose a "bias" toward short-term debt because they use short-term debt as a disciplining device, to make sure that entrepreneurs do not take advantage of a moral hazard. Third, lenders can reduce or withdraw this bias when the moral hazard problem disappears—that is, after they observe that borrowers have not extracted capital beyond the illiquidity constraint. In this case lenders transform some of the short-term debts into long-term ones because an entrepreneur who proceeds with a high-return project has no incentives to default on long-term loans.[3] In contrast, if the entrepreneurs decide to extract too much capital

3. The expression for short-term debt rollover β is valid if it is assumed that the market for debt rollover is competitive. In this case the interest rates on rolled-over short-term debt and on long-term debt are identical, and β is the minimal value that verifies equation (2).

FIGURE 2. Borrowing Capacity and Debt Portfolio Composition



Source: Author's analysis based on data described in the text.

from their project, they have incentives to default on long-term loans, so lenders have to ask for full short-term debt repayments (figure 2).

II. THE MACROECONOMIC MODEL

This section introduces this capital market framework in a macroeconomic model to shed light on the aggregate consequences of the structure of financial contracts.

Agents and Technologies

Consider a single-good economy with two types of risk-neutral agents: entrepreneurs (type e agents) and lenders (type l agents). There is a continuum of unit mass of each type of agent. All agents live for two periods and maximize their expected end-of-life profits. All have access to a storage technology, $y_{t+1} = rk_t$, with $r \geq 1$. Moreover, entrepreneurs have access to a long-term illiquid technology, $y_{t+2} = A \min \{k_t; k_{t+1}\}$, with

$$A = \begin{cases} R \text{ if } \min(k_t; k_{t+1}) \geq (1-\eta)k_t \\ 0 \text{ if } \min(k_t; k_{t+1}) < (1-\eta)k_t \end{cases}$$

So entrepreneurs who violate the illiquidity constraint $\min(k_t; k_{t+1}) \geq (1-\eta)k_t$ can extract all their capital from their long-term illiquid project at time $t+1$ and invest in the storage technology. Entrepreneurs have the best opportunities in the economy $R > r^2$. They can thus borrow capital from lenders. The capital market is exactly the same as the previous section.

Entrepreneurs can borrow with short- (one-period) and long-term (two-period) debt contracts. Long-term contracts are imperfectly enforceable; default is possible, but an entrepreneur needs to pay a marginal cost on the final output ($\bar{\tau}$ when the entrepreneur can carry out an illiquid long-term project and τ when the entrepreneur violates the illiquidity constraint and reinvests in the storage technology). Entrepreneurs are subject to a moral hazard $R > r$ and $R - \bar{\tau} < r - \underline{\tau}$.

Timing of the Model

At the start date entrepreneurs make investments and borrowing choices (short- or long-term debt). Lenders deliver loans to entrepreneurs and they invest in the storage technology the capital they have not lent. At the interim date, short-term debts are paid back or rolled over, and entrepreneurs may violate the illiquidity constraint. At the final date the returns on the different projects are realized according to what happened at the interim date, and long-term and rolled-over short-term debts are paid back.

Optimal Debt Portfolios

THE SAFE FINANCING STRATEGY. When lenders ask the entrepreneurs to pay $\alpha\mu r_s$, the entrepreneurs are still able to carry out their illiquid project, if and only if $\alpha\mu r_s \leq \eta(1+\mu)$. It is incentive-compatible for lenders to ask only for $\beta\mu r_s$ as short-term debt repayments because the entrepreneurs are always able to proceed with their illiquid project and therefore have no incentive to deviate. The program of the entrepreneurs is then

$$\max_{\alpha,\mu}(1+\mu-\beta\mu r_s)R-(1-\beta)\mu r_l$$

$$\text{(P1)} \qquad \text{such that} \begin{cases} \dfrac{1+\mu}{\mu} \geq \max\left\{(1-\alpha)\dfrac{r_l}{\tau}+\alpha r_s; \alpha\dfrac{r_s}{\eta}\right\} \\ (r_l-\bar{\tau}r_s)\beta \geq \left[r_l-\bar{\tau}\dfrac{1+\mu}{\mu}\right]^+ \end{cases}$$

Proposition 2
If $\eta < \bar{\eta} \equiv \dfrac{\bar{\tau}-\tau}{r_l-\tau r_s} r_s$, the entrepreneur optimal borrowing choices are

$$\alpha^* = \frac{\eta r_l}{\eta r_l + (1-\eta)\tau r_s} \text{ and } \mu^* = \frac{\eta r_l/r_s + (1-\eta)\tau}{r_l - \eta r_l/r_s - (1-\eta)\tau}$$

Proof: See the appendix.
The inequality $\eta < \bar{\eta}$ means that if the entrepreneur's technology is sufficiently illiquid, supplying incentives to deter entrepreneurs from liquidating long-term projects is costly, because the entrepreneur's borrowing capacity is strictly lower than it would be without the interim moral hazard. The case $\eta \geq \bar{\eta}$ is

therefore uninteresting since there is no tradeoff between individual incentives and firm profits. So it is assumed that $\eta < \bar{\eta}$.

THE RISKY FINANCING STRATEGY. When lenders ask the entrepreneurs to pay $\alpha\mu r_s$, the entrepreneurs can still carry out their illiquid project if and only if $\alpha\mu r_s \leq \eta(1+\mu)$. Similarly, if lenders ask the entrepreneurs to pay only $\beta\mu r_s$, the entrepreneurs are able to carry out their project with a large return if and only if $\beta\mu r_s \leq \eta(1+\mu)$. So two different outcomes are possible when

$$\beta\mu r_s \leq \eta(1+\mu) \leq \alpha\mu r_s \tag{3}$$

If lenders ask the entrepreneurs to pay only $\beta\mu r_s$ (some short-term debts are rolled over), the entrepreneurs can proceed with their illiquid project. It is then incentive-compatible to roll over some of the short debts and ask only for $\beta\mu r_s$ as short-term debt repayments. In contrast, if lenders ask the entrepreneurs to pay all their short-term debts, $\alpha\mu r_s$, the entrepreneurs cannot proceed with their illiquid project. It is then rational for lenders to ask for full short-term debt repayments because the entrepreneurs would otherwise default on any short-term debt that may be rolled over.[4]

Note that p is the probability that lenders decide to ask entrepreneurs to pay $\alpha\mu r_s$ as short-term debts repayments and $1-p$ is the probability that lenders decide to ask entrepreneurs to pay $\beta\mu r_s$.[5] The entrepreneur's expected profit is $\pi = (1-p)[(1+\mu-\beta\mu r_s)R - (1-\beta)\mu r_l] + p[(1+\mu-\alpha\mu r_s)r - (1-\alpha)\mu r_l]$. So, the program[6] of the entrepreneur is

$$\text{(P2)} \qquad \begin{aligned} &\max_{\alpha,\mu}(1+\mu-\beta\mu r_s)[pr+(1-p)R] - \mu[r_l + \beta(r_s R - r_l)(1-p) \\ &\quad + \alpha(r_s r - r_l)p] \\ &\text{such that} \begin{cases} \max\left\{(1-\alpha)\frac{r_l}{\tau} + \alpha r_s; \alpha\frac{r_s}{\eta}\right\} \leq \frac{1+\mu}{\mu} \leq \alpha\frac{r_s}{\eta} \\ (r_l - \bar{\tau} r_s)\beta \geq \left[r_l - \bar{\tau}\frac{1+\mu}{\mu}\right]^+ \end{cases} \end{aligned}$$

4. Due to illiquidity entrepreneurs' technology works as an increasing return to scale technology; the higher the volume of capital that remains in the project, the higher the final return. Moreover, the higher the return, the less likely the entrepreneur is to default and the less risky is a short-term debt rollover for lenders.

5. Lenders base their decision to ask for short-term debt repayment or to roll over short-term debt on an extrinsic sunspot.

6. The case where entrepreneurs pay for their debts if and only if they can carry out their illiquid project until maturity (not considered here) is always dominated; entrepreneurs have to pay for default costs and there are no benefits for the debt portfolio (size being identical and risk premium being actuarially fair).

And the solution is

$$\alpha^* = \frac{\bar{\tau}}{\bar{\tau} - \underline{\tau} r_l - \underline{\tau} r_s} \frac{r_l}{} \text{ and } \mu^* = \frac{\bar{\tau}}{r_l - \bar{\tau}}$$

Note that $(\alpha_i; \mu_i)$ is the solution to program P_i and π_i is the entrepreneur's optimal profit associated with program P_i. That leads to the following proposition.

Proposition 3

When $\eta < \bar{\eta}$, the entrepreneur chooses the safe strategy if and only if $p > q$ with $q = (\mu_2 - \mu_1)(R - r_l)/(1 + \mu_2)(R - r) + \alpha_2\mu_2(rr_s - r_l)$

Proof: Comparing π_1 and π_2 yields the proposition.

The entrepreneurs simply make financial decisions according to the probability that they may be compelled to liquidate their long-term project. If the entrepreneurs anticipate a low roll over probability on their short-term liabilities—that is, a high probability of a run—they borrow a few short-term debts to preclude any run on their liabilities. In contrast, if the rollover probability is high, entrepreneurs choose more short-term debt, with the portfolio composition ensuring complete rollover in case lenders agree to roll over short-term claims.

Having determined the optimal financial choices of firms, the article next examines how these choices affect macroeconomic variables, especially growth and volatility.

Growth and Macroeconomic Fluctuations

Note that the entrepreneur's initial wealth is w_e and lender's initial wealth is w_l. Assuming that $w_l \geq \mu_2 w_e$, short- and long-term interest rates are such that $r_s = r$ and $r_l = r^2$, and the entrepreneur's optimal debt portfolio is such that

$$\mu^* = \begin{cases} \mu_2 \text{ if } p < q \\ \mu_1 \text{ if } p > q \end{cases}$$

Two types of equilibria are possible. When the probability p is low the entrepreneur chooses program 2, the risky strategy, and the probability of a run is p. In contrast, when the probability p is large the entrepreneur chooses program 1, the safe strategy, and the probability of a run is 0. It is now possible to compute the law of motion of the macroeconomic capital stock as a function of the wealth distribution $(w_l; w_e)$. The growth factor g of the capital stock is

$$g_s = \frac{(w_l - \mu^* w_e)r^2 + (1 + \mu^*)w_e A_s(\mu^*)}{w_l + w_e}$$

where $A_h(\mu_1) = A_l(\mu_1) = R$ and $A_h(\mu_2) = R$ and $A_l(\mu_2) = r$. The following proposition can then be derived.

Proposition 4

The average growth rate of the economy m and the standard deviation of the growth rate σ are

$$m = \frac{(w_l - \mu^* w_e)r^2 + (1 + \mu^*)w_e[pA_l(\mu^*) + (1 - p)A_h(\mu^*)]}{w_l + w_e}$$

$$\sigma^2 = p(1 - p)\left[\frac{(1 + \mu^*)w_e}{w_l + w_e}[A_h(\mu^*) - A_l(\mu^*)]\right]^2$$

Proof: The mean and the standard deviation can be computed using the expression for g_s.

Growth volatility depends only on investments in the illiquid technology financed with portfolios $(\alpha_2; \mu_2)$ because those with portfolios $(\alpha_1; \mu_1)$ are never subject to a run. Average growth and growth volatility depend on three items: the entrepreneur's borrowing capacity μ^*, the volatility in the return on illiquid projects $R - r$, and the probability p of a run. The following result can then be derived.

Proposition 5

Assuming that $w_l \geq \mu_2 w_e$ and $p < q$, the probability p of a run and the volatility $R - r$ in the return on the entrepreneur's projects reduce average growth and increase growth's volatility. The probability p amplifies the negative effect of the volatility $R - r$ on growth.

Proof: Deriving the expression of m and σ with respect to p and $R - r$ yields the result.

Both the probability p, which relates to the entrepreneur's financial choices, and the volatility in the return on entrepreneur's projects $R - r$, which is exogenous, contribute to lower growth. These two sources of aggregate volatility reduce growth through independent channels; the probability of a run reduces the average return on the entrepreneur's projects, whereas the volatility $R - r$ on the return on entrepreneur's projects increases the average return on the entrepreneur's projects but imposes a negative effect on the storage technology that always dominates at the aggregate level. Moreover, there is an amplification channel; a higher probability of liquidity crisis tends to raise the growth cost of the volatility in the productivity of the entrepreneur's projects. So a higher borrowing capacity μ_1, by reducing the upper threshold of the probability p, will tend to reduce the growth cost of volatility in the productivity of the entrepreneur's projects.

The next part looks at the empirical evidence to determine whether these two different channels are empirically relevant.

III. Empirical Evidence

To test the validity of the theoretical predictions, data from three sources are considered: the Penn World Tables (Heston, Summers, and Aten 2002), the World Development Indicators database (World Bank 2005), and the World Bank Financial Structure and Economic Development Database (Beck, Demirgüc-Kunt, and Levine 1999). Macroeconomic variables come from the first two data sets, and the financial data from the third. The sample includes 87 countries for 1971–2000.[7] Following Loayza and Hnatkovska (2004), the cross-country growth regressions are carried out with average GDP per capita growth, the dependent variable, and the usual growth determinants (average private credit to GDP, average population growth, and initial GDP per capita), the independent variables. Volatility measures are added to test the predictions of the model. The regressions can be expressed as

$$\frac{y_i^{2000} - y_i^{1971}}{30} = \alpha + \beta x_i + \delta z_i + \varepsilon_i$$

where y_i^t represents the log of GDP per capita in country i in year t, α is a constant, x_i is a vector of the usual growth determinants, and z_i represents the vector of variables that the model predictions are based on.

The previous section divided growth volatility into the volatility of returns on the illiquid technology and the probability p of a run. To apply this distinction empirically, two measures of volatility are considered: the volatility of growth (the standard deviation of GDP per capita growth) and the frequency of low-growth episodes (the number of years when GDP per capita growth is below a given threshold). This threshold is equal to average GDP per capita growth minus one standard deviation of GDP per capita growth for each country. This captures the fact that crises are usually abnormal forms of volatility not captured by the standard deviation of GDP per capita growth. Symmetrically, the frequency of high-growth episodes is also considered (the number of years when GDP per capita growth is above average GDP per capita growth plus one standard deviation of GDP per capita growth).

Before going into econometric estimations, two things are worth noticing based on the correlations among the variables (see the appendix). First, all

7. The sample consists of Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Benin, Bolivia, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Democratic Republic of Congo, Costa Rica, Côte d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Ghana, Greece, Guatemala, Haiti, Honduras, Hong Kong, China, Hungary, India, Indonesia, Ireland, Italy, Japan, Kenya, Liberia, Madagascar, Malawi, Malaysia, Mauritania, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Puerto Rico, Republic of Congo, Republic of Korea, Rwanda, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Thailand, Togo, Tunisia, United Kingdom, United States, Uruguay, Venezuela, R.B., Zambia, and Zimbabwe.

measures of volatility (*growvol*, *lgfreq*, and *hgfreq*) correlate negatively with average growth, although the magnitude is much lower for the frequency of high-growth episodes. Second, the correlation between the frequency of low- and high-growth episodes is positive but rather low (0.3494).

In the econometric estimations the first tested is the prediction of the model that the forms of volatility considered should all have negative impacts on growth (table 2). Regression 1 shows that the estimated coefficients on the standard variables conform to what is usually found in the literature. Regressions 2–4 test the growth effects of the different forms of volatility. The estimates confirm that growth volatility, measured by the standard deviation of GDP growth, is harmful to growth, as is the frequency of low-growth episodes. Moreover, note that the coefficient for the frequency of low-growth episodes is much more significant than its counterpart for the standard deviation of GDP per capita growth. Regression 4 shows that the variable representing the frequency of high-growth episodes is not significant.

Regressions 5 and 6 test the hypothesis that the different volatility indicators provide nonredundant information for average growth. This seems indeed to be

TABLE 2. Growth Effects of Different Volatility Measures

Dependent variable: GDP per capita growth

	Regression					
	1	2	3	4	5	6
Log of initial GDP per capita	−0.654**	−0.729***	−0.624**	−0.648**	−0.742***	−0.755***
Population growth	−0.688***	−0.626**	−0.648***	−0.694**	−0.531**	−0.512**
Credit to GDP	3.017***	2.818***	3.027***	2.996**	2.693***	2.775***
Growth volatility	—	−0.013*	—	—	−0.220***	−0.214***
Low-growth frequency	—	—	−0.382***	—	−0.500***	−0.528***
High-growth frequency	—	—	—	−0.023	—	0.077
Number of observations	81	81	81	81	81	81

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: The dependent variable is average GDP per capita growth for each country in the sample over 1971–2000. Log of initial GDP per capita is the logarithm of GDP per capita in 1970, population growth is the average population growth rate over 1971–2000, credit to GDP is the average ratio of private credit to GDP over 1971–2000, growth volatility is the standard deviation of GDP per capita growth over 1971–2000, low-growth frequency is the number of years over 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, high-growth frequency is the number of years over 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth.

Source: Author's analysis is on the basis of the data described in the text.

the case. Both regressions show that the volatility of growth and the frequency of low-growth episodes have negative and significant coefficients. Regression 6 confirms that the high-growth-frequency variable has no significance in explaining average growth. Table 2 thus validates the prediction that volatility is harmful due both to deviations around the mean (growth volatility) and to crises (frequency of low-growth episodes) that directly reduce mean growth.

The prediction that different sources of volatility tend to have cumulative negative effects on growth is tested next. In other words, does an increase in the frequency of low-growth episodes tend to raise the negative effect of volatility on average growth? Symmetrically, does an increase in volatility tend to raise the negative effect of the frequency of low-growth episodes on average growth? Added for this test are interaction terms between the three volatility variables considered in the previous regression framework (table 3).

Regression 1 tests the interaction of growth volatility and the frequency of low-growth episodes. The amplification effect is relevant; growth volatility and the frequency of low-growth episodes tend to reinforce each other in their negative growth effects. But the significance of the interaction term is low. Regression 2 shows that the interaction between growth volatility and the frequency of high-growth episodes is not significant. In contrast, regression 3 shows that there are dampening effects between the frequency of low- and high-growth ones. This seems natural since the two variables should have, other things equal, opposite effects on average growth. Regressions 4–6 provide essentially similar results, but the significance is higher when the three different sources of volatility are introduced. In particular, regression 5 shows that a higher frequency of high-growth episodes tends to raise the growth cost of growth volatility.

To sum up, there are two different empirical results. First, both normal volatility (the standard deviation of GDP per capita growth) and abnormal volatility (the frequency of years when GDP per capita growth is below the average minus one standard deviation) have negative effects on average GDP per capita growth. Empirical estimations have shown that these two sources of volatility are nonredundant growth determinants. With a given volatility, a higher frequency of low growth reduces average GDP per capita growth. Similarly, with a given episode, frequency of low- and higher-growth volatility also reduces average GDP per capita growth.

Second, some evidence suggests that the negative growth effects of these two sources of volatility tend to reinforce each other. The negative effect on growth of the frequency of low-growth episodes seems to be amplified by a higher standard deviation of GDP per capita growth.

Before going into further evidence for these two conclusions, it is important to note that it might be argued that a higher frequency of low-growth episodes tautologically reduces average growth, the former variable being embedded in the latter. This remark misses two points. First, a higher frequency of low-growth episodes can be compensated for by what is called "low growth" actually being higher, with countries trading off the frequency against the severity

TABLE 3. Interaction Effects of Different Volatility Measures

Dependent variable: GDP per capita growth						
	Regression					
	1	2	3	4	5	6
Log of initial GDP per capita	−0.751***	−0.767***	−0.559**	−0.761***	−0.825***	−0.653**
Population growth	−0.483**	−0.596***	−0.570**	−0.470*	−0.444*	−0.442*
Credit to GDP	2.598***	2.708***	2.929***	2.663***	2.745***	2.446***
Growth volatility	0.009	−0.033	−	0.007	−0.016	−0.247***
Low-growth frequency	−0.162	—	−1.080***	−0.192	−0.561***	−1.38***
High-growth frequency	—	0.224	0.550	0.059	0.490**	−0.794**
Growth volatility × low-growth frequency	−0.072***	—	—	−0.070*	—	—
Growth volatility × high-growth frequency	—	−0.689	—	—	−0.093**	—
Low-growth frequency × high-growth frequency	—	—	0.166*	—	—	0.213***
Number of observations	80	80	80	80	80	80

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: The dependent variable is the average GDP per capita growth for each country in the sample over 1971–2000. Log of initial GDP per capita is the logarithm of GDP per capita in 1970, population growth is the average population growth rate over 1971–2000, credit to GDP is the average ratio of private credit to GDP over 1971–2000, growth volatility is the standard deviation of GDP per capita growth over 1971–2000, low-growth frequency is the number of years over 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, high-growth frequency is the number of years over 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth.

Source: Author's analysis is on the basis of the data described in the text.

of low-growth episodes. If that is so, the frequency of low-growth episodes could well correlate positively with average growth. Empirical evidence suggests that this is not so. Second, a higher frequency of low-growth episodes could similarly be traded off against a higher frequency of high-growth episodes, and average growth could also correlate positively with the frequency of low-growth episodes. Once again empirical evidence shows that this does not seem to be so. For these two reasons the result that the frequency of low-growth episodes is bad for growth is not trivial.

A simple way to address whether the frequency of low-growth episodes is indeed embedded in average growth is to consider the exogenous component of this measure and estimate its impact on average growth. This can be achieved with instrumental variable estimation. But before getting to these results, note that the result that both the standard deviation and the frequency of low GDP per capita growth episodes correlate negatively with average GDP per capita growth sheds light on growth theories relating average growth and growth skewness. This literature highlights that, given the negative growth effect of the standard deviation of GDP per capita growth, there is a positive growth effect from GDP per capita growth skewness, arguing that countries experiencing more frequent crises grow faster (Rancière, Tornell, and Westermann forthcoming, 2008). The empirical evidence here goes in the opposite direction, showing that the frequency of crises (low-growth episodes) does indeed always decrease growth.

Next to be determined is whether the two empirical predictions here are confirmed after the endogeneity bias is removed (table 4). Instrumental variable estimations are used to this end. Following the literature on the growth-volatility relationship, the variables are terms of trade-growth volatility, trading partners' GDP per capita-growth volatility, average trade to GDP, average share of urban population in total population, average consumer price index (CPI) inflation rate, CPI inflation rate volatility, average black market premium, black market premium volatility, a low and a high initial income dummy variables. Econometric tests confirm both the endogeneity bias of the previous estimates and the validity of this instrument set.

Regressions 1 and 2 confirm that each of the volatility measures here has significant predictive power for growth. Both variables have, as previously, a negative effect on growth. Compared with ordinary least-squares estimations, the estimated coefficient is much higher in both cases (-0.724 compared with -0.013 for growth volatility and -1.99 compared with -0.382 for the frequency of low-growth episodes). This indicates that volatility, however measured, is much more costly for growth than first found here. Regression 3 shows that the frequency of high-growth episodes has a negative impact on the average growth of GDP per capita for a given frequency of low-growth episodes. Although the significance is low, this regression confirms that there is a growth gain for countries in which growth is more stable, whether around low- or high-growth episodes.

Regressions 4 and 5 test whether the different volatility measures have independent predictive power for growth. The two regressions confirm that the exogenous component of GDP per capita growth volatility and the frequency of low GDP per capita growth episodes are costly for mean growth. As seen previously, the magnitude of the coefficients is larger than for ordinary least-squares estimates. Moreover, the estimated coefficient for the frequency of low-growth episodes is much more significant. One interpretation of this finding is that the first-order effect on the average growth of GDP per capita comes from the frequency of low-growth episodes, whereas GDP per capita growth volatility has only a second-order effect. This is confirmed by the

magnitude of coefficients, which is four times bigger for the frequency of low-growth episodes than for the volatility of GDP per capita growth (regression 4). A one-standard-deviation increase in the frequency of low-growth episodes thus induces a growth loss that is more than 30 percent larger than the growth loss induced by a one-standard-deviation increase in growth volatility (table 4).[8]

Interaction effects have also been investigated. Regression 6 shows that the interaction between the exogenous components of GDP per capita growth volatility and the frequency of low GDP per capita growth episodes is not a significant predictor of average growth. But this article's theoretical model suggests that the growth effect of volatility depends on credit constraints. To examine this possibility, an interaction term is introduced between the volume of credit to GDP and the volatility variables (table 5). It turns out that the volume of credit to GDP significantly affects the relationship between growth and volatility when volatility is measured as the standard deviation of GDP per capita growth. But this is not so for the frequency of low-growth episodes whose growth effect is independent of the volume of credit (regressions 1 and 2, table 5).

This result is robust both to the inclusion of other alternative volatility measures and to controlling for endogeneity (regressions 3–6).

IV. Conclusions

This article shows that macroeconomic fluctuations in the form of liquidity crises can emerge endogenously. When long-term financial contracts are imperfectly enforceable and in the presence of a moral hazard, lenders bias debt portfolios toward short-term debt to overcome the possibility of borrowers defaulting strategically. But this generates maturity mismatches between assets and liabilities and can lead to a global liquidity shortage when projects are illiquid. On the basis of this mechanism, the article shows that the relationship between volatility and growth is negative—whatever the volatility measure considered (the standard deviation of growth or the frequency of low-growth episodes)—and that the two sources of volatility tend to reinforce each other.

Empirical evidence, based on a large international data set, confirms that the two volatility sources have autonomous negative effects on growth. Financial development tends to dampen the growth cost of normal volatility (when volatility is measured as the standard deviation of GDP growth). But it does not seem to affect the growth cost of abnormal volatility (measured as the frequency of growth collapses). These results show that distinguishing different volatility sources is important for economic policy because the growth cost of volatility depends on the relative weights of normal and abnormal volatility.

8. Dispersion in the GDP per capita growth volatility variable is about three times the dispersion of the frequency of low-growth episode variables. So given the magnitude of coefficients, a one-standard-deviation increase in the frequency of low-growth episodes reduces growth by a factor of four-thirds compared with the growth loss induced by a one-standard-deviation increase in GDP per capita growth volatility. The growth loss is therefore about 30 percent larger.

TABLE 4. Interaction Effects between the Exogenous Components of Different Forms of Volatility

Dependent variable: GDP per capita growth						
	Regression					
	1	2	3	4	5	6
Log of initial GDP per capita	−0.695	−0.927	−0.892	−0.550	−0.608	−0.790**
Population growth	1.070	−0.815	−0.861	−0.226	−0.187	−0.343
Credit to GDP	4.587**	4.440**	4.269*	2.274**	2.388***	2.456***
Growth volatility	−0.724***			−0.364*	−0.384*	−0.588
Low-growth frequency	—	−1.99***	−1.98***	−1.54***	−1.54***	−1.73**
High-growth frequency	—	—	−0.137*	—	0.144	—
Growth volatility × Low-growth frequency	—	—	—	—	—	0.048
Hausman test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00
Sargan test (p-value)	0.47	0.98	0.97	0.62	0.49	0.57
Number of observations	80	80	80	80	80	80

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: The dependent variable is the average GDP per capita growth for each country in the sample over 1971–2000. Log of initial GDP per capita is the logarithm of GDP per capita in 1970, population growth is the average population growth rate over 1971–2000, credit to GDP is the average ratio of private credit to GDP over 1971–2000, growth volatility is the standard deviation of GDP per capita growth over 1971–2000, low-growth frequency is the number of years over 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, high-growth frequency is the number of years over 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth. The Hausman test indicates whether the ordinary least-squares estimation is biased, with a p-value less than 5 percent indicating bias. The Sargan test indicates whether the instrument set is valid, with a p-value greater than 5 percent indicating that the instrument set is valid.

Source: Author's analysis is on the basis of the data described in the text.

Proof of proposition 1

Consider a contract (α,μ). The entrepreneurs have three options. They can pay back their debts and carry out their illiquid project until the end. Then their profit is $\pi = (1 + \mu - \alpha\mu r_s)\bar{R} - (1 - \alpha)\mu r_l$. They can also default on long-term debts. In this case, given that there is a moral hazard $\underline{R} - \underline{\tau} > \bar{R} - \bar{\tau}$, the entrepreneurs are better off stopping their illiquid project. Their profit is then

TABLE 5. Interaction Effects of Financial Development and Different Volatility Measures

Dependent variable: GDP per capita growth						
	Regression					
	1	2	3	4	5	6
Log of initial GDP per capita	−0.728***	−0.657**	−0.738***	−0.790***	−0.995**	−0.965**
Population growth	−0.894***	−0.634**	−0.774***	−0.506**	−0.957**	−0.712**
Credit to GDP	−1.974***	0.871	−1.232	−0.079	−6.972**	−3.893
Growth volatility	−0.724***	—	−0.365***	−0.233***	−0.876***	−0.738***
Low-growth frequency	—	−0.549**	−0.384***	−0.721***	—	−0.430**
Growth volatility × credit to GDP	1.453***	—	1.199***	—	2.975***	2.169***
Low-growth frequency × credit to GDP	—	0.537	—	0.685	—	—
Hausman test (p-value)	—	—	—	—	0.00	0.00
Sargan test (p-value)	—	—	—	—	0.56	0.52
Number of observations	81	81	81	81	80	80

*Significant at the 10 percent level; **significant at the 5 percent level; ***significant at the 1 percent level.

Note: The dependent variable is the average GDP per capita growth for each country in the sample over 1971–2000. Log of initial GDP per capita is the logarithm of GDP per capita in 1970, population growth is the average population growth rate over 1971–2000, credit to GDP is the average ratio of private credit to GDP over 1971–2000, growth volatility is the standard deviation of GDP per capita growth over 1971–2000, low-growth frequency is the number of years over 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, high-growth frequency is the number of years over 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth. The Hausman test indicates whether the ordinary least-squares estimation is biased, with a p-value less than 5 percent indicating bias. The Sargan test indicates whether the instrument set is valid, with a p-value greater than 5 percent indicating that the instrument set is valid.

Source: Author's analysis is on the basis of the data described in the text.

$\pi' = (1 + \mu - \alpha\mu r_s)(\underline{R} - \underline{\tau})$. A contract (α,μ) is incentive-compatible only if $\pi \geq \pi'$, meaning that

$$\frac{1+\mu}{\mu} \geq (1-\alpha)\frac{r_l}{\tau} + \alpha r_s$$

If an entrepreneurs can carry out a project in the production technology with a debt portfolio (α,μ), it is then incentive-compatible to exchange this portfolio against a portfolio (β,μ) if and only if $(1+\mu-\beta\mu r_s)\bar{R} - (\alpha-\beta)\mu r_l - (1-\alpha)\mu r_l \geq (1+\mu-\beta\mu r_s)(\bar{R}-\bar{\tau})$. Assuming that $r_l \geq \bar{\tau}r_s$ and noting $[y]^+ = \max(y;0)$, this last expression can be simplified as

$$(r_l - \bar{\tau}r_s)\beta \geq [r_l - \bar{\tau}(1+\mu)/\mu]^+$$

Proof of proposition 2

When $\mu \leq \bar{\tau}/(r_l - \bar{\tau})$, then $\beta = 0$ and the entrepreneur's profit is $\pi = (1+\mu)R - r_l\mu$. It is strictly increasing in μ. When $\mu > \bar{\tau}/(r_l - \bar{\tau})$ the entrepreneur's profit is strictly lower than $\pi = (1+\mu)R - r_l\mu$. Hence, the solution is $\mu = \bar{\tau}/(r_l - \bar{\tau})$ and $\alpha^* = r_l/\tau\bar{\tau} - \tau/r_l - \tau r_s$. But due to the illiquidity constraint, this portfolio is possible if and only if $\eta \leq r_s(\bar{\tau}-\tau)/(r_l - \tau r_s$. So when this last condition is not met, the entrepreneur chooses α and μ such that $(1-\alpha)(r_l/\tau + \alpha r_s = \alpha(r_s/\eta$ and $(1+\mu/\mu = \alpha r_s\eta$, to maximize the volume of capital borrowed μ while minimizing the share of short-term debt α, which yields

$$\alpha^* = \frac{\eta r_l}{\eta r_l + (1-\eta)\tau r_s} \text{ and } \mu^* = \frac{\eta r_l/r_s + (1-\eta)\tau}{r_l - \eta r_l/r_s - (1-\eta)\tau}$$

Appendix

Table A-1. Summary Statistics

Variable	Number of observations	Mean	Standard deviation	Minimum	Maximum
growth	85	1.410	1.924	−4.817	6.935
growvol	85	4.661	3.036	1.632	21.229
lrgdpch	84	8.092	1.005	6.177	9.958
hgfreq	85	3.624	1.336	0	6
lgfreq	85	4.141	1.197	1	8
dpopm	85	1.915	0.9364	−0.036	3.529
pcgdpm	82	0.388	0.333	0.001	1.518

Note: The average GDP per capita growth of the sample for each country over 1971–2000 is *growth*, *growvol* is the standard deviation of GDP per capita growth over 1971–2000, *lrgdpch* is the logarithm of GDP per capita in 1970, *hgfreq* is the number of years in 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth, *lgfreq* is the number of years in 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, *dpopm* is the average population growth rate over 1971–2000, and *pcgdpm* is the average ratio of private credit to GDP over 1971–2000.

Source: Author's analysis is on the basis of the data described in the text.

TABLE A-2. Correlation Table

	growth	lrgdpch	dpopm	growvol	lgfreq	hgfreq	pcgdpm
growth	1.0000	—	—	—	—	—	—
lrgdpch	0.3186	1.0000	—	—	—	—	—
dpopm	−0.4359	−0.7641	1.0000	—	—	—	—
growvol	−0.3956	−0.5131	0.4805	1.0000	—	—	—
lgfreq	−0.2763	0.0057	0.0296	−0.2557	1.0000	—	—
hgfreq	−0.0085	0.1544	−0.1771	−0.2535	0.3494	1.0000	—
pcgdpm	0.5456	0.6955	−0.5918	−0.4740	0.0029	−0.0014	1.0000

Note: The average GDP per capita growth of the sample for each country over 1971–2000 is *growth*, *growvol* is the standard deviation of GDP per capita growth over 1971–2000, *lrgdpch* is the logarithm of GDP per capita in 1970, *hgfreq* is the number of years in 1971–2000 when GDP per capita growth was above average GDP per capita growth plus one standard deviation of GDP per capita growth, *lgfreq* is the number of years in 1971–2000 when GDP per capita growth was below average GDP per capita growth minus one standard deviation of GDP per capita growth, *dpopm* is the average population growth rate over 1971–2000, and *pcgdpm* is the average ratio of private credit to GDP over 1971–2000.

Source: Author's analysis is on the basis of the data described in the text.

FUNDING

This article was completed while the author was a Ph.D. student at the Department and Laboratory of Applied and Theoretical Economics (DELTA), Paris, France.

REFERENCES

Acemoglu, D., and F. Zilibotti. 1997. "Was Prometheus Unbound by Chance? Risk, Diversification and Growth." *Journal of Political Economy* 105(4):709–51.

Aghion, P., A. Banerjee, and T Piketty. 1999. "Dualism and Macroeconomic Volatility." *Quarterly Journal of Economics* 114(4):1359–97.

Albuquerque, R., and H. Hopenhayn. 2004. "Optimal Lending Contracts and Firms Dynamics." *Review of Economic Studies* 71(2):285–315.

Baig, T., and I. Goldfajn. 2002. "Monetary Policy in the Aftermath of Currency Crises: The Case of Asia." *Review of International Economics* 10(1):92–112.

Barclay, M., and C. Smith. 1995. "The Maturity Structure of Corporate Debt." *Journal of Finance* 50(2):609–31.

Beck, T., A. Demirg-Kunt, and R. Levine. 1999. "A New Database on Financial Development and Structure." *World Bank Economic Review* 14(3):597–605.

Bernanke, B., and M. Gertler. 1989. "Agency Costs, Net Worth, and Business Fluctuations." *American Economic Review* 79(1):14–31.

Chang, R., and A. Velasco. 2000. "Banks, Debt Maturity and Financial Crises." *Journal of International Economics* 51(1):169–94.

Chang, R., and A Velasco. 2001. "A Model of Financial Crises in Emerging Markets." *Quarterly Journal of Economics* 116(2):489–517.

Claessens, S., S. Djankov, and L. Lang. 1998. "East Asian Corporates: Growth, Financing and Risks over the Last Decade." Policy Research Working Paper 2017. World Bank, Washington, D.C.

Claessens, S., S. Djankov, and T. Nenova. 2000. "Corporate Growth Risk around the World." Policy Research Working Paper 2271. World Bank, Washington, D.C.

Corsetti, G., P. Pesenti, and N. Roubini. 1999. "What Causes the Asian Currency and Financial Crises? A Macroeconomic Overview." *Japan and the World Economy* 11(3):305–73.

Demirg-Kunt, A., and V. Maksimovic. 1999. "Institutions, Financial Markets, and Firm Debt." *Journal of Financial Economics* 54(3):295–336.

Diamond, D. 1991. "Debt Maturity Structure and Liquidity Risk." *Quarterly Journal of Economics* 106(3):709–37.

Diamond, D., and P. Dybvig. 1983. "Bank Runs, Deposit Insurance and Liquidity." *Journal of Political Economy* 91(3):401–19.

Eichengreen, B., and R. Hausmann. 1999. "Exchange Rates and Financial Fragility." NBER Working Paper 7418. Cambridge, MA: National Bureau of Economic Research.

Flannery, M. 1986. "Asymmetric Information and Risky Debt Maturity Choice." *Journal of Finance* 41(1)19–37.

Furman, J., and J. Stiglitz. 1998. "Economic Crises: Evidence and Insights from East Asia." *Brookings Papers on Economic Activity* 2:1–136.

Greenwald, B., and J. Stiglitz. 1993. "Financial Market Imperfections and Business Cycles." *Quarterly Journal of Economics* 108(1):77–114.

Greenwood, J., and B. Jovanovic. 1990. "Financial Development, Growth, and the Distribution of Income." *Journal of Political Economy* 98(5):1076–107.

Heston, A., R. Summers, and B. Aten. 2002. "Penn World Table Version 6.1." Center for International Comparisons, University of Pennsylvania, Philadelphia, PA.

Jones, L., R. Manuelli, and E. Sachetti. 1999. "Technology and Policy Shocks in Models of Endogenous Growth." NBER Working Paper 7063. Cambridge, MA: National Bureau of Economic Research.

Kale, J., and T. Noe. 1990. "Risky Debt Maturity Choice in a Sequential Game Equilibrium." *Journal of Financial Research* 13(2):155–65.

Kiyotaki, N., and J. Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105(2):211–48.

Krugman, P. 1979. "A Model of Balance of Payments Crises." *Journal of Money Credit and Banking* 11(3):311–25.

———. 1999. "Balance Sheets, the Transfer Problem, and Financial Crises." *International Tax and Public Finance* 6(4):459–72.

Loayza, N., and V. Hnatkovska. 2004. "Volatility and Growth." In J. Aizenman, and B. Pinto eds., *Managing Economic Volatility and Crises: A Practitioner's Guide*. Cambridge: Cambridge University Press.

Radelet, S., and J. Sachs. 1998. "The Onset of the East Asian Financial Crisis." NBER Working Paper 6680. Cambridge, MA: National Bureau of Economic Research.

Ramey, G., and V. Ramey. 1995. "Cross-country Evidence on the Link between Volatility and Growth." *American Economic Review* 85(5):1138–51.

Rancire, R., A. Tornell, and F. Westermann. (forthcoming, 2008). "Systemic Crises and Growth." Quarterly Journal of Economics.

Rey, P., and J. Stiglitz. 1993. "Short-term Contracts as a Monitoring Device." NBER Working Paper 4514. Cambridge, MA: National Bureau of Economic Research.

Rodrik, D., and A. Velasco. 1999. "Short-term Capital Flows." In B. Pleskovic, and J. E. Stiglitz eds., *Annual World Bank Conference on Development Economics, 1999*. Washington, D.C.: World Bank.

Tornell, A., F. Westermann, and L. Martinez. 2004. "The Positive Link between Financial Liberalization, Growth and Crises." Working Paper 1164. Munich: CESifo.

World Bank. 2005. *World Development Indicators Database*. Washington, D.C.

Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar

Hanan G. Jacoby and Bart Minten

Formalizing land rights has been promoted as a way to encourage agricultural investment and stimulate land markets, yet little is known about the benefits of such policies in Sub-Saharan Africa, where the preconditions for success are less favorable. The analysis uses a large sample of plots from an intensively titled rice-growing area of Madagascar and compares land-specific investments, land productivity, and land values for titled and untitled plots cultivated by the same household. Having a title has no significant effect on plot-specific investment and correspondingly little effect on land productivity and land values. These results are broadly consistent with a simulation of a theoretical model of investment under expropriation risk calibrated to the same data. A cost–benefit analysis suggests that the current system of formal titling should not be extended in rural Madagascar and that any new system of land registration would have to be quite inexpensive to be worthwhile. JEL code: Q15.

Reducing land tenure insecurity is seen as a legitimate role for the state and often as a cost-effective intervention. Evidence from Asia and Latin America suggests that formalizing land ownership, through registration and titling, can deliver large productivity gains. Formalization is particularly attractive where indigenous tenure systems are weak or absent, where the return on investment in land is high, and where collateralized lending has taken hold. In most of Sub-Saharan Africa, however, none of these conditions apply, leading some to question the wisdom of registering land and widely distributing land titles.[1]

There has been little empirical work on the effects of land rights formalization in Sub-Saharan Africa, reflecting the small fraction of farmland there that

Hanan G. Jacoby (corresponding author) is lead economist in the Development Research Group of the World Bank; his e-mail address in hjacoby@worldbank.org. Bart Minten is a senior research fellow at the International Food Policy Research Institute; his e-mail address is bminten@iris.mg. The authors are grateful to Klaus Deininger, Gershon Feder, and Rogier van den Brink, as well as to the referees and the journal editor for comments. A supplemental appendix to this article is available at http://wber.oxfordjournals.org/.

1. These well-known arguments are summarized in World Bank (2003), Feder and Nishio (1999), Firmen-Sellers and Sellers (1999), Bruce and Migot-Adholla (1997), Atwood (1990), and Migot-Adholla et al. (1991). Migot-Adholla et al. (1991) are among those who point out that Sub-Saharan Africa lacks the infrastructure, factor market development, and other prerequisites for land tenure reform to promote agricultural intensification and productivity growth.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 461–485 doi:10.1093/wber/lhm011
Advance Access Publication 30 June 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

is registered and titled. Evidence from Kenya, considered the African test case for tenure reform, shows little if any economic impact of land registration (Place and Migot-Adholla 1998; Carter et al. 1997). A larger literature exists on customary land rights in Africa (see, for example, Besley 1995; Gavian and Fafchamps 1996; Brasselle et al. 2002), but it is concerned mainly with the economic response to greater tenure security. This article focuses on the potential benefits of a land titling program. Land tenure reform will not necessarily succeed even if greater tenure security leads to large increases in investment and land productivity. The reform must, first of all, reduce insecurity. However, introducing or expanding a modern property rights regime alongside an indigenous tenure system is not guaranteed to reduce insecurity, or to reduce it by much, and could even have the opposite effect.

Indigenous tenure, through a set of well understood and respected rules governing land use and transfer within the community, imparts a certain degree of tenure security and could thus render land titling largely redundant. Indeed, establishing a modern property rights system without legally recognizing informal rights may expand the scope for rent-seeking, thus creating additional insecurity (Atwood 1990). Such tenure uncertainty can in turn create demand for formalization where previously none existed. According to Bruce et al. (1997, p. 259): "Much of the titling demand for smallholders in Africa can be viewed as 'preemptive'—representing an attempt to prevent the state from allocating the land to someone else, rather than the expression of a felt need for new operating rules of tenure." Land registration and titling, in other words, become privately valuable even while these institutions, in the broader sense, might be socially wasteful.

With these considerations in the background, this study estimates the private benefits of land titles in Madagascar, a country where modern and informal tenure systems coexist and overlap to a considerable extent in certain zones. Using a large data set recently collected in an intensively titled area, the Lac Alaotra Basin, the analysis compares economic performance on titled and untitled land. This focus on a long settled, irrigated, and relatively productive rice-growing area contrasts with much of the work on African customary tenure, which examines investments in tree crops. While this means that the conclusions may not generalize to tree-growing regions or to areas of recent settlement, they should be relevant to much of the continent's agriculture.

Institutionally, Madagascar also shares salient features with many other African countries. Although local communities have found ways of legitimizing land transfer and ownership, such institutions offer little safeguard against attempts at expropriation by powerful outsiders, rare though these may be.[2] To ballpark the empirical magnitudes of the titling effects that one might

2. To be sure, there are settings with high expropriation risk in Africa. In Ethiopia, which has a history of institutionalized land redistribution, Deininger and Jin (2006) find a strong impact of land rights on investment.

expect to find in such a setting, simulations are presented from a simple model of investment subject to expropriation risk. The emphasis on potential land expropriation is further motivated by the low level of financial intermediation found in rural Madagascar, another commonality with much of Sub-Saharan Africa. While limited collateralized lending does exist in Lac Alaotra, evidence summarized later shows that formal credit is unresponsive to land titling. Credit, therefore, is unlikely to be a major channel for land titling to enhance investment.

A key empirical concern in any study of this type is endogenous take-up of land titles. Elsewhere, this problem has been dealt with by comparing areas where titles are available to those where they are not. For example, the landmark study of Feder et al. (1988) in Thailand constructs a comparison group for farmers with titled land from among farmers cultivating plots in adjacent state forest reserves, in which titles cannot be legally issued. A similar methodology is adopted here by comparing titled and untitled plots in a very restricted geographical area, within which differences in infrastructure, market development, returns to land-specific investment, and soil fertility should be minimal. In addition, the data allow comparison between titled and untitled plots cultivated by the same household, thus eliminating selection bias at the farmer level. Such selection bias may be particularly salient in the case of investment, which depends on farmer-level attributes that are difficult to observe, such as entrepreneurial ability and wealth; these attributes may also affect the decision to pursue land titling in the first place.[3]

Section I describes the setting and data used in the study, focusing on the relationship between formal and informal property rights in land. Section II presents arguments for why land titling might be beneficial and assesses their relevance in rural Madagascar. Section III develops the empirical estimates of the impacts of land titles on land-specific investment, land productivity, and land values. Section IV lays out the implications of the findings for land policy in Madagascar and Sub-Saharan Africa more broadly.

I. Setting and Background

Lac Alaotra is the principal rice-growing region of Madagascar, a country where rice is the main staple food and is cultivated by almost every rural household. The Lac Alaotra basin encompasses nearly 30,000 hectares of rice land under modern irrigation, lying within four vast irrigated perimeters along the lakeshore, and another 72,000 hectares of lowlands under traditional forms of irrigation. The large irrigated perimeters, called *mailles* (French for "mesh," evoking the crisscrossing irrigation canals), were carved out of marshland beginning in the 1950s under the French colonial administration. Dams and canals were built to control water flows, thus limiting periodic floods and allowing a reliable supply of irrigation. Rice yields have been much higher

3. Deininger and Chamorro (2004) follow a similar household fixed-effects strategy in their study of Nicaragua, but only for land values, not for investment.

within the *mailles* than on adjacent lands. By international standards, though, rice productivity in Lac Alaotra and throughout Madagascar is low, as the green revolution has largely bypassed Sub-Saharan Africa.

Most land within the irrigated perimeters of Lac Alaotra was claimed by French settlers until Independence in 1960, when the zones of colonization were abolished and land ownership reverted to the state. Under the new law peasants occupying land could obtain formal title just as the colonists had. The old titling system, based on the Torrens model, in which the state guarantees ownership (so that the rights to the property cannot be challenged in court), lived on in the post-Independence era. However, the formal titling procedure, better suited to large tracts of highly productive farmland than to the typically small Malagasy plot, was (and is) complex and costly, involving 24 steps and taking years to complete.

When the Malagasy administration took over management of the *mailles* in 1961 through the state Development Agency for the Lac Alaotra Region (SOMALAC), it began to redistribute land among current occupants as well as newcomers. Tenants conforming to SOMALAC's by-laws were eventually to receive formal title to the reconfigured parcels. Farmers with land in the *mailles* first had to pay a "maintenance" fee entitling them to a certificate of occupation. Though only a first step toward formal title, having this document significantly lowered the barriers to a title application.[4]

Despite the attention paid to formalizing land ownership within this special zone, a large share of *maille* parcels still have no titles to this day. There are many reasons for this, not least of them lack of resources and capacity in the office of land administration. Other cases have more to do with the determination of the landowners themselves. Farmers frequently failed to pay the maintenance fee, thus blocking progress toward a title. Sometimes, the originally designated owner died during the lengthy titling process, and the heirs could not agree on a single representative to take over, or they were late in obtaining the necessary documentation for the inheritance. Often titles were abandoned after the parcel was divided or sold in a manner contrary to SOMALAC's by-laws (CIRAD 2004).

The upshot is that the Lac Alaotra Basin not only contains some of the country's most productive rice land but is also perhaps the most intensively titled area of rural Madagascar. Importantly, though, not all land within the *mailles* is titled and not all land outside the *mailles* is untitled. This makes it possible to distinguish empirically between the effects of having titles and the effects of simply having land within the *mailles*.

Data and Sampling

A specially designed survey covering more than 1,700 households in 38 communes was conducted around Lac Alaotra in April–May 2005. About 900

4. Another advantage was that SOMALAC undertook the cartography for all *maille* parcels, work that would otherwise have had to be done by the understaffed land administration. With the dissolution of SOMALAC in 1991, its role in facilitating land titling ended abruptly.

landowning households were randomly selected from 29 communes lying wholly outside the irrigated perimeters. In order to oversample households with titled land, about 800 households were randomly selected from the nine communes encompassing the *mailles*.

The survey asked about land documentation, agricultural production, and investment for all household parcels—lowland (*riziere*), upland, and forest plots. There is a clear distinction between these types of land in Madagascar. Although rice may occasionally be cultivated on upland plots, lowland plots are used exclusively for growing rice during the main (wet) season and are virtually never converted to alternative agricultural uses. The focus here is exclusively on lowland plots, by far the most valuable type. Thus, the sample consists of 3,232 rice plots owned by 1,604 households. Descriptive statistics at the plot and the household level are shown in tables S1 and S2 of the supplemental appendix (available at http://wber.oxfordjournals.org/).

Analysis confirms the two observations made above regarding rice land within the *mailles*. First, an unusually high proportion of the land is titled (table 1). Whether the land is considered by plot or by area, farmers have formal title to about half of the land in the *mailles*, some four to six times higher than outside the *maille* where the prevalence of titled land is just above the national figure of around 7 percent of area. Second, land within the *mailles* is considerably more productive than land outside; rice yield (for the 2004 crop), revenue from rice (net of purchased input costs), and estimated plot values are all around 40 percent higher for *maille* plots.[5]

The extent to which this greater productivity is due to the higher rate of titling in the *mailles* is addressed in detail in section III. For now, a cursory answer is provided in figure 1, which illustrates the estimated densities of log plot value per hectare by *mailles* location and title status. The dominant feature is the shift of the entire distribution of land values between *mailles* and non-*mailles* plots. Within each location, however, the distributions for titled and untitled plots are virtually indistinguishable. Whether this conclusion holds up when other factors are controlled for remains to be seen, but the preliminary evidence suggests that titling effects are subtle, at best.

Informal Tenure in Madagascar

Data from the Lac Alaotra region, summarized in table 2, reveal a rich tapestry of land documents of varying degrees of formality, the so-called *petits papiers*, or "little documents." In most cases these documents appear to exist independently of the formal titling status of the plot. In the table, titles in the name of a current household member or relative are referred to as "up to date" and

5. Productivity also varies across the four large perimeters, but not nearly as much as between *maille* and non-*maille* plots. Average yield, for example, ranges between 3.1 and 3.6 tons per hectare within the four *mailles*. The coefficient of variation of yield, revenue, and plot value inside the *mailles* are all 60–70 percent as large as they are outside, probably reflecting the fact that land quality, including quality of irrigation, is more uniform within the modern irrigated perimeters.

TABLE 1. Descriptive Statistics for Rice Plots

			Plot-specific productivity					
	Titled (%)		Yield (metric tons per hectare)		Net revenue per hectare (US$)		Value per hectare (US$)	
Plot type	Share of plots	Share of area	Median	Mean	Median	Mean	Median	Mean
Maille plot[a]	51	53	3.47	3.31(1.16)	670	655(261)	1,300	1325(527)
Non-*maille* plot	8	12	2.24	2.32(1.39)	446	466(303)	800	918(519)
All plots	27	34	3.00	2.77(1.38)	574	552(299)	1,000	1102(560)

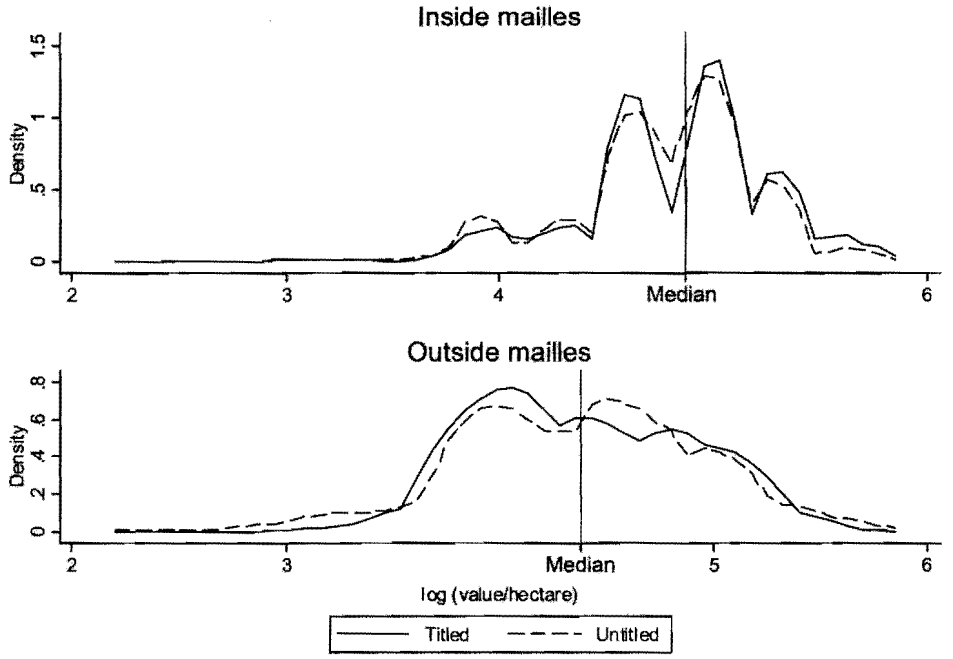
	Plot-specific investment							
	Irrigation /drainage canal		Protective bunds		Land leveling		All investments	
Plot type	Share of plots (%)	Mean	Share of plots (%)	Mean	Share of plots (%)	Mean	Share of plots (%)	Mean
Maille plot[a]	91	17(38)	46	12(76)	18	10(85)	94	39(188)
Non-*maille* plot	75	25(47)	40	15(41)	32	16(54)	85	56(102)
All plots	82	21(44)	43	13(60)	25	13(70)	89	48(147)

Note: Numbers in parentheses are standard deviations. Yields, revenues, and investment data are for main season rice crop and are based on about 2,800 owner-cultivated plots. The sample for the titling and plot value figures includes rented out and uncultivated plots (2 percent of total), but value excludes the 8 percent of plots with missing data, leaving a total of 2,961 plots.

[a]Plot located within a modern irrigated perimeter (45 percent of sampled rice plots).

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

FIGURE 1. Plot Value by Location and Title Status



Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

those in the name of a deceased person as "out of date." Overall, 42 percent of titled plots are in the out-of-date category, reflecting both the costliness of the procedure for recording land transactions and inheritances as well as resource constraints in the land administration bureaucracy.

Regarding purchased plots, which account for more than 40 percent of the total,[6] the vast majority of land sales are accompanied by a sales receipt, usually handwritten (*acte de vente*). In most cases, this document is signed by the village (*fokontany*) head in front of the parties to the transactions and possibly other witnesses—it is thus "certified." The main purpose of such a procedure seems to be to assure the buyer that, in the eyes of the community, the plot actually belongs to the seller and, moreover, has not already been sold to someone else. It is perhaps not surprising, then, that transactions among close relative are somewhat less likely to involve these receipts and substantially less likely to be certified by the village head (see table 2). In acknowledging that a proper land transaction took place, an *acte de vente* can also subsequently

6. Lac Alaotra is notable for the extent of land market activity. Nationally, only about 13 percent of lowland plots in rural areas are purchased (according to the EPM 2001 national household survey). Also, one-quarter of cultivated plots in the sample are leased, compared with the national figures of 10 percent.

TABLE 2. Land Documentation for Rice Plots, by Mode of Acquisition (percent)

Mode of acquisition and documentation[a]	Share of plots	Share of plots with document			
		Titled[b]			
		Up-to-date	Out-of-date	Untitled	All
Purchased from close relative	11	8	6	85	100
Acte de vente		93	91	91	91
Certified *acte de vente*		74	86	74	75
Acte de donation		39	17	16	18
Purchased from distant relative, neighbor, stranger	30	11	6	83	100
Acte de vente		98	98	96	96
Certified *acte de vente*		91	87	89	89
Acte de donation		38	18	17	20
Inherited	42	15	20	65	100
Acte de patrimoine		50	70	59	60
Acte de notorité		52	71	55	58
Acte de donation		34	21	23	24
At least one of three above		57	77	60	63
Cleared by owner	7	9	0	91	100
Authorization for clearing		45	—	28	30
SOMALAC[c]	10	44	5	51	100
Acte d'attribution		—	—	85	—
All plots	100	16	11	73	100

—, is not applicable.

Note: Figures in bold are row percentages for titled status by mode of acquisition.

[a]See text for description of the documentation listed in table.

[b]"Up to date" refers to titles in the name of a current household member; "out of date" refers to titles in the name of a deceased person.

[c]Development Agency for the Lac Alaotra Region, the state land administration agency for the *mailles*.

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

serve as proof of ownership. Indeed, among the few land sales reported in the data over the past 10 years involving previously purchased plots, most mention the original *acte de vente* as the main proof of ownership.

There are several other *petits papiers* listed in table 2, depending on the mode of plot acquisition. An *acte de donation*, issued by the commune, indicates that a specific person has transferred a well-demarcated parcel of land to another person, either through purchase or inheritance; in both cases, this document is uncommon. Inherited land is generally less well documented than is purchased land, with only two-thirds of inherited rice plots having any kind of paper (most commonly an *acte de patrimoine*, itemizing the estate of the deceased, and an *acte de notorité*, certifying the heirs). For about a third of the lowland plots that were originally cleared by the current owner (virtually all

outside the *mailles*), the owner obtained advance written authorization for the exploitation. Legally, in such cases, one can apply for title based on the principle of *mise en valeur* (improvement) if one can establish occupancy for at least 10 years. Finally, 10 percent of rice plots in the sample were acquired directly from SOMALAC as part of the land redistribution in the 1960s and early 1970s. The owners of most of these plots that remain untitled report having an *acte d'attribution*, a certificate of occupation issued by SOMALAC. After so many years, however, the titling process in these cases is for all intents and purposes moribund.

Since, unlike the case of many other African countries, Madagascar land law does not recognize customary tenure, none of the aforementioned documents has the same juridical standing as a formal title. Nonetheless, they may provide farmers with a considerable sense of tenure security.

Investment in Rice Land

Land-specific investment comes in three basic varieties: initial clearing of land to make it cultivable, installation of new infrastructure, and maintenance of existing infrastructure. The scope for the first type of investment depends on the extent of unexploited lowlands. Since the region around Lac Alaotra has a long history of settlement, there is now little land left to clear for irrigated rice cultivation. Only 7 percent of rice plots were acquired through clearing by the current owner, and few of these plots were cleared recently (less than 20 percent of them after 1990; see table 2).

As for plot infrastructure, the survey collects detailed data on all investments in land over the past five years on owned plots, including cash costs and family labor inputs. There are three dominant types of investment in lowland rice plots, which are, in order of importance, the construction/maintenance of irrigation/drainage canals, the construction/maintenance of protective bunds, and land leveling (see table 1). Other investments (installation of wells, tree-planting, terracing) are virtually unheard of for rice plots in Lac Alaotra. Investments related to water management (canals) are more prevalent within the modern irrigated perimeters, whereas land leveling is more common outside the *mailles*, where plots are more prone to sedimentation.

Overall, total annualized investment expenditures (valuing family labor days at the local wage) over the past five years average only about 1 percent of plot value. Such relatively low expenditures and their high frequency suggest that investments are largely for maintenance of existing plot infrastructure. There are other indications that the vast bulk of investment in rice land is recurrent. For 92 percent of the cases of canal work, 91 percent of bund work, and 87 percent of land leveling (almost by definition a maintenance activity on existing rice plots) the investment was reported to have already existed on the plot five years before and thus was not being made for the first time only in the last five years.

II. Economic Benefits of Land Titles in Madagascar

Land titling can increase investment in land, agricultural productivity, and land values in three ways, which Brasselle et al. (2002) term the *assurance*, *realizability*, and *collateralizability* effects. The assurance effect arises insofar as titling reduces the risk of land expropriation. As the expected length of tenure increases, improving or maintaining one's land becomes more attractive. While the assurance effect is the focus of this section, the relevance of the other titling effects in rural Madagascar is considered later.

The Assurance Effect and the Social Value of Titling

For 37 percent of untitled plots in Lac Alaotra the owner either currently has a title demand pending or intends to make one in the future, albeit not necessarily with an awareness of the full costs involved. What underlies this apparently strong latent demand for titling? The evidence suggests that a formal land title provides a virtually ironclad ownership guarantee, despite Madagascar's weak legal system. Ninety percent of farmers questioned in the survey see protection against competing claimants as the chief benefit of a title. Another 6 percent said that a title mainly facilitates bequests of land to children, which, arguably, amounts to the same thing insofar as the inheritance of a titled plot is harder to challenge.

Notwithstanding these expressions of demand for tenure security, the actual risk of land expropriation does not appear to be high. When asked whether they had heard of cases of households having lost land because they lacked proper documentation, 91 percent responded rarely or never. Most (69 percent) of those who had heard of such cases identified large landowners or powerful individuals as the instigators of the conflict. Such responses reflect an underlying perception of rent-seeking and corruption in the land administration office that often emerges in field interviews. The principal fear is that influence could be used within the land administration office to have false titles issued.

As indicated earlier, a large fraction of land titles in Madagascar are in the name of a deceased person. Do such out-of-date titles have any value? While this is ultimately an empirical question, there is good reason to believe that, with regard to expropriation of the sort just discussed, an out-of-date title still confers considerable protection. First, in most cases of inheritance, the title will bear the same family name as that of the current owner. Second, the issuance of the title, even if many years in the past, implies that the parcel is part of the title deed registry and its boundaries and title number appear in the cadastral record at the land administration office. Consequently, it would be extremely difficult to have a new title issued for land incorporating a previously titled parcel, even one subsequently subdivided among several co-inheritors. Certainly, it would be far easier to exploit the modern titling system to nullify an informal ownership claim than a formal one.

If farmer opinion is any indication, the main channel for titling to have an economic impact in the Lac Alaotra region is through the assurance effect.[7] However, even if these economic impacts turn out to be large, the fact that landowners demand titles in an area already exposed to titling does not imply that introducing a land titling program into a previously untitled area is a good idea. That depends on the extent to which the modern system of title deeds creates additional tenure insecurity on land remaining outside its umbrella. The larger the externality imposed on those with informal tenure and the more difficult it is to make titling universal, the more likely it is that a land titling initiative will entail a net social cost.

Quantifying the Impact of Expropriation Risk

If most land-specific investment in Madagascar rice land is indeed for plot maintenance, as the data suggest, then the quantitative importance of the assurance effect of land titles can be assessed a priori. Consider the simple model of recurrent investment in land subject to expropriation risk used by Jacoby et al. (2002). Let the instantaneous (annualized) probability of losing one's plot, θ, be constant over time. The private value of the plot is then $\pi/(r + \theta)$, where π is net revenue per hectare (net of recurrent investment costs) and r is the annual discount rate.[8] Recurrent investment, the stock of capital, and net revenue are all decreasing in θ. Obtaining legal title to a plot, to the extent that it lowers the threat of expropriation, raises land values both by increasing steady-state investment, thus raising land productivity, and by lowering the effective discount rate, $r + \theta$. Thus land titles are valuable to farmers even if they do not appreciably enhance investment in land.

What magnitude of expropriation risk would have to be present to obtain an empirically detectable effect of land titling on recurrent investment and on land values? Assume that output per hectare is produced according to the function $k^{1-\alpha}/(1 - \alpha)$, where k is the stock of plot infrastructure and $\alpha \in (0,1)$. Suppose further that granting a formal title reduces expropriation risk from θ to 0. Under these assumptions, the ratio of investment expenditures on titled land to that on untitled land is independent of the unit cost of investment and takes the simple form $[1 + \theta/(r + \delta)]^{1/\alpha}$, where δ is the depreciation rate on infrastructure. The analogous ratio for land values, which is

7. Atwood (1990) argues that land titles can also *create* insecurity and conflict within a community. Evidence of conflicts in the Lac Alaotra data is quite rare, involving only 3 percent of owned rice plots; this figure encompasses the entire ownership period and falls to just 1.4 percent for conflicts over the past five years. There is some evidence that conflicts are more prevalent on titled plots than on untitled plots, other things being equal, but the number of conflicts in the data set is simply too small to inspire much confidence in this finding.

8. Specifically, the farmers problem is to maximize $\int_0^\infty e^{-(r+\theta)t}\pi(k(t))dt$, subject to $\dot{k}(t) = -\delta k(t) + x(t)$, where $\pi = F(k(t)) - cx(t)$, F is the production function with unit output price, k is the capital stock, c is the unit cost of recurrent investment, x is the flow of recurrent investment, and δ is the rate of depreciation.

an overall measure of the benefits of a title, is also given by a simple formula.[9] Both of these ratios are easily calculated for different configurations of the parameters $\{r,\delta,\theta,\alpha\}$.

For the discount rate, let $r = 0.1$ throughout the simulation exercise. Since plot infrastructure, such as canals and bunds, can quickly silt up or erode without continual maintenance, both a high and low depreciation rate are considered. If three-quarters of the capital stock depreciates in five years, then δ solves $e^{-5\delta} = 0.25$, or $\delta = 0.28$. If only a quarter of the capital stock depreciates within this time, then $\delta = 0.06$. These are the two values used in the simulations in table 3.

Absent any informed guess at a value for α, the model is calibrated against the data using the ratio of annualized investment expenditures to plot value. The model delivers the expression $\delta(1 - \alpha)(r + \theta)/(r + \theta + \delta\alpha)$ for this ratio. The calibrated percentages at different parameter values are shown in the top panel of table 3, and these can be compared to the actual figure of 1.2 percent. For $\delta = 0.28$, a value of $\alpha = 0.85$ is most consistent with the investment data, whereas for $\delta = 0.06$, $\alpha = 0.75$ is more appropriate.

The percentage changes in investment expenditures due to titling under alternative choices of α and θ are reported in the middle panel of table 3. For initial expropriation risk on the order of 10 percent, as found in China under an explicit regime of village-level land reallocation (see Jacoby et al. 2002), the investment responses are always large. But the magnitudes fall roughly proportionally with θ. At $\theta = 0.001$ investment expenditures hardly respond at all to land formalization, whichever δ is chosen. The story is more or less the same for land values, although the titling effects are larger than for investment (bottom panel of table 3).

Crude as these calculations may seem, they do suggest that detecting titling assurance effects in a data set of typical size might be difficult. Even a one in a thousand chance of losing a plot in a given year is probably unrealistically large in the environment of rural Madagascar. To put this into perspective, consider that the typical village in the sample has about 300 households, each owning an average of two rice plots (along with two upland plots). A θ of 0.1 percent would imply that around one household per year in a village loses a plot. Yet in the survey, 72 percent of households report never having heard of *anyone* (ever) having lost land due to lack of proper documents, and an additional 19 percent had "rarely" heard of such cases.

The Realizability Effect

Land tenure formalization, insofar as it facilitates land transactions, can also increase land-specific investment through the so-called realizability effect (see

9. The expression is $((r + \theta)(r + \theta + \delta)^{1/\alpha}(r + \alpha\delta))/(r(r + \delta)^{1/\alpha}(r + \theta + \alpha\delta))$. Notice that, as the depreciation rate approaches zero, the ratio of the value of titled to untitled land approaches $(1 + \theta/r)^{1/\alpha}$. Thus, in this limiting case, recurrent investment falls to zero and is unresponsive to expropriation risk, but titled land is still more valuable than untitled land, with the premium directly related to θ.

TABLE 3. Investment and Land Value Differences Due to Titling

	$\delta = 0.28$			$\delta = 0.06$		
	$\theta = 0.1$	$\theta = 0.01$	$\theta = 0.001$	$\theta = 0.1$	$\theta = 0.01$	$\theta = 0.001$
Calibration: Investment expenditure/value × 100						
$\alpha = 0.50$	8.2	6.2	5.9	2.6	2.3	2.3
$\alpha = 0.75$	3.4	2.4	2.3	1.2	1.1	1.0
$\alpha = 0.85$	1.9	1.3	1.25	0.7	0.6	0.6
Investment expenditure percentage differential of titled compared with untitled						
$\alpha = 0.75$	37	3.5	0.4	91	8.4	0.8
$\alpha = 0.85$	32	3.1	0.3	77	7.4	0.7
Land value percentage differential of titled compared with untitled						
$\alpha = 0.75$	106	10	1.0	126	12	1.1
$\alpha = 0.85$	103	10	1.0	113	11	1.1

Note: Simulated percentage differences with $r = 0.1$ assumed throughout.

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

Besley 1995). Greater transferability of land not only enhances the return on investment, but it also improves allocative efficiency, putting land in the hands of those who value it most. A title is the ultimate proof to the buyer that the land truly belongs to the seller and that no one will later challenge the original owner's right to sell. Furthermore, by relinquishing the title deed to the buyer, the seller provides assurance that the plot has not already been sold to someone else. Buyers, especially outsiders without access to village information networks and lacking familiarity or trust in village institutions, may therefore be willing to pay a premium for titled land, as a sort of transaction insurance.[10] If so, a higher proportion of titles would be expected among purchased plots than among inherited plots.

There is another side of the story, however. Under Madagascar's dysfunctional land administration, updating or transferring a title is expensive, in both money and time, especially if subdivision has occurred since the original deed was issued. Purchasing a titled plot without easily being able to update the name on the document exposes the buyer to the risk that a relative of the seller, sharing the family name, might subsequently claim the plot or challenge the transfer.

More generally, land titles under these circumstances create transaction costs. To illustrate, take the model described previously in which a plot's value is $\pi/(r + \theta)$. Assume that there are a number of potential buyers of the plot, each with a different estimate of its long-run future profitability, π'. When

10. Farmers in Lac Alaotra were asked whether they had ever heard of cases of the same plot of land having been sold to two different people. Although the vast majority (82 percent) said that such swindles rarely or never happen, they do appear to be somewhat more common than land expropriation.

buyer and seller share the same θ (and r), a sale occurs only if a buyer can be found for whom $\pi' \geq \pi$. Now suppose that the current owner views a titled plot as completely secure, or $\theta = 0$. If titles not bearing the plot owner's family name are seen as providing inferior protection against expropriation and if it is prohibitively costly to transfer title, then potential buyers have $\theta = \theta' > 0$. Since the plot is now sold only if $\pi' \geq \frac{r+\theta'}{r}\pi > \pi$, it follows that the market is more limited for titled land than for untitled land; in particular, purchased plots should be less likely to be titled than inherited plots.

The data indicate that both of these phenomena may be important in Lac Alaotra. On the one hand, inherited plots are about twice as likely to be titled as are purchased plots (35 percent and 17 percent), suggesting that the market for titled land is indeed more limited. On the other hand, titles for purchased plots are more likely to be up-to-date (64 percent) than titles for inherited land (43 percent), a difference that is highly significant in a regression that also controls for year of plot acquisition. This finding reflects the stronger incentives to update titles for purchased plots, which, even if already titled at the time of purchase, do not necessarily bear the buyer's family name.[11]

Finally, titling may enhance the realizability of land-specific investment through leasing. Absent other effective means of property rights protection, a title could provide the landowner with the security necessary to be willing to lease when there is danger of expropriation by tenants. However, in results reported elsewhere (Jacoby and Minten, 2006), there is no evidence that having land with a title influences either the decision to lease out a plot or the duration of the lease. Despite the informality of tenure on the majority of plots, there appears to be little perceived danger of expropriation by squatting tenants. To summarize, land titling as currently practiced in Madagascar is unlikely to enhance investment or land values by facilitating land transactions.

The Collateralizability Effect

In a study of rural Thailand, Feder et al. (1988) argue that institutional lenders prefer titled land as collateral because it is easier to repossess and sell. Farmers squatting in untitled areas are unable to provide such collateral and consequently have fewer funds to buy seasonal inputs, purchase equipment, and make land improvements. In principle, then, titling can broaden access to formal credit and allow existing borrowers to obtain larger loans, resulting in higher investment. As pointed out by Feder and Feeny (1991), the market value of a titled plot should include a premium reflecting the income flow from the additional credit that can be obtained by pledging the

11. As indicated in table 2, many land purchases are from close relatives, with whom the buyer probably shares a family name. In these cases, titles are less likely to be up-to-date than among titled plots purchased from distant relatives, friends, or strangers (56 percent compared with 66 percent), although this difference is not statistically significant.

land. In practice, however, such effects presuppose the penetration of banks into the business of agricultural lending as well as the existence of a legal framework for mortgaging land, conditions that do not generally prevail in Sub-Saharan Africa.

While institutional lenders play a miniscule role in rural Madagascar as a whole—the nationally representative 2001 household survey (EPM) showed less than 1 percent of cultivating households borrowing from formal sources—the relatively commercialized Lac Alaotra region is exceptional. Among surveyed households, oversampled as they are from the wealthier *maille* areas, 14 percent report taking out a formal sector loan in the past three years. Most of this credit came from institutions run by nongovernmental organizations, which generally demand collateral, though not necessarily in the form of land.

Analyses omitted here for brevity indicate that there is no significant advantage to owning titled land in terms of a household's access to formal credit, after controlling for the household's landholdings within the *mailles* (such land being much more likely to be titled), and titled *plots* are no more likely to be used as collateral for formal loans than are untitled plots of equivalent size, after also controlling for their position in the *mailles* (see Jacoby and Minten 2006). Thus, it does not appear that intensive land titling has opened up institutional credit opportunities for farmers in Lac Alaotra, at least not yet. For this reason, the market value of titled land in Lac Alaotra should not incorporate a significant collateral premium.

III. Impact of Titles on Investment, Productivity, and Value of Land

The empirical strategy can be described with the following regression model

$$y_{ih} = \alpha T_{ih} + \beta' x_{ih} + \eta_h + \varepsilon_{ih}, \tag{1}$$

where y_{ih} is an outcome observed on plot i belonging to household h, T_{ih} is the titling status of the plot, and x_{ih} is a set of plot attributes (and possibly farm characteristics). The error term has a component common to all plots within the same household, η_h, and an idiosyncratic component, ε_{ih}. The first of these components reflects household- or farm-level factors, such as entrepreneurial or farming ability, wealth, access to credit, local land characteristics, and infrastructure, that affect behavior (for example, investment) and its consequences (productivity, land values) on all the household's plots. The second component captures plot-specific aspects of soil fertility or infrastructure that are not included among the vector of observable characteristics, x_{ih}.

For ease of interpretation, each dependent variable is normalized by the mean of y_{ih} taken over all untitled plots (except for land value, which is estimated in logs). In this way, for continuous variables, α estimates the percentage

difference in the mean between titled and untitled plots, whereas for binary variables (investment indicators) it measures the percentage difference in proportions between titled and untitled plots.

The key estimation issue is the endogeneity of the decision to seek title for a particular plot. Titles are costly to obtain, in both time and money, but are viewed as valuable. Both the ability to bear these costs as well as the perceived benefits are likely to vary substantially across households. Holding constant the physical characteristics of the plot, one might expect more entrepreneurial or wealthier households, for instance, to be more willing and able to pursue a title.[12] Thus, T_{ih} is likely to be correlated with η_h, and ordinary least squares (OLS) estimates of α will be biased as a consequence. Under the most plausible scenarios, OLS will overestimate α; unobserved farmer characteristics that enhance the probability of obtaining a title also tend to be positively related to farm productivity and investment. To deal with this problem, household fixed effects are used, eliminating η_h from equation 1. This estimator exploits the fact that most households in the sample own more than one plot and that, in many of those cases, the titling status of the plots varies within the household.

A second endogeneity issue is that the return to titling may be higher on more fertile plots (those with a high ε_{ih}). These plots may also receive greater investment and are certainly more productive. In this case even the household fixed-effects procedure would overestimate α. There is indeed evidence that plots are selected for titling on the basis of observable characteristics, even after accounting for the strong effect of position in the *mailles*. Estimates from a household fixed-effects linear probability model (not reported here) show that larger, less remote, and more reliably irrigated plots are significantly more likely to be titled. Since there is no obvious instrument for T_{ih} (one that varies across plots within the same household), the household fixed-effects estimate of α should be viewed as an upper bound on the true titling effect.

Titles and Investment

The sample for the estimation of recurrent investment decisions consists of 2,652 owner-cultivated rice plots. Plots that are currently leased out are excluded so as not to confound titling effects with the issue of investment disincentives due to leasing (see Jacoby and Mansuri 2006). Also excluded in this and later analyses are lowland plots situated more than a two-hour walk from the respondent's house, unless all of the household's plots are exactly the same walking distance from the house. The rationale for this decision, which eliminates about 5 percent of plots, is that plots that are far away from the house (in different directions) are likely to be far away from each other and thus less

12. For example, wealthier households might have found it easier to pay SOMALAC's maintenance fee that initiated the titling process within the *mailles* before 1991. Despite this possibility, households with land in the *mailles* and with at least one titled plot are not that much wealthier, in terms of observable assets, than those with land in the *mailles* but with no titled plots (see table S2).

comparable in terms of unobservables. In the final estimation sample, 13 percent of the households own plots across which titling status varies; these plots account for 21 percent of the total sample. Given this degree of within-variation, a household fixed-effect procedure should yield reasonably precise estimates.

All of the investment regressions in table 4 include controls for the plot's position in the *mailles*, log of plot area, travel time to domicile, travel time between plot and nearest route passable by zebu cart, soil type, and irrigation (see table S1 in the supplemental appendix for descriptive statistics). A plot-specific irrigation quality index is also constructed. Farmers were asked to rank the availability of water and the frequency of floods, each on a four-point scale. The index is a sum of these rankings, with the highest value indicating that water is always available and floods never occur. It might seem problematic to condition on the nature and quality of the plot's irrigation infrastructure, as this is, after all, a consequence of past investments. The justification for including these irrigation variables is that they reflect public investment, over which the individual farmer has little control. Irrigation infrastructure should, therefore, not be correlated with the same plot-level unobservables that determine private recurrent investment.

Estimation results for binary indicators of investment, overall and by type, in the past five years using a linear probability model, as well as results for per hectare investment expenditures (cash plus imputed labor costs), are given in table 4. All estimations use household fixed effects, as a Hausman test strongly rejects random effects for each investment variable.[13] As expected, the titling coefficients estimated by random effects are uniformly larger than those based on fixed effects, indicating positive bias.[14]

There is little evidence that land titles enhance recurrent investment. None of the titling coefficients for the binary indicators and all but one coefficient for the expenditure variables differ significantly from zero. This is true even though the estimates for the binary investment indicators are, in some cases, quite precise, as indicated by the inverse power function thresholds (see Andrews 1989) reported in table 4. For example, one can be 95 percent confident that, had land titling raised the proportion of plots on which any investment occurred by more than 10.5 percent, the null hypothesis of zero effect would have been rejected. Thus, fairly small impacts can be detected in these data. On the other hand, the corresponding low power threshold indicates that the odds are merely even of detecting true titling effects below 5.3 percent.

13. Using fixed-effects logit instead would drop households without variation in investment across plots. This could reduce precision when also controlling for a number of other plot characteristics.

14. No correction is made for censoring of investment expenditures at zero. This is difficult to do in the fixed-effects model if one wants to obtain marginal effects. Note, however, that for total investment only 11 percent of the observations are censored at zero, a proportion low enough to be safely ignored in the estimation.

TABLE 4. Titles and Recurrent Investment in Land

Independent variable	Irrigation/drainage canal		Protective bunds		Land leveling		All investments	
Any investment								
Titled plot	0.022 (0.038)		0.040 (0.060)		−0.170 (0.121)		−0.030 (0.032)	
Up-to-date title		0.025 (0.042)		0.043 (0.066)		−0.140 (0.133)		−0.020 (0.036)
Out-of-date title		0.017 (0.052)		0.034 (0.082)		−0.230 (0.165)		−0.049 (0.044)
High-power threshold[a]	0.125		0.197		0.398		0.105	
Low-power threshold[b]	0.063		0.099		0.199		0.053	
Investment expenditures per hectare								
Titled plot	−0.023 (0.114)		0.249 (0.188)		0.105 (0.271)		0.090 (0.114)	
Up-to-date title		0.047 (0.125)		0.416** (0.206)		−0.079 (0.297)		0.120 (0.125)
Out-of-date title		−0.165 (0.155)		−0.093 (0.255)		0.483 (0.369)		0.027 (0.154)
High-power threshold[a]	0.375		0.619		0.892		0.375	
Low-power threshold[b]	0.188		0.309		0.446		0.188	

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. All regressions include household fixed effects and the plot characteristics listed in supplemental appendix table S.1 (http://wber.oxfordjournals.org/).

[a]True value of titling effect above which there is 95 percent certainty of rejecting the null hypothesis of zero effect.

[b]True value of titling effect below which there is 50 percent certainty of rejecting the null hypothesis of zero effect.

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

In contrast, power is generally poor for the investment expenditure variables. In particular, one can only be highly certain of detecting titling effects if titling actually increased overall investment expenditures by 38 percent. Despite this, when titles are disaggregated into up-to-date and out-of-date titles, up-to-date titles attract a positive and significant coefficient in the case of protective bunds. This is also the only case where the hypothesis that up-to-date and out-of-date titles have identical effects on investment can be rejected. Given the number of tests performed in table 4, however, this last result may be due to nothing more than random chance.

Titles and Land Productivity

Within the framework developed in section II, the only channel through which land titling can affect land productivity is investment. Assurance, realizability, and collateralizability effects, to the extent that they operate at all on productivity, do so through increased land-specific investment. As just discussed, however, there is no compelling evidence that recurrent investment responds to formalization of land tenure; at least the magnitude of any such response is below the threshold detectable in the data. One reason to examine productivity directly, therefore, is that the data set may fail to capture some relevant land-specific investment or, more plausibly, that investment is measured with considerable error. Productivity data, if sufficiently less noisy, might show titling effects where the investment data did not.

Two measures of land productivity are considered: main season rice yield (gross productivity) and value of main season rice yield net of purchased input costs per hectare (net productivity). Since variable input costs are generally quite small, the two productivity measures are highly correlated. A third measure that nets out annualized recurrent investment expenditures as well could also be considered; this essentially corresponds to π in the conceptual model. However, given the relative unimportance of these investment expenditures, π is almost perfectly correlated with net revenue as conventionally defined, so that only results for net revenue are reported.

The gross and net productivity estimates appear in the first six columns of table 5.[15] Random- and fixed-effects estimates are very close in this case; the titling coefficients, in particular, are statistically indistinguishable. As before, the biggest difference is the estimated precision, with the random-effects standard errors being about 60 percent the size of their fixed-effect counterparts. For this reason, there is a significant impact of titling on yields and net

15. Log of plot area has a negative and highly significant coefficient in all of the productivity regressions. There are two potential explanations for this finding. The first is that smaller rice plots are actually more productive because they are easier to keep level and hence completely submerged during irrigation. The second explanation is "division bias." Specifically, if plot area is measured with error, then there will be a spurious negative correlation between output, revenue, or value per hectare and plot area. It is difficult, though, to come up with instruments that affect plot area but do not influence productivity directly.

revenue only in the former specifications. At any rate, this impact, at about 7 percent, is not large (the *ceteris paribus* productivity effect of having a plot in the *mailles*, by comparison, is on the order of 30 percent), and as argued earlier should be viewed as an upper bound on the true effect.[16] Finally, note from table 5 that productivity impacts do not differ significantly for out-of-date titles.

Titles and Land Values

The land value differential between otherwise identical titled and untitled plots is a comprehensive measure of the private benefit of titles. The value of land incorporates any productivity effect of titling operating through increased land-specific investment, as well as the direct effect of expropriation risk operating through the risk-adjusted discount rate, $r + \theta$. Finally, market values should also reflect the extent to which titled land is easier (or more difficult) to transact.

Titles may be endogenous with respect to land values, but the argument is somewhat different than for the cases of investment and productivity. If reported plot values reflect their true market valuation and all relevant plot characteristics can be controlled for, then OLS should produce unbiased estimates of the titling effect. This may not hold, however, if the land market is segmented. To the extent that the marginal product of land cannot be fully equalized across households, land may be more productive in the hands of wealthier or better farmers, who would thus value it more highly than poorer or less able farmers. At the same time, wealthier farmers may be more willing or able to obtain titles.

The survey asks farmers to estimate the current value of their parcel in total and also on a per hectare basis (in 8 percent of cases, the respondent had no idea of the market value). Because plot values per hectare can be cross-checked against total value divided by plot area, the land value data are generally pretty accurate. Evidence of this is the fact that the standard errors for the log plot value regressions, in the last three columns of table 5, are considerably smaller than those for the corresponding coefficients in the land productivity regressions.[17] There is also much less of a difference

16. When *observed* investment variables (the three binary indicators and total expenditures per hectare) are included in the productivity regressions, there is only a minor attenuation of the titling coefficients (see Jacoby and Minten 2006). This is not surprising given the lack of relationship between investments and titling already noted.

17. The land value regression is run in logarithms because this transformation provides a better fit to the data than a linear model. Such was not the case for yields and net revenues. The set of controls is also slightly different across the two cases. Household asset variables are not included in the random-effects specification for land values since the total value of land itself is a major component of these assets. Distance of the plot to the domicile is also excluded from the land value regressions on the grounds that the market value of a plot should not depend on its distance to any particular house.

TABLE 5. Titles, Land Productivity, and Land Values

	Yield			Net revenue per hectare			Log value per hectare		
Independent variable	1	2	3	1	2	3	1	2	3
Titled plot	0.072**	0.059		0.069**	0.062		0.041**	0.056**	
	(0.025)	(0.042)		(0.027)	(0.046)		(0.020)	(0.024)	
Up-to-date titled plot			0.056			0.058			0.051
			(0.046)			(0.051)			(0.026)
Out-of-date title plot			0.065			0.070			0.066**
			(0.057)			(0.063)			(0.032)
Plot in *mailles*	0.325**	0.292**	0.291**	0.318**	0.289**	0.289**	0.371**	0.340**	0.340**
	(0.025)	(0.042)	(0.042)	(0.028)	(0.046)	(0.046)	(0.020)	(0.024)	(0.024)
Log plot area	−0.097**	−0.080**	−0.079**	−0.097**	−0.080**	−0.080**	−0.034**	−0.042**	−0.042**
	(0.012)	(0.016)	(0.016)	(0.013)	(0.018)	(0.018)	(0.008)	(0.009)	(0.009)
Log travel time to nearest zebu cart route	−0.003	−0.013	−0.013	−0.002	−0.017**	−0.017**	−0.010**	−0.011**	−0.011**
	(0.005)	(0.008)	(0.008)	(0.005)	(0.009)	(0.009)	(0.004)	(0.004)	(0.004)
Log travel time to home	−0.036**	−0.038**	−0.038**	−0.036**	−0.035**	−0.036**			
	(0.009)	(0.014)	(0.014)	(0.010)	(0.015)	(0.015)			
No irrigation (rainfed)	0.031	0.021	0.021	0.025	0.053	0.054	0.056	−0.019	−0.019
	(0.054)	(0.087)	(0.087)	(0.060)	(0.095)	(0.095)	(0.040)	(0.047)	(0.047)
Irrigated by river	0.091	0.166	0.167	0.098	0.186	0.187	0.157**	0.126**	0.126**
	(0.060)	(0.103)	(0.103)	(0.067)	(0.113)	(0.113)	(0.047)	(0.056)	(0.056)
Quality of irrigation index	0.036**	0.046**	0.046**	0.036**	0.051**	0.052**	0.042**	0.035**	0.035**
	(0.009)	(0.015)	(0.015)	(0.010)	(0.017)	(0.017)	(0.007)	(0.008)	(0.008)
Household effects	Random	Fixed	Fixed	Random	Fixed	Fixed	Random	Fixed	Fixed
Hausman test *P*-value	0.338			0.339			0.0054		
Sample size	2642	2642	2642	2633	2633	2633	2769	2769	2769

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. Other variables included but not reported: constant term; soil type (red, black, brown); log value of owned land, log value of farm equipment, and log value of zebus (for random-effects specifications of yield and net revenue only).

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

between the precision of the fixed- and random-effect estimates. The random-effect specification, at any rate, is rejected in favor of fixed-effects in the present case.

Titled plots are found to be around 6 percent more valuable than untitled plots, a statistically significant difference. Again, this is an upper bound estimate, one that suggests that the productivity effect of 6–7 percent is unlikely to be entirely real, since the impact of titles on productivity is bounded from above by the impact of titles on the market value of land. The point estimate of the market premium for titled plots is even higher than the simulations in table 3 might indicate. Yet, the upper end of the 95 percent confidence interval for this estimate is only about 10 percent. To put this into context, the World Bank (2003) reports comparable land value differentials in Asia and Latin America ranging from 40 to 80 percent. The corresponding differentials for rural Madagascar clearly lie well below this range.

Plots with up-to-date and out-of-date titles do not differ significantly in value, as indicated in the last column of table 5. This finding is consistent with the earlier conjecture that the entire value of a title could lie in the mere fact of having an official record of the title in the land administration office. Once such a record exists, it becomes extremely difficult to obtain a new title for the same land under false pretenses.

Results reported in the supplemental appendix attempt to distinguish the channels by which titles influence land values (table S3). One can ask whether titles are valued more by households who view land expropriation as probable. But there is no significant interaction in the land value regression between the titling status of the plot and whether the farmer has regularly or occasionally (compared with rarely or never) heard of cases of expropriation in the community.[18] The transaction insurance benefit of a title is investigated by examining the interaction between possession of title and an *acte de vente* (sales receipt) certified by the village head. To the extent that such a document provides informal transaction insurance, it should attenuate the benefit of a title. However, a suitably augmented land value regression provides no firm evidence to this effect. Neither the titling premium nor the value of the plot itself is significantly influenced by having a certified *acte de vente*. Of course, the power of this test is predicated on there being significant transactions risk in the absence of a certified *acte de vente*. Yet, only 15 percent of purchased plots are without such a document, and for two-thirds of these transactions an uncertified *acte de vente* exists, which for all intents and purposes may be equivalent to one certified by the village head.

18. Of course, farmers who have heard of many cases of land lost due to lack of ownership documentation do not necessarily fear that their own land is thus endangered, and conversely farmers may fear expropriation even if they have never heard of specific cases in the community.

IV. Conclusions and Policy Implications

No consensus has yet emerged on the practical importance of increasing land tenure security in most of Sub-Saharan Africa. Brasselle et al. (2002, p. 373) conclude for Burkina Faso, after failing to find significant investment effects, that "the traditional village order, where it exists, provides the basic land rights required to stimulate small-scale investment." Deininger and Jin (2006) argue that such conclusions are premature because the vast majority of studies in this literature are based on small samples, in which tenure security effects, if they exist, would be difficult to detect. The findings of this study are based on a very large sample of plots and support the notion that indigenous tenure provides adequate security for farmers to undertake the limited range of investment activities commensurate with the prevailing agricultural technology.

The results further imply that the private economic benefits from extending land titling in Madagascar would be minor and, in particular, would not exceed the cost of doing so under the current system. The median rice plot in the Lac Alaotra region is worth about $1,000 per hectare, and titling it would raise its value by no more than $60 per hectare.[19] Teyssier (2004) estimates the total cost of titling a parcel in Madagascar today at about $350, including "unofficial" costs.[20] Based on this figure, it makes economic sense only to title plots larger than about 6 hectares. Less than 3 percent of the plots in the sample (which, because of the focus on *mailles* areas, is already weighted toward larger plots) are 6 hectares or larger. Put another way, the marginal cost of a title would have to fall by a factor of six to make it economical to title the median-size plot in the sample (1 hectare). Even a comprehensive restructuring of the current land administration would be unlikely to achieve an efficiency gain of such magnitude. For Madagascar as a whole, the problem is compounded by the highly fragmented nature of landholdings: the national median plot size is only 0.20 hectare.

Looking forward, the more salient policy question is what system of land administration would be best suited to rural Madagascar and similar regions of Sub-Saharan Africa? As discussed in World Bank (2003), a menu of land registration options is available, with each option varying in degree of tenure security, precision, and unit costs. The estimates indicate that even in Lac Alaotra, where irrigation, transport, and market infrastructure are relatively well developed and plots are relatively large, the average costs of registering a parcel

19. Feder et al. (1988) argue that the private value of a title, as estimated here, exceeds its social value because society is neutral with respect to the risk induced by land expropriation, whereas individuals are risk averse. No attempt is made to account for risk aversion in the estimates, except to note that the $60 per hectare figure represents an upper bound on the social value of a title.

20. This is probably an overstatement of the true resource cost, since bribes to various officials can reflect monopoly rents in addition to the opportunity cost of the applicant's time. Raharinjanahary (2001) estimates that the cost to the applicant of all official procedures is on the order of $150, but this figure probably understates the true resource cost.

under any new system would have to be quite modest just to break even. Where conditions are less favorable, full-fledged land tenure reform may not be worthwhile compared with alternative rural development policies.

Finally, the possibility was raised earlier that land titling, as an institution, could be socially wasteful to the extent that its sole or main benefit is protection against those who would exploit the titling system itself to grab untitled land. Although it is impossible to decompose the benefits of land titles in Lac Alaotra to determine how much can be attributed to this type of protection, the social cost can be bounded from above. At most, owners of untitled land would be willing to pay 6 percent of their plot's value to eliminate this insecurity. According to the data, 47 percent of Lac Alaotra's 30,000 hectares of rice land within the irrigated perimeters and 88 percent of its 72,000 hectares outside them are untitled. This puts the social cost of the modern titling system in the Lac Alaotra Basin for rice land alone at up to $4.5 million[21]—a substantial amount when compared, say, with the value of the region's annual rice production of $28 million. Given this *potential* cost, future research should strive to determine whether such negative titling externalities are indeed empirically important.

Supplementary Material

Supplementary material is available online at http://wber.oxfordjournals.org/.

References

Andrews, D.W.K. 1989. "Power in Econometric Applications." *Econometrica* 57(5):1059–90.

Atwood, D.A. 1990. "Land Registration in Africa: The Impact on Agricultural Production." *World Development* 18(5):659–71.

Besley, T. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy* 103(5):903–37.

Brasselle, A.S., F. Gaspart, and J.P. Platteau. 2002. "Land Tenure Security and Investment Incentives: Puzzling Evidence from Burkina Faso." *Journal of Development Economics* 67(2):373–418.

Bruce, J., and S. Migot-Adholla eds. 1997. *Searching for Land Tenure Security in Africa.* Dubuque, Iowa: Kendall/Hunt.

Bruce, J.W., S.E. Migot-Adholla, and J. Atherton. 1997. "The Findings and their Policy Implications: Institutional Adaptation or Replacement." In J.W. Bruce, and S.E. Migot-Adholla eds., *Searching for Land Tenure Security in Africa.* Dubuque, Iowa: Kendall/Hunt.

Carter, M.R., K.D. Weibe, and B. Blarel. 1997. "Tenure Security for Whom? Differential Effects of Land Policy in Kenya." In J.W. Bruce, and S.E. Migot-Adholla eds., *Searching for Land Tenure Security in Africa.* Dubuque, Iowa: Kendall/Hunt.

21. Average value for *mailles* and non-*mailles* plots is taken from table 1. Tenure insecurity may also affect the value of upland and forest plots, which are largely untitled in Lac Alaotra. Estimating the titling premium on these types of land is left for future research. Finally, this calculation ignores the costs already incurred by current title-holders to obtain their titles. However, since this cost is sunk, it should not enter the decision of whether to suspend the current system.

CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement). 2004. "Diagnostic foncier sur le PC 15, les vallées du sud-est et les périmètres irrigués d'Imamba et d'Ivakaka." Ambatondrazaka, Madagascar.

Deininger, K., and J.S. Chamorro. 2004. "Investment and Equity Effects of Land Regularisation: The Case of Nicaragua." *Agricultural Economics* 30(2):101–16.

Deininger, K., and S. Jin. 2006. "Tenure Security and Land-related Investment: Evidence from Ethiopia." *European Economic Review* 50(5):1245–77.

Feder, G., T. Onchan, Y. Chalamwong, and C. Hongladarom. 1988. *Land Policies and Farm Productivity in Thailand.* Baltimore, MD: Johns Hopkins University Press.

Feder, G., and D. Feeny. 1991. "Land Tenure and Property Rights: Theory and Implications for Development Policy." *World Bank Economic Review* 5(1):135–53.

Feder, G., and A. Nishio. 1999. "The Benefits of Land Registration and Titling: Economic and Social Perspectives." *Land Use Policy* 15(1):143–69.

Firmen-Sellers, K., and P. Sellers. 1999. "Expected Failures and Unexpected Successes of Land Titling in Africa." *World Development* 27(7):1115–28.

Gavian, S., and M. Fafchamps. 1996. "Land Tenure and Allocative Efficiency in Niger." *American Journal of Agricultural Economics* 78(2):460–71.

Jacoby, H.G., G. Li, and S. Rozelle. 2002. "Hazards of Expropriation: Tenure Security and Investment in Rural China." *American Economic Review* 92(5):1420–47.

Jacoby, H.G., and G. Mansuri, 2006. "Incomplete Contracts and Holdup: Land Tenancy and Investment in Rural Pakistan." World Bank, Development Research Group, Washington, D.C.

Jacoby, H.G., and B. Minten. 2006. *Land Titles, Investment, and Agricultural Productivity in Madagascar: A Poverty and Social Impact Analysis.* Washington, D.C.: World Bank.

Migot-Adholla, S., P. Hazell, B. Blarel, and F. Place. 1991. "Indigenous Land Rights Systems in Sub-Saharan Africa: A Constraint on Productivity?" *World Bank Economic Review* 5(1):155–75.

Place, F., and S. Migot-Adholla. 1998. "The Economic Effects of Land Registration on Smallholder Farms in Kenya: Evidence from Nyeri and Kakamega Districts." *Land Economics* 74(3):360–73.

Raharinjanahary, L. 2001. "Le foncier dans la production agricole." Pact-Ilo Program, Antananarivo, Madagascar.

Teyssier, A. 2004. "Programme national foncier: contribution à l'elaboration d'une politique publique de sécurisation des droits sur le sol, MAEP." Direction des Domaines et des Services Fonciers, Antananarivo, Madagascar.

World Bank. 2003. *Land Policies for Growth and Poverty Reduction.* Washington, D.C.: World Bank.

Land Tenure, Investment Incentives, and the Choice of Techniques: Evidence from Nicaragua

Oriana Bandiera

The choice of cultivation techniques is a key determinant of agricultural productivity and has important consequences for income growth and poverty reduction in developing countries. Household data from Nicaragua are used to show that the choice of cultivation technique depends on farmers' tenure status even when techniques are observable and contractible. In particular, tree crops are less likely to be grown on rented than on owner-cultivated plots. Further evidence indicates that the result follows from landlords' inability or unwillingness to commit to long-term tenancy contracts rather than from agency costs due to risk aversion or limited liability.
JEL codes: D23, D82, O12, Q15.

The importance of agriculture for the welfare of the poorest can hardly be overstated. The adoption of new cultivation techniques is a key determinant of agricultural productivity, and their promotion is often at the core of development projects. Thus, identification of obstacles to the diffusion of new techniques is crucial to the design of development policies.

This article assesses whether cultivation techniques differ on plots cultivated by their owners from those on plots cultivated by tenants. The analysis looks at the effect of ownership status on the cultivation of trees in combination with annual crops in a sample of Nicaraguan farms. Growing a mix of trees and annual crops is generally more profitable than growing annual crops alone. Trees are both profitable in their own right and enhance nutrient recycling, conserve soil moisture, maintain fertility, and reduce soil erosion.

Oriana Bandiera is assistant professor at the London School of Economics and Political Science (LSE) and research affiliate at the Centre for Economic Policy Research (CEPR) and at the Bureau for Research and the Analysis of Economic Development; her email address is o.bandiera@lse.ac.uk.
The author thanks Abhijit Banerjee, Tim Besley, Robin Burgess, Raquel Fernandez, Markus Goldstein, Gilat Levy, Andrea Prat, and Imran Rasul for insightful discussions. Jaime de Melo and three anonymous referees offered useful comments. The author would also like to thank participants at the CEPR Public Policy Symposium, the Northeast Universities Development Consortium, and seminars at Essex University, the World Bank, and the LSE for useful discussions. Barbara Veronese provided excellent research assistance. Financial support from Suntory and Toyota International Centres for Economics and Related Disciplines and the Economic and Social Research Council is gratefully acknowledged.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 487–508 doi:10.1093/wber/lhm005
Advance Access Publication 9 May 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

The analysis finds that Nicaraguan farmers are more likely to grow trees on plots they own than on plots they rent. The result holds both in a sample of farmers that cultivate an owned and a rented plot and in a cross-section of pure owners and pure tenants.

Following the finding that ownership status does matter, the article seeks to shed some light on the mechanisms that drive the difference between owners and tenants. The separation of ownership and cultivation rights is key because landowners cannot observe the effort exerted by tenants. This affects the choice of cultivation techniques through two channels. First, landowners might not adopt techniques that are complementary to unobservable production effort if they cannot provide the tenants with sufficiently strong effort incentives.[1] Second, landowners might not adopt techniques that require noncontractible investment, for instance in maintenance, if they cannot commit to letting tenants reap the benefits of their investment.

The first channel implies that tenants' wealth determines incentive costs and hence the equilibrium choice of effort and techniques. Indeed, theories of moral hazard in agriculture indicate that landowners might not be able to provide tenants with sufficiently strong effort incentives because of either risk aversion or limited liability, both of which are more important when the tenant is poor (Stiglitz 1974; Braverman and Stiglitz 1986; Mookherjee 1997; Banerjee, Gertler, and Ghatak 2002). Contrary to this prediction, however, tenants' wealth is not a significant determinant of tree cultivation in Nicaragua.

Further analysis reveals that the probability of tenants' farming trees is higher when their tenancy contract is longer. The results indicate that long-term commitment is important. This finding is in line with the observation that since a tenant's effort affects tree productivity in the future, proper incentives can be provided only by offering a long-term contract that makes the tenant's pay conditional on future output.

Long-term contracts, however, are rare in Nicaragua. A cursory look at the history of land policies and current land laws suggests a number of reasons why landlords might be unwilling to commit to long-term contracts. Following the 1979 Sandinista revolution, large landholdings not managed by their owners were expropriated and redistributed to former tenants and landless peasants. Landlords may fear another reform and hence prefer not to make long-term commitments. In addition, current land laws grant strong rights to long-term tenants and make their eviction difficult, effectively increasing the cost of long-term commitments.

The findings in this article are in line with those of Shaban (1987), who shows that the productivity differential between owner-cultivated and share-cropped plots in a sample of Indian farms derives from different levels of both

1. It is important to note that, in contrast to noncontractible effort, contractible techniques can be chosen by the owner of the land regardless of whether the land is rented out or cultivated directly. In other words, the fact that tenants face different incentives has no direct consequence for the choice of techniques if these are subject to contract.

observable and unobservable inputs. In addition, the evidence on the effects of ownership status on tree cultivation is complementary to Besley's (1995) findings for Ghana, where owners-cultivators who hold secure rights to their plots are more likely to grow trees. This article instead compares plots cultivated by tenants with plots cultivated by their owners and also finds that tenure security goes together with tree cultivation. It also finds that on tenant-cultivated plots trees are more likely to be grown by tenants who have long-term contracts.[2]

Section I presents the data and the empirical strategy. Section II illustrates the main results. Section III discusses the predictions of a tenancy theory and offers an interpretation of the results. Section IV briefly touches on policy implications and areas for further research.

I. Data Description and Empirical Strategy

This section describes the data, the main variables, and the empirical approach.

Data Description

Nicaragua is one of the poorest countries in Latin America. In 1998, the year of the survey data used in this study, per capita GNP was $430, about half the population lived below the poverty line. The economy relies heavily on the rural sector. In 1998, agriculture accounted for a third of GDP and almost half the population lived in rural areas. The distribution of landholdings and hence the incidence of tenancy derive from a number of land reforms implemented between 1981 and 1997. In 1981, the Sandinista National Liberation Front (FSLN) expropriated large land holdings and redistributed them to landless peasants, tenants, and farmers cooperatives (Decretos 760 and 782).

The democratic government elected in 1990 privatized and redistributed state-owned land and recognized the property rights acquired by both individual farmers and farmers cooperatives through the FSLN land reform.[3] Land distribution is still very unequal. According to the latest Agricultural Census (2001), the Gini coefficient is 0.71, only slightly improved from 0.79 in 1963.

Household data from the 1998 Nicaragua Living Standard Measurement Study survey are used for the analysis. The survey covers the entire country, and

2. To the extent that trees increase agricultural productivity, the evidence in this article speaks to the microfoundations of the well-known aggregate relationship between land inequality and agricultural productivity. A large literature suggests that small owner-cultivated farms are more productive than large farms that rely on hired labor and than farms operated by tenants, yet there is little evidence on the determinants of such differences. The issue is especially relevant in Central and South America, where land distribution is highly unequal and the productivity differential in favor of small family farms is the largest in the world (Binswanger, Deninger, and Feder 1995 Banerjee 1999).

3. See Ley de Proteccion a la Propiedad Agraria. Ley 88 (April 2, 1990) Decreto-Ley de revision de confiscaciones Decreto 11–90 (May 11, 1990), Ley de estabilidad de la propriedad Ley 209 (November 30, 1995), and Ley sobre propriedad reformada urbana y agraria Ley 278 (November 26, 1997).

the sampling strategy is based on population data from the 1995 Census. The survey contains detailed information on the agricultural activities of 1,258 households. Of these, 57 percent farm their own plots, 36 percent farm rented plots, and 7 percent farm both an owned and a rented plot. In addition, 11 percent of owner-cultivators also rent out land. No household in the sample rents in and out at the same time. Finally, most farms in the sample consist of one or two plots.

The unit of analysis is the household. In general, one household member—typically the household head—is solely responsible for agriculture and takes all farming decisions, whereas other household members provide farming labor. Interviews about the farming activities of the household are held with the household member who manages the farm in 97 percent of the cases.

Dependent Variables

This article analyzes the choice between growing a mix of annual and tree crops and growing annual crops only. The combination of annual and tree crops has recently been promoted by most agricultural development institutions and nongovernmental organizations since tree crops enhance nutrient recycling, conserve soil moisture, maintain fertility, and reduce soil erosion. The opportunity cost in terms of other crop yields is low because annual crops can be grown under the trees. Evidence from agroforestry projects in Central America suggests that this practice is profitable under a broad range of conditions (Current, Lutz, and Scherr 1995).[4]

With a few exceptions, the main tree crops grown in Nicaragua—coffee, citrus, bananas, and mangoes—are more profitable, but also more expensive and effort intensive, than the main annual crops (maize, beans, and cassava). The sample average fertilizer expenditure, for instance, is about twice as high for farmers who grow a combination of trees and annual crops (406 cordobas compared with 217 cordobas). The relative profitability of one technique over the other is therefore likely to depend on the level of effort exerted by the farmer.

The survey asks farmers to name the two main crops they grow and collects information on every crop grown in the last 12 months. To separate farmers who grow a mix of trees and annual crops from those who grow annual crops only, two variables are defined. The first, *tree_mix*, is equal to one when the farmer grows at least one tree crop. The second, *tree_main*, is equal to one when at least one of the main crops is a tree. To be clear, *tree_mix* is defined at the farm level; whether the farmer grows trees is known but not on which plot if the farm comprises more than one. In contrast *tree_main* is defined at the plot level.

These two variables represent an upper and a lower bound estimate of the number of farmers who grow trees. The first variable overestimates the number

4. There is a clear positive correlation between national income and tree cultivation in Central America. Trees cover about 10 percent of Nicaragua's agricultural land, compared with 55 percent in Costa Rica, 30 percent in El Salvador, 29 percent in Guatemala, and 19 percent in Honduras. The correlation between share of tree crops and 1998 GDP per capita is 0.94. (Crop data are from FAO, FAOSTAT Land Use; GDP data are from World Bank *World Development Indicators*.)

of farmers who choose a combination of tree and annual crops because, according to the definition, even a farmer who grows only one tree is counted as growing trees. About 58 percent of the farmers in the sample grow a mix of annual and tree crops (table 1), which is in line with the 2001 rural Census figure of 52 percent. The second variable underestimates the number of farmers who grow trees because it counts only farmers for whom trees are one of the two most important crops, whereas farmers grow on average four different crops. The sample average of *tree_main* is just 9 percent.

The main tree crops in the sample are coffee, banana, mango, and citrus. Since coffee and citrus are more expensive and more effort intensive than annual crops while mangoes and bananas may not be, the dependent variable was also redefined as *tree_mix2*, equal to one when the farmer farms at least one coffee or citrus tree together with annual crops. About 42 percent of farmers in the sample grow coffee or citrus according to this definition.

Unconditionally, there is a clear difference between crops grown by tenants and those grown by owner-cultivators. In particular, trees are more likely to be grown on owner-operated plots: 63 percent of owners grow at least one tree, whereas 49 percent of tenants do. The difference is more striking for the *tree_main* variable: 13 percent of owners grow trees as a main crop compared with only 4 percent of tenants. All the differences are statistically significant at conventional levels.

Farmers who cultivate both owned and rented plots are more similar to the owner-cultivators. Trees are one of the two main crops in 12 percent of the plots cultivated by these farmers. The structure of the survey is such that the other two measures of tree cultivation (*tree_mix* and *tree_mix2*) cannot be built in this sample. Indeed, while respondents were asked to report the two main crops grown on each plot separately, information on other crops is pooled at the farm level, and it is therefore impossible to establish whether these are grown on the rented or the owned plot.

TABLE 1. Descriptive Statistics for Dependent Variables

Dependent variable	All farmers	Farmers who cultivate owned plots only	Farmers who cultivate tenanted plots only	Farmers who cultivate both owned and tenanted plots
Tree_mix	0.58	0.63	0.49	
	(0.49)	(0.48)	(0.50)	
Tree_mix2	0.42	0.48	0.34	
	(0.49)	(0.49)	(0.47)	
Tree_main	0.09	0.13	0.04	0.12
	(0.29)	(0.33)	(0.19)	(0.32)

Note: Numbers in parentheses are standard deviations.

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

Looking at the statistics for the individual crops reveals that owners and tenants are equally likely to grow any type of annual crop, but owners are significantly more likely to grow any type of tree. The difference is particularly striking for coffee (14 and 4 percent), which is possibly the most effort intensive but also most profitable crop.

Farmer and Household Characteristics

The empirical analysis identifies the effect of ownership on tree cultivation both from the cross-section of farmers who either own or rent a plot and from the sample of farmers who cultivate both an owned and a rented plot. The survey does not contain information on the plots that are rented out by a subset of the owners.

Table 2 presents the descriptive statistics for a number of farmer and household characteristics. Two patterns emerge for every wealth measure. First, tenants are significantly poorer than owner-cultivators. Second, owners who rent out are significantly richer than owners who do not.

In the presence of moral hazard in both the credit and tenancy markets, household wealth plays an important role for the choice of technique for both owner-cultivators and tenants. Indeed, for owner-cultivators, wealth determines the relevance of credit constraints and hence whether the farmers can afford to grow trees. Credit constraints themselves matter much less for tenants, as the owners of their plots are typically wealthy and can finance tree cultivation if they find it profitable. Nevertheless, models of moral hazard with either risk aversion or limited liability indicate that tenants' wealth determines the cost of providing incentives for noncontractible effort and hence the choice of cultivation techniques when these are complementary to effort.

Farmers who manage household agricultural activities are on average 44 years old and have two years of formal education (see table 2). Most (93 percent) of them are male. To control for scale effects in wealth and the availability of family labor, household size is controlled for throughout. The average household size is about six, regardless of ownership status. Households that cultivate both a tenanted and an owned plot tend to be larger (seven) than households that own or rent only (six). Other measures of household structure, such as the number of adults or the dependency ratio, also do not vary by ownership status and are not reported for reasons of space. The average farm is 25 *manzanas* (about 18 hectares) and owner-cultivated farms are on average significantly larger than tenanted farms. The standard deviation of farm size is quite high in all samples.

Finally, table 2 reports two town-level variables that are employed in the analysis: population, a measure of town size, and the sample average distance to the closest market for agricultural produce. The average town has a population of 40,000 and the average farm is about 2 hours from the market. Both variables are included because most of the yield of tree crops is likely to be sold rather than consumed at home, and exchange is presumably easier in

TABLE 2. Descriptive Statistics for Farmer and Household Characteristics

Farmer characteristics	Farmers who cultivate owned plots only	Farmers who cultivate tenanted plots only	Test 1, *p*-value	Farmers who cultivate both owned and tenanted plots	Farmers who cultivate owned plots and rent out some land	Farmers who cultivate owned plots and do not rent out some land	Test 2, *p*-value
Household wealth$*10^{-4}$	9.30	1.17	0.00	6.23	14.7	8.6	0.043
	(25.14)	(2.98)		(9.03)	(29.5)	(24.5)	
Durables value $*10^{-4}$	0.130	0.066	0.00	0.071	0.225	0.118	0.056
	(0.469)	(0.165)		(0.129)	(0.590)	(0.452)	
House value$*10^{-4}$	1.42	0.725	0.00	1.26	2.18	1.32	0.011
	(2.83)	(2.29)		(2.11)	(5.11)	(2.40)	
Number of bedrooms	2.05	1.72	0.00	2.16	2.44	2.01	0.002
	(1.21)	(0.949)		(1.23)	(1.76)	(1.12)	
Farmer's age	47.0	39.0	0.00	44.2	47.1	47.0	0.941
	(15.3)	(14.5)		(15.8)	(15.7)	(15.2)	
Farmer's gender (female = 1)	0.086	0.053	0.03	0.035	0.101	0.084	0.617
	(0.281)	(0.224)		(0.184)	(0.306)	(0.278)	
Farmer's education (years)	2.34	2.09	0.17	1.78	2.91	2.26	0.087
	(3.16)	(2.65)		(2.60)	(3.40)	(3.13)	
Household size	6.37	6.13	0.18	7.09	5.97	6.42	0.202
	(2.94)	(2.86)		(3.58)	(2.72)	(2.97)	
Farm size (*manzanas*)	37.2	6.79	0.00	8.86	44.4	36.40	0.438
	(87.1)	(23.8)		(24.5)	(79.9)	(88.1)	
Town size (population in thousands)	37.1	43.6	0.07	42.5	31.2	37.8	0.299
	(53.1)	(66.2)		(37.2)	(22.3)	(55.7)	

(Continued)

TABLE 2. Continued

Farmer characteristics	Farmers who cultivate owned plots only	Farmers who cultivate tenanted plots only	Test 1, *p*-value	Farmers who cultivate both owned and tenanted plots	Farmers who cultivate owned plots and rent out some land	Farmers who cultivate owned plots and do not rent out some land	Test 2, *p*-value
Average distance to market-town	1.90 (1.02)	1.82 (0.98)	.21	1.89 (0.92)	1.95 (0.99)	1.89 (1.03)	0.641
Number of observations	718	454	86	79	639		

Note: Numbers in parentheses are standard deviations.

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

larger towns and transportation costs are lower in towns that are closer to a market. Owner-cultivators, tenants, and landlords are equally distributed across towns.

Empirical Strategy

Let mix_i be a variable that equals one if farmer i grows a combination of trees and annual crops and zero otherwise. Trees will be grown when the expected return, $R_i(trees)$, is larger than the expected return from growing annual crops, that is

$$\begin{aligned} mix_i &= 1 \quad \text{if } R_i(trees) - R_i(annual) > 0 \\ mix_i &= 0 \quad \text{otherwise.} \end{aligned} \tag{1}$$

Two samples from the 1998 survey are used to identify the effect of ownership status on tree cultivation. The first contains information on farmers who cultivate both an owned and a rented plot. The second contains information on farmers who cultivate either an owned or a rented plot.

Farmer Fixed-Effect Specification

First, the effect of ownership status on tree cultivation is analyzed by comparing owned and rented plots cultivated by the same farmer. Throughout, a linear probability model is used to estimate the choice in equation (1). The crop-choice equation estimated is of the form:

$$mix_{ij} = \alpha + \beta own_{ij} + \gamma size_j + b_i + e_{ij} \tag{2}$$

where mix_{ij} denotes the choice of farmer i on plot j, own_{ij} equals one when farmer i owns plot j, $size_j$ is the area of plot j, and b_i is the farmer fixed effect.

Using a linear probability model instead of a discrete choice model entails both advantages and disadvantages. The main reason to use it in this context is that including farmer fixed effects does not bias the coefficients when the model is linear. In addition, measurement error (misclassification) of the dependent variable can strongly bias the coefficient estimates in discrete models, while it is of much less consequence when the model is linear (see, for example, Hausman, Abrevaya, and Scott-Morton 1998). In addition, omitted variables are less troublesome in a linear model than in a probit because the coefficients of the included variables are biased only if the two are correlated (see Yatchew and Griliches 1985).

The main advantage of fixed-effect estimates is that the effect of ownership on tree cultivation does not suffer from selection bias on individual unobservables. However, fixed-effect estimation, by definition, does not allow comparing the effect of ownership status with the effect of other farmer characteristics on the choice of production techniques. To this purpose, the remainder of the

analysis focuses on the cross-sectional evidence from the sample of pure owners and pure tenants.

Cross-Section Specification: Least Squares Estimates

The general crop choice equation estimated by least squares is:

$$mix_{iv} = \alpha + \beta own_{iv} + x_{iv}\gamma + z_v\delta + \eta_p + e_{iv} \quad (3)$$

where mix_{iv} denotes the choice of farmer i in town v. The variable own_{iv} equals one if farmer i owns the land and zero otherwise. The x_{iv} term is a vector of household and farmer characteristics, which include household wealth and size and farmer's age, gender, and educational achievement. Town characteristics, z_v, include town population and the sample average distance to market. To control for other geographic and policy characteristics, all regressions include province fixed effects (η_p).

Cross-Section Specification: Matching Estimates

Nonexperimental matching procedures might yield estimates that improve over linear regression estimates in the sense of being closer to those produced by a randomized experiment. The main difference between linear regression and matching estimators is the weighting scheme; matching estimators give more weight to the difference between similar observations. This might lead to different point estimates if the effect of ownership on the probability of growing trees varies with observable characteristics. To allow for this, the following section reports estimates for the average treatment effect of ownership on tree cultivation, using nearest neighbor matching over farmer and town characteristics.

II. The Effect of Ownership Status on Tree Cultivation

Following Abadie and Imbens (2004), the bias-adjusted estimator is used to purge the estimates of the bias due to matching over several covariates. The inverse of the sample variance–covariance matrix of the covariates is used to specify the weight given to each variable in defining nearest neighbor matches.

Main Results

Fixed-Effects Estimates. The estimates of crop-choice equation (2) are presented in table 3. The effect of ownership is identified from the comparison of owned and rented plots cultivated by the same farmer. The dependent variable is *tree_main*, which equals one when one of the two main crops is a tree. The structure of the survey does not permit building the other two measures (*tree_mix* and *tree_mix2*) in this sample.

The results show that ownership status matters: farmers are more likely to grow trees on the fields they own than on the fields they rent. The coefficient

TABLE 3. Land Ownership and Trees: Linear Probability Model Fixed-Effect and Cross-Section Estimates

Variable	Fixed effects	Cross-section					
		Tree_mix		*Tree_mix2*		*Tree_main*	
	Tree_main (1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Farmer owns plot	0.182***	0.144***	0.120***	0.135***	0.108***	0.090***	0.073***
	(0.045)	(0.03)	(0.032)	(0.029)	(0.031)	(0.015)	(0.016)
Household wealth*10^{-6}			0.127*		0.129**		0.198***
			(0.065)		(0.056)		(0.046)
Farmer's age			0.002**		0.004***		0.001**
			(0.001)		(0.001)		(0.001)
Farmer's gender			0.013		−0.005		0.039
			(0.054)		(0.057)		(0.038)
Farmer's education (years)			0.009*		0.005		0.009**
			(0.005)		(0.005)		(0.004)
Household size			0.011**		0.007		−0.007***
			(0.005)		(0.005)		(0.002)
Farm size*10^{-3}			−0.562***		−0.381**		−0.235*
			(0.207)		(0.188)		(0.131)
Plot size*10^{-3}	−668						
	(1.25)						
Town size*10^{-6}			0.354		0.336		0.180
			(0.228)		(0.236)		(0.186)
Average distance to market town			−0.063***		−0.046***		−0.029***
			(0.016)		(0.016)		(0.010)
Percent increase in probability when moving from tenancy to ownership		29	24	39	30	248	157
Province fixed effect	No	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations (farmers)	86	1172	1172	1172	1172	1172	1172
R^2	0.08	0.02	0.10	0.02	0.10	0.02	0.15

*Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.

Note: Numbers in parentheses are standard errors based on White's robust "sandwich" estimator for the asymptotic covariance matrix. The percentage change is calculated as the percentage change in the predicted probability of cultivating trees evaluated at the sample mean of all dependent variables when the ownership dummy goes from zero (tenant) to one (owner).

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

on the ownership variable is significant at more than the 1 percent level, which is quite surprising given the small sample size. The marginal effect of tenure is 0.18, which is large considering that the sample mean of *tree_main* is 0.12.

Similar results are obtained in a random-effects model, and the Hausman test fails to reject the null hypothesis of systematic difference in the coefficients, with a *p*-value of 0.7764. While the power of the test is low because of the small sample size, the result is nevertheless reassuring for the cross-sectional estimates that follow.

LEAST SQUARE ESTIMATES. For all three definitions of the tree variable, the findings indicate that owners are more likely than renters to grow trees (see table 3). The effect is significant at the 1 percent level in all cases. The unconditional effect of ownership on tree cultivation is very close in magnitude to the conditional estimate, suggesting that although owners and tenants differ on a number of observable characteristics, most notably wealth and age, these do not drive the difference in crop choice.

In all cases, ownership status has the largest effect on the probability of growing trees. For instance, for the *tree_mix* variable, the estimates in column 2b of table 3 indicate that the probability of growing trees is 0.12, or 24 percent higher on owner-operated farms. This is equivalent to an increase in educational achievement of 12 years (or four standard deviations), namely the difference between no schooling and completion of basic secondary education. The effect of ownership is also equivalent to an increase of wealth of five standard deviations, or 1 million cordobas ($100,000) and to a decrease in the travel time to the market of 2 hours. The effect of ownership on *tree_mix* (all trees) and *tree_mix*2 (citrus and coffee) is very similar, while it is much bigger for *tree_main*.

Education, wealth, age, and household size are also significant determinants of tree cultivation. Trees are more likely to be grown by better-educated, richer, and older farmers. The effect of household size depends on how the dependent variable is defined. It is positive for *tree_mix*, zero for *tree_mix*2, and negative for *tree_main*. Including other measures of household structure, such as number of adult males or number of children, does not yield additional insights.

The results also show that trees are more likely to be grown on smaller farms, which rules out the hypothesis that there are increasing returns to scale to tree cultivation and that the observed difference between owners and tenants is due to the fact that owners farm larger plots.

Finally, trees are more likely to be grown by farmers in larger towns and in towns that are closer to agricultural markets. The province fixed effects are jointly significant.

The percentage increase in probability that is imputable to the ownership variable is generally large, particularly so for *tree_main* (see table 3, last

TABLE 4. Land Ownership and Trees: Nearest Neighbor Matching Estimates

	(1) *Tree_mix*	(2) *Tree_mix2*	(3) *Tree_main*
Farmer owns plot	0.191*	0.159*	0.082*
	(0.036)	(0.035)	(0.017)
Number of observations	1172	1172	1172

*Significant at the 1 percent level.

Note: Numbers in parentheses are standard errors based on Abadie and Imbens (2004). Heteroskedasticity robust estimator of the variance uses one match within treated and control units. Observations are matched on the same farmer and town characteristics used in table 3

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

column), indicating that tenants are less likely to grow trees and very unlikely to grow them as a main crop.

MATCHING ESTIMATES. Table 4 reports the nearest neighbor estimates of the average treatment effect, using the same set of farmer and town characteristics as in table 3 and a single match for each of the three definitions of the dependent variable. The results show that the effect of ownership is, if anything, larger when identified from the comparison of the most similar observation. The nearest neighbor estimates of the average effect of ownership on *tree_main* is comparable to the ordinary least squares (OLS) estimate, whereas the nearest neighbor estimates of the average effect of ownership on *tree_mix* and *tree_mix2* is one and a half times the OLS estimate. The results indicate that the effect of ownership status on tree cultivation varies with observable characteristics. Further analysis reveals that the effect is increasing in wealth (discussed subsequently).

Finally, the results do not differ with different definitions of the dependent variable. For ease of exposition, and without loss of generality, the analysis that follows employs the more general definition of *tree_mix*.

Econometric Concerns

The analysis raises two main econometric concerns, one due to the unavailability of soil quality measures and the other due to the potential endogeneity of wealth.

First, the fact that soil quality is in the error term biases the estimates if soil quality is correlated with the ownership variable. In particular, if tree crops necessitate a specific soil type and all plots of that specific soil type are cultivated by owners, the ownership variable would also capture the effect of the omitted soil type.

Three strategies are applied to address the issue of omitted soil quality. First, land rental value is used as a proxy for soil type. Second, the effect of

TABLE 5. Soil Type Controls: Linear Probability Model (dependent variable, *tree_mix*)

Variable	(1) Baseline specification	(2) Land value	(3) Town fixed effects	(4) Segment fixed effects	(5) Land reform
Farmer owns plot	0.120***	0.102***	0.092***	0.068*	0.134***
	(0.032)	(0.033)	(0.033)	(0.037)	(0.033)
Land rental value		0.117**			
		(0.005)			
Individual land reform					−0.048
					(0.076)
Collective land reform					−0.105
					(0.066)
Household wealth $*10^{-6}$	0.127*	0.135*	0.102	0.186	0.119*
	(0.065)	(0.073)	(0.076)	(0.149)	(0.063)
Farmer's age	0.002**	0.002**	0.002*	0.001	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Farmer's gender	0.013	0.038	0.011	−0.068	0.010
	(0.054)	(0.058)	(0.057)	(0.068)	(0.054)
Farmer's education	0.009*	0.006	0.009*	0.002	0.009*
	(0.005)	(0.005)	(0.005)	(0.007)	(0.005)
Household size	0.011**	0.010**	0.009*	0.005	0.011**
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Farm size$*10^{-3}$	−0.562***	−0.478**	−0.374	−0.651**	−0.555***
	(0.207)	(0.217)	(0.228)	(0.292)	(0.204)
Town size$*10^{-6}$	0.354	0.305			0.379
	(0.228)	(0.232)			(0.234)
Average distance to market-town	−0.063***	−0.063***			−0.065***
	(0.016)	(0.017)			(0.016)
Province fixed effects	Yes	Yes	No	No	Yes
Town fixed effects	No	No	Yes	No	No
Segment fixed effects	No	No	No	Yes	No
Number of observations	1172	1100	1172	915	1172
R^2	0.10	0.10	0.22	0.31	0.10

*Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.

Note: Numbers in parentheses are standard errors based on White's robust "sandwich" estimator for the asymptotic covariance matrix. In columns 3 and 4, the town level variables are absorbed by the fixed effects. The number of observations is lower in column 2 because of missing values in the rental value variable, and in column 4 because segments with no variation in ownership status are dropped.

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

ownership is identified from within small geographic areas where the variation in soil type is likely to be small. Third, information on the mode of acquisition of the plot is exploited.

To the extent that the suitability of soil for trees is reflected in the rental value of the land, this can be used to proxy for soil type. The survey asks both

owner-cultivators and tenants to report how much their land could be rented for per year. This amount is used to build a measure of rental value for one unit (*manzana*) of land.

Table 5 includes the land value variable in the crop-choice equation. Note that this variable is likely to be endogenous because trees might increase the value of the land. Thus, the coefficient of land value cannot be interpreted as the causal effect of land value on tree cultivation.

That notwithstanding, if the ownership variable were exclusively proxying for land type, its coefficient should drop once land value is controlled for. Instead, the estimated effect of ownership does not change from the base specification when the land-value variable is added (see table 5, column 2). Land value has a positive and significant effect, but it does affect the estimates of the other coefficients. Results are similar in the fixed-effect specification. Land rental value has a positive effect on tree cultivation, and the estimated coefficient of tenure status is unchanged.[5]

The second test identifies the effect of ownership status by comparing owners and tenants within small geographic areas that have more homogeneous soil types because of their size. The survey data permit identification of two such areas: townships and census segments.

Town population varies between 3,000 and 900,000 for the capital, Managua. The median size is 20,000, or about 4,000 households. Town dummy variables explain 67 percent of the variation in unit land value in the sample. Census segments identify very small geographic areas of 50–60 households. They are thus much smaller than a rural village and unlikely to exhibit meaningful soil variation. Not surprisingly, census segment dummy variables explain 80 percent of the variation in unit land value.

If the previous results for ownership status were driven entirely by unobservable soil quality, this should, at least in part, be picked up by the town and segment-fixed effects, resulting in a large drop in the ownership coefficient.

Results for the crop-choice equation with town and segment dummy variables show that the tenure effect is robust to the inclusion of town and segment controls (see table 5, columns 3 and 4). Point estimates are somewhat smaller (0.07 and 0.09) but not significantly different from the baseline estimate (0.12). Note that ownership status and farm size are the only two significant determinants of tree cultivation in the segment fixed-effect regression.

The final test augments the estimated equation with an interaction term between ownership and a dummy variable that equals one when the land was obtained through land reform rather than purchase or inheritance. The reform redistributed only land that had previously been rented out, implying that if all tenanted land is unsuitable for tree cultivation, all farms obtained through land

5. The average rental value is higher for owner-operated than for tenanted land, but the difference is due entirely to the top 3 percent of the rental value distribution. Results are unchanged if these observations are dropped from the sample.

reform must be unsuitable for tree cultivation. Therefore, if ownership were proxying for soil type, owners who have obtained their farms through land reform should be less likely to grow trees than owners who purchased or inherited their farms.[6]

The results indicate that owners who got their farm through land reform do not make different choices than owners who bought or inherited their farm, implying that not all rented land is unsuitable for trees (see table 5, column 5).

Second, farmers' wealth might be endogenous to crop choice if cultivating trees makes farmers richer. In this case the OLS estimate of the ownership effect in equation (3) is inconsistent. The root cause of the problem is that many of the characteristics that make the farmer choose to grow trees are not observable, and some of these also affect the farmer's ability to accumulate wealth. To the extent that omitted variables affect wealth and tree cultivation in the same direction, such that, for instance, more able farmers are more likely to cultivate trees and more able to accumulate wealth, the OLS estimate of the ownership effect is biased downwards.[7] The data do not contain information on exogenous variations in wealth that can be exploited to address this issue.

III. Why Are Tenants Less Likely to Farm Trees?

This section examines theoretical and empirical evidence on why tenants may be less likely to farm trees.

Theoretical Background

The key difference between owners and tenants is that ownership and cultivation rights are separated for tenants. This might explain the observed difference in crop choice if information is asymmetric, in that the owner of the plot cannot observe the effort exerted by the tenant. Moral hazard theories suggest that asymmetric information might affect the choice of cultivation techniques through two channels.

First, landowners might not adopt techniques that are complementary to unobservable production effort if they cannot provide tenants with sufficiently strong effort incentives because of risk aversion or limited liability.

If the tenant is risk averse, providing strong incentives through a fixed-rent contract is suboptimal because the tenant bears the entire production risk (Stiglitz 1974). A risk-neutral landlord can achieve a higher payoff by insuring the tenant against bad outcomes, by making the tenant's pay less sensitive to

6. To keep the comparison clean, it is important to distinguish between farms that were assigned to individual farmers and farms that were assigned to a farmers group or cooperative, whose organizational form results in a different incentive structure. Ley 88 (April 2, 1990), Ley 209 (November 30, 1995), and Ley 278 (November 26, 1997) recognize the property rights acquired by individual farmers and farmers cooperatives with the Sandinistas Land Reform (Decreto 782 and Ley 14, July 19, 1981). See Article 1 Ley 88 and Article 3 Ley 209 and Ley 278.

7. The formal proof is available from the author on request.

output. Insurance, however, reduces the tenant's stake in success and leads to the underprovision of effort. Or tenants' productivity might be lower than first best if they are subject to limited liability (Shetty 1988; Mookherjee 1997; Banerjee, Gertler, and Ghatak 2002). Limited liability makes incentive provision costly by imposing an upper bound on the feasible punishment. When the limited liability constraint binds, the landlord can provide incentives only by increasing the reward for success. Since rewards are costly, the landlord might achieve a higher payoff by providing weaker incentives.

Thus if effort provision is below first best, because of either risk aversion or limited liability, the landowner might resist adoption of techniques that are complementary to effort, even when these are contractible and more profitable in a first-best sense (Braverman and Stiglitz 1986; Banerjee, Gertler, and Ghatak 2002).

Second, landowners might not adopt techniques that require noncontractible investment if they cannot provide incentives for the tenant to undertake such investment. For instance, trees require maintenance, but the effects of maintenance investments on productivity go beyond the period in which the investments are undertaken. Tenants will choose the optimal level of maintenance if they can reap the benefits of increased future productivity. Incentives to invest in maintenance can thus be provided by offering tenants a contract long enough to benefit from higher future productivity.

Landlords might be unable to commit not to expropriate the tenant's investment if, for instance, courts are ineffective at enforcing contracts or judges can be bribed. In this case, long-term contracts are ineffective because tenants anticipate that once their investments are sunk, they will be held up (Masters and McMillan 2003).

Even if landlords can credibly commit to a long-term contract, doing so might be costly since they give up the possibility of adjusting the terms of the contract to changes in the environment. They give up the option of cultivating the land themselves for the duration of the contract, and the contract reduces the resale value of the land if a buyer is bound to honor an existing tenancy agreement.

Empirical Evidence

This section examines whether trees are not cultivated on rented plots because effort incentives are low-powered (due to risk aversion or limited liability) or because tenants fear their maintenance investment will be expropriated. Although not mutually exclusive, the two hypotheses have distinct predictions on the effect of wealth and contract duration.

Since poorer tenants are more likely to be risk averse (Binswanger 1980) and because the limited-liability constraint is more likely to be binding for poor tenants, models of risk aversion or limited liability share the prediction that tenants' wealth determines the cost of providing incentives and hence effort and the choice of production techniques. In particular, poor tenants should be less likely to cultivate trees. In contrast, if the mechanism driving the result is

that trees require maintenance effort, tree cultivation and contract duration should be correlated. In particular, tenants with short-term contracts should be less likely to cultivate trees.

PREDICTION 1: TENANTS' WEALTH AND TREE CULTIVATION. To establish whether poorer tenants are less likely to cultivate trees, in line with the predictions of moral hazard models with risk aversion or limited liability, the effect of wealth is permitted to differ for owners and tenants in equation (3). The effect of wealth is positive and significant for owner-cultivators and negative and not significant for tenants (table 6, column 1).[8]

That wealth affects crop choice for owner-cultivators is consistent with the notion that moral hazard generates credit constraints, but the result might also reflect unobservable farmer characteristics that drive both wealth and the decision to grow trees, such as entrepreneurship.[9] Identifying the precise mechanism through which owners' wealth affects tree cultivation is beyond the scope of this article, however.

That wealth is not a significant determinant of crop choice in rented plots, in contrast, goes against the predictions of moral hazard models with risk aversion or limited liability, suggesting that low-powered effort incentives are not the binding constraint in this setting.

A possible concern is that the coefficient of wealth is biased toward zero because of endogenous matching of tenants and soil types.[10] The argument runs as follows. Assume that poorer tenants are more risk adverse and therefore have a strong preference for land of higher quality if this is also less risky. If, at the same time, land of higher quality is better suited for trees, no relationship would be observed between tree cultivation and wealth because poor tenants who farm the right type of land cannot afford tree cultivation while richer tenants who can afford tree cultivation do not farm land that is suitable for trees. However, the findings indicate that wealth is a significant determinant of tree cultivation for owner-cultivators, suggesting that if matching takes place at all it has a substantially different impact according to ownership status, which is implausible.

As noted, owner-cultivators have a higher average wealth with a higher variance than tenants (see table 1). Another possible concern is that wealth does

8. There are not enough farmers who cultivate both an owned and a rented plot to estimate the interaction between wealth and ownership status with farmers' fixed effects.

9. Results from the questionnaire show that only 20 percent of owner-cultivators are currently in debt. About 20 percent of nonborrowing farmers do not borrow because they do not need or do not want to. The rest state that they wanted to borrow but could not, because they thought they would be rejected, because loans are too expensive, or because there are no lenders in the community. Results from the Rural Census (2001) exhibit a similar pattern: only 24 percent of the 200,000 farmers interviewed asked for credit in 2001. Of those who asked, more than a third (37 percent) were turned down.

10. For a detailed analysis of endogenous matching and tenancy see Ackeberg and Botticini (2002).

TABLE 6. Empirical Predictions of Moral Hazard Models: Linear Probability Model (dependent variable, *tree_mix*)

Variable	(1) All	(2) Tenants
Farmer owns plot	0.111***	
	(0.033)	
Owner*household wealth $*1^{-6}$	0.131**	
	(0.068)	
Tenant*household wealth $*10^{-6}$	−0.541	1.01
	(0.584)	(0.967)
Farmer's age	0.002**	0.003
	(0.001)	(0.002)
Farmer's gender	0.024	0.186*
	(0.054)	(0.107)
Farmer's education (years)	0.009*	0.004
	(0.005)	(0.010)
Household size	0.011**	0.011
	(0.005)	(0.008)
Farm size$*10^{-3}$	−0.005***	−0.002*
	(0.002)	(0.001)
Town size	0.351	0.203
	(0.223)	(0.332)
Average distance to market-town	−0.064***	−0.080***
	(0.016)	(0.029)
Number of years farming the same plot		−0.005
		(0.004)
Contract length: two years		0.223***
		(0.067)
Contract length: three years		0.268***
		(0.079)
Contract length: more than three years		0.351***
		(0.087)
Contract type: sharecropping		0.097
		(0.118)
Province fixed effects	Yes	Yes
Number of observations	1172	397
R^2	0.4744	0.1870

*Significant at the 10 percent level; **Significant at the 5 percent level; ***Significant at the 1 percent level.

Note: Numbers in parentheses are standard errors based on White's robust "sandwich" estimator for the asymptotic covariance matrix. The residual category for contract length is one year. Contract type = one if the landlord gets a share of the produce (sharecropping) and zero otherwise (fixed rent).

Source: Author's analysis based on data from the 1998 Nicaragua Living Standards Measurement Study survey.

not exhibit sufficient variation in the tenant sample compared with the owner sample, which makes the coefficient estimates less precise and so makes it harder to reject the null. Standard measures of dispersion, however, take similar values in the two samples; the coefficient of variation is 2.4 for tenants and 2.7 for owners.

To investigate whether the wealth coefficient is biased toward zero because the relationship between wealth and tree cultivation is assumed to be linear, the relationship is estimated nonparametrically for both owners and tenants. The nonparametric estimates, not reported for reasons of space, show that for the sample of tenants the effect of wealth on the probability of tree cultivation is not significantly different from zero. In contrast, the relationship between tree cultivation and wealth is positive for owner-cultivators, and linearity cannot be rejected.

PREDICTION 2: CONTRACT DURATION AND TREE CULTIVATION. To assess the importance of noncontractible investment, for instance in tree maintenance, the effect of contract duration on the probability of tenants cultivating trees is estimated. While the relevant variable for investment incentives is the expectation of being able to appropriate future returns—and hence the future duration of the contract—this might be correlated with the duration of previous contracts and hence capture plot-specific skills that the farmer might have accumulated in the past. To address this issue, the specification also controls for the number of years the farmer has been cultivating the same plot. Finally, the specification also controls for the type of tenancy contract, whether sharecropping or fixed rent.

The results indicate that the duration of the tenancy agreement is strongly correlated with tree cultivation: tenants who are employed on contracts longer than one year are more likely to grow trees (see table 6, column 2). The estimated effect of contract duration is large, with the coefficients implying that moving from a one-year contract to a more than three-year contract increases the probability of cultivating trees by 80 percent.

It is the length of the contract not the duration of the relationship that matters. Tenants who have been farming the same plot longer than other tenants are not more likely to grow trees if they are employed on short-term contracts. Finally, the type of tenancy contract (sharecropping or fixed rent) is not correlated with tree cultivation. This suggests that in line with the previous findings on wealth, the duration of the agreement is the only binding constraint. Since both contract duration and crop type might be chosen simultaneously by the landlord, the coefficient of contract length should be interpreted as a correlation with tree cultivation rather than as a causal effect.

What is surprising is that long-term contracts are so rare: 60 percent of contracts are one year long, 20 percent are two years long, and only 6 percent last longer than five years. It may be that most landlords cannot credibly commit to a long-term contract, perhaps because courts are unable to enforce them or

because the contracts are too complex, possibly requiring history-dependent payments.

Alternatively, landlords might simply be unwilling to commit to long-term contracts. Although quantitative evidence is unavailable, it could be that Nicaraguan landlords are unwilling to commit to long-term contracts for fear of granting too many rights to tenants. In 1981, rented land was redistributed from large landowners to tenants and landless peasants, and the Constitution (Titulo VI, Cap. II) and reform laws favor small owner-cultivators and make the eviction of long-term tenants difficult.

IV. Conclusions

This analysis of cultivation techniques by Nicaraguan farmers indicates that owner-cultivators are more likely than tenants to grow trees, an effect that seems to derive from ownership status rather than from unobservable farmer characteristics. The effect is due not to risk aversion or limited liability but to the fact that long-term agreements, necessary to provide incentives for noncontractible maintenance investment in tree cultivation, are rare.

The results suggest scope for further investigation of the effect of ownership status on other types of contractible techniques and fixed investments. While immobile investments such as irrigation and farm equipment in this setting are rare, the few that exist are on owner-cultivated plots.[11]

The results have important implications for land policy, a core issue in most developing countries. First, encouraging the use of long-term contracts might lessen the bias against tree cultivation and other long-term investments on rented farms. Operation Barga tenancy reform, implemented in West Bengal in the late 1970s, provides a somewhat extreme example. The reform gave all registered tenants the right to cultivate their plots indefinitely, provided they gave 25 percent of their annual output to the landlord. Operation Barga had a large positive impact on agricultural productivity (Banerjee, Gertler, and Ghatak 2002).

Second, the success of a redistributive land policy depends crucially on the identity of the beneficiaries. In this sample, poor owners are as unlikely as poor tenants to grow trees, while the effect of ownership status is strong for wealthier farmers. Whether this is a pure wealth effect whose impact could therefore be undone by a transfer of resources to the poorest farmers, or whether wealth proxies for unobservable farmer characteristics cannot be identified from the data used in this study. The issue is of fundamental importance for

11. With the same specification as in table 3, analysis shows some evidence that owner-cultivators are more likely to have immobile equipment such as irrigation systems, silos, and barns, while ownership does not affect mobile capital such as water pumps, trucks, and horse carts. Since immobile investments are rare in this setting, the nature of the data precludes further analysis along these lines.

evaluating the impact of land redistribution and is left as an open question for future research.

References

Abadie, Alberto, and Guido. Imbens 2004. *Large Sample Properties of Matching Estimators for Average Treatment Effects*. Cambridge, Mass: Harvard University, Kennedy School of Government.

Ackeberg, Dan, and Maristella Botticini. 2002. "Endogenous Matching and the Empirical Determinants of Contract Form." *Journal of Political Economy* 110(3):564–91.

Asamblea Nacional de la Republica de Nicaragua, Ley 209, *La Gaceta* 227, 1 December 1995; Ley 278, *La Gaceta* 239, 16 December 1996. Decreto 11-90, *La Gaceta* 98, 23 May 1990.

Banerjee, Abhijit. 1999. "Land Reforms: Prospects and Strategies." Working Paper 99/24. Cambridge, Mass: Massachusetts Institute of Technology, Department of Economics.

Banerjee, Abhijit, Paul Gertler, and Maitreesh Ghatak. 2002. "Empowerment and Efficiency: Tenancy Reform in West Bengal." *Journal of Political Economy* 110(2):239–80.

Besley, Timothy. 1995. "Property Rights and Investment Incentives: Theory and Evidence from Ghana." *Journal of Political Economy* 103(5):903–37.

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

Binswanger, Hans, Klaus Deininger, and Gershon. Feder 1995. "Power, Distortions, Revolt, and Reform in Agricultural Land Relations." In J. Behrman, and T.N. Srinivasan, eds. *Handbook of Development Economics*. Vol. 3B. Amsterdam, North-Holland.

Braverman, Avishay, and Joseph Stiglitz. 1986. "Landlords, Tenants, and Technological Innovations." *Journal of Development Economics* 23(2):313–32.

Current, Dean, Ernst Lutz, and Sara. Scherr 1995. "Costs, Benefits, and Farmer Adoption of Agroforestry: Project Experience in Central America and the Caribbean." Environment Paper 14. World Bank, Washington, D.C.

FAO (Food and Agriculture Organization). FAOSTAT database. Rome. (http://faostat.fao.org/site/336/default.aspx).

Hausman, Jerry, Jason Abrevaya, and F.M. Scott-Morton 1998. "Misclassification of the Dependent Variable in a Discrete-Response Setting." *Journal of Econometrics* 87(2):239–69.

Junta De Gobierno De Reconstruccion Nacional, Decreto 782, Published in *La Gaceta* 188, 21 August 1982.

Masters, William, and Margaret McMillan. 2003. "An African Growth Trap: Production Technology and the Time-Consistency of Agricultural Taxation, R&D, and Investment." *Review of Development Economics* 7(2):179–91.

Mookherjee, Dilip. 1997. "Informational Rents and Property Rights in Land." In J. Roemer, ed. *Property Rights, Incentives and Welfare*. New York: MacMillan Press.

Shaban, Radwan. 1987. "Testing between Competing Models of Sharecropping." *Journal of Political Economy* 95(5):893–920.

Shetty, Sudhir. 1988. "Limited Liability, Wealth Differences, and the Tenancy Ladder in Agrarian Economies." *Journal of Development Economics* 9(1):1–22.

Stiglitz, Joseph. 1974. "Incentives and Risk Sharing in Sharecropping." *Review of Economic Studies* 41(2):219–55.

World Bank. *World Development Indicators*. Various years. Washington, D.C.: World Bank.

Yatchew, Adonis, and Zvi. Griliches 1985. "Specification Error in Probit Models." *Review of Economics and Statistics* 67(1):134–39.

Earnings, Schooling, and Economic Reform: Econometric Evidence From Hungary (1986–2004)

Nauro Campos and Dean Jolliffe

How does the relationship between earnings and schooling change with the introduction of comprehensive economic reform? This article sheds light on this question using a unique data set and procedure to reduce sample-selection bias. The evidence is from consistently coded, nonretrospective data for about 4 million Hungarian wage earners. Returns to skill increased 75 percent from 1986 to 2004 (that is, during the period stretching from communism to full membership in the European Union). The winners were those with a college or university education and those employed in the services sector (which here excludes those in public services). The reform losers were those in construction and agriculture, those with only a primary or vocational education (who experienced a decline in returns to their education), and younger workers who acquired most of their education after the main reforms were in place. JEL Codes: I20, J20, J24, J31, O15, O52, P20.

The rise and demise of communism are two of the most important economic events of the twentieth century. One of communism's indisputable

Nauro Campos (corresponding author) is a professor of economics at Brunel University, London, and a research affiliate at the Centre for Economic Policy Research, London; his e-mail address is nauro.campos@brunel.ac.uk. Dean Jolliffe is an economist with the Economic Research Service, United States Department of Agriculture, and a research affiliate with the National Policy Center at the University of Michigan; his e-mail address is jolliffe@ers.usda.gov. The authors are affiliated with the Institute for the Study of Labour, Bonn, and the William Davidson Institute at the University of Michigan. The authors are grateful to Tim Barmby, Elizabeth Brainerd, John DiNardo, Peter Dolton, Francisco Ferreira, Randall Filer, Stepán Jurajda, Harmut Lehmann, Jaime de Melo, Branko Milanovic, three anonymous referees, and seminar participants at the Universities of Queen's Belfast, Bristol, and Newcastle; Bank of Finland Institute for Economies in Transition; World Bank Inequality and Pro-Poor Growth Conference; and the Northeast University Development Consortium Conference for valuable comments on previous versions. They also thank János Köllo, Gábor Kezdi, Gábor Körösi, and György Lázar for the help with the data, and Dana Žlábková and Ján Plánovský for excellent research assistance. The views and opinions expressed in this article do not necessarily reflect the views of the Economic Research Service of the United States Department of Agriculture. Supplemental appendixes to this article are available at http://wber.oxfordjournals.org/. This work benefited from financial support from Phare ACE Grant 97-8085.

THE WORLD BANK ECONOMIC REVIEW, VOL. 21, NO. 3, pp. 509–526 doi:10.1093/wber/lhm012
Advance Access Publication 19 July 2007
© The Author 2007. Published by Oxford University Press on behalf of the International Bank for Reconstruction and Development / THE WORLD BANK. All rights reserved. For permissions, please e-mail: journals.permissions@oxfordjournals.org

achievements was an egalitarian distribution of income, which was accomplished in large part by wage compression. Returns to skill were determined centrally, with wages set below equilibrium.

The transition from a centrally planned to a market-based economy was expected to have powerful effects. First, the liberalization of labor markets was expected to significantly raise returns to skill, as these were artificially compressed under communism. Second, at least until the collapse of communism, a large share of the labor force used vastly outdated technologies, and those specific skills would not be expected to be valued in a market economy. Third, such skill deterioration would have been accompanied by a devaluation of the labor market experience acquired during communism. Finally, the transition from a centrally planned to a market economy would involve sharp reductions in government education expenditures, which could translate into lower quality education.[1] The aim of this article is to present econometric evidence that throws light on these effects using unique data from Hungary from 1986 (before the fall of communism) to 2004 (the year Hungary became a member of the European Union).

The paucity of published studies about a country as important as Hungary is surprising. Although one of the most liberalized economies in the Soviet bloc, Hungary started the transition from communism with a gradualist approach to reform, albeit with a welcoming attitude toward foreign investors.[2] In addition to focusing on an economy that has not received attention commensurate with its importance,[3] this article is one of the few examining labor markets in transition economies to use sufficiently large and representative samples of wage earners before, during, and after the introduction of massive economic reform.[4] The data cover almost

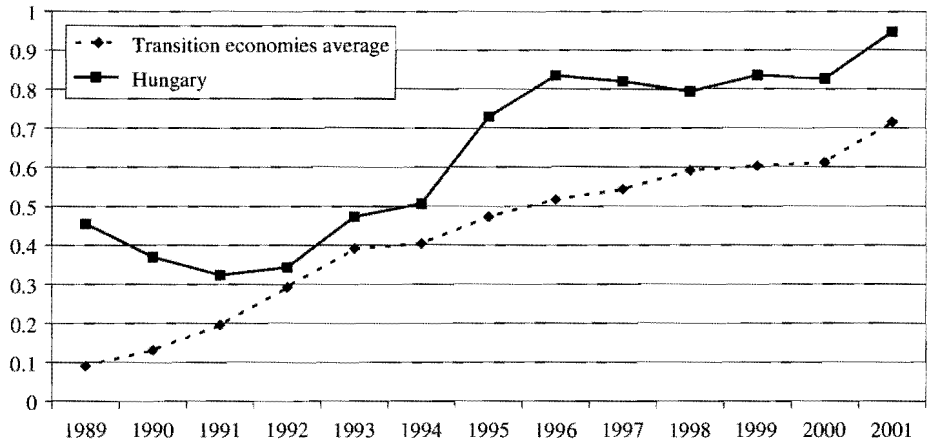
1. These effects are seldom independent. Although socialism compressed earnings, it may have rewarded different skills in nonpecuniary terms. The anecdotal evidence points to vacations and access to consumer goods as such rewards.

2. Further details about macroeconomic developments and labor market reform in Hungary are provided in Supplemental Appendix S.1, available at http://wber.oxfordjournals.org/

3. Svejnar (1999), Boeri and Terrell (2002), and Fleisher, Sabirianova, and Wang (2005) provide excellent reviews of the literature on returns to schooling in transition economies, whereas Card (1999) reviews this literature for nontransition economies. See Supplemental Appendix S.2 for a brief discussion of the literature.

4. Although voluminous, this literature has few studies that present estimates for the period before and after reform because of data availability constraints. Most data collected before 1989 have to be extensively recoded. The primary data used for this study are unique in this respect: they were recoded to current standard international classifications. Two of the main drawbacks of these data are that they do not contain information on self-employment or actual hours worked. Fleisher, Sabirianova, and Wang (2005) note the lack of studies that deal with under-reported economic activity or the informal sector. They report that only about 14 percent of estimates of returns to skills in transition economies are corrected for hours worked and that "when earnings data are adjusted for hours worked, estimated returns to schooling are not significantly larger" (p. 363). Empirical evidence from the economic reform literature is scarce. For reviews of this literature, see Rodrik (1996) and Harrison and Hanson (1999). Studies tend to compare the effects at two points in time (before and after), focus on a single aspect of reform (for instance, trade liberalization), and assume that the reform was effectively implemented and

FIGURE 1. Liberalization Index: Hungary and Transition Economies Average, 1989–2001.



Source: Campos and Horvath (2006).

4 million wage earners from 1986 to 2004 and, using a technique based on DiNardo, Fortin, and Lemieux (1996), also permit addressing the bias from selection on observables.

The results show that returns to a year of schooling increased by 75 percent, from 6.1 in 1986 to 10.7 percent in 2004. General secondary, college, and university education show the largest gains in returns from 1986 to 2004, whereas vocational and primary education show a decline in returns. Service employees experienced the largest gains in returns to skill, whereas construction and agricultural employees experienced the smallest gains.

How do these findings relate to the introduction of the massive economic reform mentioned earlier? Liberalization of the Hungarian economy was somewhat more intense than that of other transition economies (figure 1), and the results suggest that a link can be made between the progressively rising returns to schooling and the progressive liberalization of the Hungarian economy. Returns to skill increased rapidly overall, but the increase was much smaller for those employed in construction and agriculture and those with vocational (narrow) secondary education. These findings support the notion that the changes in returns to education during the transition may be taken as an indicator of the deepening of the reform process.

sufficient time has transpired to measure its impact. This study tries to overcome these difficulties by studying an unambiguously broad and effective reform at multiple points before and after its introduction.

I. Data and The Empirical Specification

The data used in the analysis are from the Wage and Earnings Survey of the National Labor Center in Hungary and contain information on wages, education, type of employment, and other demographic details. Data for the seven years 1986, 1989, 1992, 1995, 1998, 2001, and 2004 cover the communist and transition periods.[5] Wage earners are selected following a systematic, random-selection procedure (for details see Supplemental Appendix S.3). With assistance from the National Labor Center and the Hungarian Central Statistical Office considerable effort went into ensuring that variables were coded consistently over time, work that involved substantial recoding of the data.[6]

Wage equations are estimated using a standard Mincer equation:

$$\ln(w_i) = \beta_1 S_i + \beta_2 E_i + \beta_3 E_i^2 + \beta_4 X_i + \varepsilon_i, \tag{1}$$

where subscript i denotes the individual, w is wages, S is years of schooling (type of education in some specifications), E is potential experience, and X contains a set of variables to control for institutional and demographic characteristics as well as spatial price differences. Each variable is described in more detail below.

The monthly value of wages used in the analysis is the sum of the official base wage received and other payments to the employee (rewards given in the reference month, provisions, overtime work, shift work, and other special payments). In addition, the value of wages includes a prorated estimate of irregular payments (1/12 of irregular payments in the previous year).

Two measures of schooling are examined. The first is a vector of six dummy variables that denote the highest type of schooling completed. The school types include primary, three types of secondary (vocational, technical, and gymnasium or general), college, and university.[7] In 2004, 17 percent of wage earners had only primary schooling or less, whereas 21 percent had a college or university education. Of the remaining 62 percent of wage earners who had completed some form of secondary schooling, slightly less than half

5. The number of observations varies across the years of the survey and is lowest for 1992. Two factors account for the decline in the 1992 sample size. First, there was a planned reduction in sample size for 1992, which was driven by changes in the sample design. Second, the nonresponse rate increased immediately after the collapse of communism. Because the survey takes place in the first semester, 1992 is the first data point after the fall of communism (the 1989 survey was carried out before the collapse of the regime). The sample size increases again in 1995, as smaller firms were added to the frame. For example, in 1986 one of seven manual laborers was selected into the sample. Starting in 1992, all manual laborers born on the 5th and 15th of each month (or approximately 2 out of every 30 manual employees) were selected.

6. Campos and Žlábková (2001) give details on how consistent definitions of industry, ownership, and occupation codes were obtained.

7. The omitted category is individuals with less than primary schooling.

had attended vocational school (29 percentage points of the total). The second measure of schooling is an estimate of years of school attainment, which is created by converting the data on highest school type completed into years of schooling. The average value of this variable increased from 9.7 in 1986 to 11.5 years in 2004. Potential experience is constructed as the wage earner's age minus six years and minus the number of years of schooling.

The variables designated by X include a set of eight dummy variables to control for differences across industries,[8] a dummy variable for large firms (more than 300 employees), and a gender dummy variable to control for the large difference in wages across the sexes. The set of control variables also contains a dummy variable for each of Hungary's 19 counties and the capital, Budapest. These spatial variables control for any variation that is specific to Budapest or a specific county. In particular, these dummy variables control for spatial variation in prices, which is likely to be significant since wages and prices in Budapest are higher than in other regions. The county dummy variables will also control for region-specific differences in labor markets, which are potentially important since unemployment rates are lower in Budapest and the counties along the Budapest–Vienna highway and along the Austrian border. Similarly, the county dummy variables will control for the potential measurement problem that a year of schooling may result in different levels of human capital accumulation over different regions if there are differences in schooling quality across regions.

The controls for firm size and industry, as well as the county fixed effects, reduce the potential for omitted-variable bias in the estimation of equation (1). Having data that were collected using the same survey instrument also significantly improves the credibility of measured changes. That avoids the question, common when data come from different sources, of whether changes over time reflect actual changes in the population or simply the use of different survey instruments. These are important advantages to using the Wage and Earnings Survey data.

The primary disadvantage of using the survey data is that the choice of variables is small and thus the ability to empirically address violations of the ordinary least squares (OLS) assumptions is limited.[9] In particular, if education is correlated with the residual, which can occur for several reasons, including if people select into (or out of) the sample based on some characteristic correlated with education, then the OLS estimator is biased. For example, if people with high returns are more likely to be wage earners and those with expected low returns opt out of the sample, this would induce correlation and result in

8. The eight classifications are: industry, construction, transportation and telecommunications, trade, water, services, health and social services, and public services. The excluded classification is agriculture.

9. As already noted, the lack of information on actual hours worked and on self-employment, albeit common in this literature, is also an important drawback of the data.

sample-selection bias.[10] This source of bias is typically corrected by modeling the selection decision, which requires data on the individuals who have opted out of the wage market. Because the survey provides information only on wage earners, this approach is unavailable. However, unique features of the labor market in 1986 provide important information that can be exploited to reduce sample-selection bias.

In centrally planned economies workers had limited ability to select in or out of the wage market. In principle, everyone of working age was required to work, official unemployment was close to zero, and the opportunity to choose to work in nonwage employment was highly limited. This lack of freedom to select out of the wage market implies that the pre-transition, 1986 estimates of wage equation (1) will be less susceptible to sample-selection bias.[11]

Access to the 1986 pre-transition data is a unique feature of this analysis and helps to mitigate selection bias in the later, post-1986 years. The principal assumptions are that sample-selection bias was minimal in 1986 and that the decision to participate in the wage market after 1986 is correlated with age, gender, and schooling demographics.[12] Changes in these demographic variables in the post-1986 data are assumed to come from people selecting in and out of the wage market. The data are then reweighted to have the same demographic composition as in 1986, thereby purging labor supply changes from the data. This reweighting results in a counterfactual conditional wage distribution that corrects for (reduces) overt sample-selection bias.

This method is similar to that developed by DiNardo, Fortin, and Lemieux (1996), who propose a semiparametric estimation strategy to answer questions such as: what would the distribution of wages be if workers' attributes had remained as before? They note that the methodological contribution of their paper is to show that the estimation of such counterfactual densities can be "greatly simplified by the judicious choice of a reweighting function" (p. 1009).[13] The current study generates a baseline density by treating the 1986 sample as

10. For the former Democratic Republic of Germany, Hunt (2002) finds that the 10 percentage point improvement in the gender wage gap between 1990 and 1994 is a result of the reduction in participation of low-wage women in the labor market.

11. Munich, Svejnar, and Terrell (2002, p. 6) note that "In addition to regulating wages, the central planners regulated employment and admissions to higher education. With minor exceptions, all able-bodied adults were obliged to work. Jobs were provided for everyone and employment security was assured." Horvath and others (1999) show that while the registered unemployment rate in Hungary increased with the launching of reforms, in 1990 this rate was only 1.4 percent. Fazekas and Koltay (2006, p. 234) show rapidly declining rates of labor market participation, falling from 75.9 in 1990 to 61.4 percent in 2000. See Supplemental Appendix S.1 for further details.

12. Svejnar (1999) and Boeri and Terrell (2002) observe that early retirement schemes, youth unemployment, and the reduction of female labor force participation rates are stylized facts of the post-1989 transition.

13. DiNardo (2002, p. 16) argues that "It is therefore clear that this propensity score reweighting is merely a special case of the Heckman selection framework."

the one with the least severe sample-selection bias and reweights the other 6 years according to the demographic distribution of the 1986 sample. More specifically, each of the survey samples is partitioned by sex, six age categories (under 30, 30–34, 35–39, 40–44, 45–49, ≥50), and the seven school types described above, for a total of 84 sex-age-education categories. The proportion of the population that belongs to each of these categories in year t is then defined as:

$$(2) \qquad \upsilon_k^t \equiv \frac{\sum_i^{j_k} \omega_{i,k}^t}{\sum_i^{j_k} \sum_k^K \omega_{i,k}^t},$$

where the k subscripts runs from 1 to K and represents the 84 sex-age-education categories, i subscripts the individual observation and runs from 1 to j_k for each of the k categories, and $\omega_{i,k}$ represents the weight or expansion factor for individual i in category k.

To reweight the data, so that the demographic composition in later years matches the composition for 1986, new weights are constructed for each year:

$$(3) \qquad \varpi_{i,k}^t = \left(\frac{\upsilon_k^{86}}{\upsilon_k^t}\right) \omega_{i,k}^t, \forall k \in K.$$

The ν^{86} term in the numerator adjusts the weights to reflect the demographic composition in 1986, and the ν^t in the denominator normalizes the adjustment to ensure that the sum of unadjusted weights equals the sum of adjusted weights.

Consider for example that low-educated young males constitute a larger proportion of the sample in 1986 than in 1995. This method adjusts their 1995 weights upward (in this example) to ensure that they represent the same proportions across both years. One difficulty with this approach is that it does not allow for any true population changes in the sex, age, and education composition of the sample.[14] Although this affects the interpretation of the results, it is in some ways a desirable characteristic. Changes in returns to education can result from changes in the composition of the labor force and from the way the labor market rewards education, conditional on labor market characteristics. Reweighting the data to the 1986 demographic composition purges changes in the labor supply from the analysis so that the focus is on market changes in the demand for wage labor and on whether firms are responding to reforms by providing greater returns to investment in human capital.

14. The Hungarian Central Statistical Office reports that population declined by about 2 percent between 1990 and 1998 and also aged slightly.

II. Results

To examine how returns to schooling changed from 1986 to 2004, county fixed-effects estimates of equation (1) are provided in tables 1–4. Panel B of table 1 provides fixed-effects estimates for all firms with more than 50 employees. Panel A and all the other tables report fixed-effects estimates for the same sample weighted according to the formula above and therefore corrected for selection on observables. The standard errors listed in all tables are corrected for heteroscedasticity of unknown form through the use of the sandwich variance estimator.[15] The disadvantage, as noted by Kauermann and Carroll (2001), is that the sandwich variance estimator is inefficient and often results in estimated standard errors that are too conservative (large). Given the large sample sizes, the cost of the sandwich or robust variance estimates are not qualitatively important, and the benefit of consistency is desirable.

The results from Panel B of table 1 show that the uncorrected returns to a year of schooling increased 123 percent, from a return of 6.1 in 1986 to 13.6 percent in 2004, and the increase is statistically significant. Once corrected for sample selection on observables, the increase in returns is smaller, suggesting the existence of the positive correlation between education and the decision to participate in the wage sector that was discussed above. Panel A shows that the selection-corrected return to schooling for wage earners from firms with 50 or more employees increased by only 75 percent, from 6.1 in 1986 to 10.7 percent in 2004. This result supports the hypothesis that central planners undervalued education and that the market has quickly corrected this undervaluation.[16]

Comparing the panels shows that sample-selection bias is positive and quite large throughout the period of analysis. The direction of the bias is consistent with the notion that people who expect to receive higher returns in the wage market choose to enter, whereas those who expect lower returns opt out. The decision of workers to select in and out of the sample appears to happen quickly. By 1992, the magnitude of the bias is more than 10 percent and remains above this level throughout the 1990s.[17]

Table 1 also provides evidence of decreasing returns to experience throughout the transition from a centrally planned to a market economy. This result

15. An advantage of the Wage and Earnings Survey design is that the sample was selected in a single stage, and thus there is no need to correct estimates of the sampling variance for any design-induced dependence.

16. The declining size of the male coefficient indicates that the premium to male earners has fallen over time, indicating relative improvement for women in the labor force. Jolliffe and Campos (2005) examine the changing gender wage gap over time in detail using traditional Oaxaca decompositions.

17. The analysis in this article is restricted to firms with 50 or more employees. While this restriction corrects for the change made to the sample frame in 1995, it has the disadvantages of excluding from the analysis wage earners in smaller firms. Examination of the full sample reveals that the restriction on the sample does not qualitatively affect the results.

TABLE 1. Returns to Years of Schooling, 1986–2004: Spatial and Industry Fixed-effects Estimation of Equation (1)

	1986	1989	1992	1995	1998	2001	2004
Panel A: Selection-corrected estimates							
Years of schooling	0.061 (0.0004)	0.073 (0.0004)	0.082 (0.0009)	0.098 (0.0009)	0.104 (0.0012)	0.108 (0.0012)	0.107 (0.0010)
Gender dummy variable (male = 1)	0.280 (0.0022)	0.295 (0.0024)	0.216 (0.0070)	0.169 (0.0043)	0.163 (0.0055)	0.171 (0.0050)	0.178 (0.0042)
Potential experience	0.028 (0.0003)	0.021 (0.0004)	0.024 (0.0011)	0.020 (0.0008)	0.018 (0.0010)	0.013 (0.0010)	0.015 (0.0008)
Experience squared/100	−0.041 (0.0007)	−0.028 (0.0008)	−0.031 (0.0024)	−0.018 (0.0018)	−0.015 (0.0024)	−0.011 (0.0024)	−0.014 (0.0018)
Firm size dummy (300+ employees = 1)	−0.009 (0.0051)	−0.002[a] (0.0022)	−0.024 (0.0093)	−0.139 (0.0042)	−0.171 (0.0051)	0.123 (0.0056)	0.142 (0.0047)
Number of observations	149,274	383,720	48,261	371,882	334,207	346,217	431,391
R^2	0.45	0.40	0.39	0.38	0.38	0.40	0.40
Panel B: Uncorrected estimates							
Years of schooling	0.061 (0.0004)	0.078 (0.0004)	0.096 (0.0007)	0.112 (0.0007)	0.117 (0.0007)	0.126 (0.0006)	0.136 (0.0005)
Gender dummy variable (male = 1)	0.280 (0.0022)	0.279 (0.0022)	0.154 (0.0042)	0.141 (0.0036)	0.136 (0.0038)	0.180 (0.0029)	0.173 (0.0027)
Potential experience	0.028 (0.0003)	0.026 (0.0003)	0.029 (0.0007)	0.025 (0.0006)	0.025 (0.0007)	0.022 (0.0005)	0.024 (0.0005)
Experience squared/100	−0.041 (0.0007)	−0.037 (0.0007)	−0.036 (0.0015)	−0.028 (0.0013)	−0.030 (0.0015)	−0.031 (0.0011)	−0.034 (0.0009)
Firm size: ≥300 employees	−0.009 (0.0051)	0.001[a] (0.0019)	−0.014 (0.0054)	−0.138 (0.0034)	−0.162 (0.0034)	0.147 (0.0031)	0.123 (0.0029)
Number of observations	149,274	383,720	48,261	371,882	334,207	346,217	431,391
R^2	0.45	0.41	0.43	0.43	0.44	0.45	0.49

Note: Numbers in parentheses are standard errors robust to heteroscedasticity of unknown form. Dependent variable is the log of monthly wages. Sample consists of all firms with 50 or more employees. The eight industry dummy variables are jointly significant and are excluded from the table. County fixed effects are also jointly significant. All listed point estimates are significant with a $p < 0.01$ except for the firm-size dummy variable, which is significant with a $p < 0.05$ for all years, but 1986 and 1989.

[a]The only statistically insignificant point estimate.

Source: Authors' analysis based on the Wage and Earnings Survey data described in the text.

appears to support the notion that labor market experience acquired under communism loses value after the introduction of economic reform.[18] There is still little research focusing on the returns to experience in the labor market before, during, and after reform (Fleisher, Sabirianova, and Wang 2005), an area in need of in-depth research.

Under communism, a substantial share of the labor force was employed in large state-owned industrial enterprises. Government subsidies enabled these firms to survive with minimal technological modernization. Consequently, at the outset of transition a considerable share of the workforce had skills that were relevant for production technologies that were obsolete in the rest of the world (certainly in the Organization for Economic Co-operation and Development countries). Returns to the skills of manufacturing workers would thus be expected to be lower than returns to the skills of workers in other sectors (especially services). Table 2 shows estimates of the returns to skill from 1986 to 2004 in eight sectors.

The largest increases in returns to schooling are found in the service industries (excluding those in public services), with returns increasing 91 percent from 1986 to 2004. Correspondingly, the share of college-educated workers in the service industry doubled from 6 to 12 percent, suggesting an increase in demand for greater skills. Returns declined in construction (45 percent) and increased slightly in agriculture (27 percent). Similarly, the share of college-educated workers in these two industries declined from 42 to 6 percent. These results are consistent with the notion that the planned economy undervalued skilled labor used in the production of nonphysical goods and services.

There are several possible explanations for the varying returns to types of schooling during transition. One is that different types of schooling produce different skill sets, and these skills may be more or less well suited to the needs of the new market economy. A related explanation is that the government traditionally steered students into certain types of schools, and this planned aspect of the economy no longer provided the correct mix of skills. Both explanations are based on the idea that the changing market environment produced changes in the market value of certain skills. These hypotheses ignore the fact that under the planned economy returns to skills were set by planners and were not determined by the market. Prior to the transition wage setting was used to favor certain industries and certain types of labor. Labor who had been trained in technical and vocational schools and was involved in the production of certain goods tended to be more highly valued, whereas labor who had been more academically trained and less likely to be working in the physical production of goods was less highly valued. Presumably, the market economy

18. We are grateful to an anonymous referee for pointing out the need for care in interpreting returns to experience using cross-sectional data. If returns to experience are rising, but at a diminishing rate, cross-sectional returns might underestimate the life-cycle returns for newer cohorts (see, for example, Noorkôiv and others 1998).

TABLE 2. Selection-Corrected Returns to Years of Schooling by Sector, 1986–2004: Spatial Fixed-effects Estimation of Equation (1)

Sector	1986	1989	1992	1995	1998	2001	2004	Change 1986–2004 (percent)
Industry	0.070 (0.0011)	0.070 (0.0015)	0.073 (0.0025)	0.095 (0.0024)	0.097 (0.004)	0.114 (0.0026)	0.107 (0.0023)	53
Construction	0.058 (0.0013)	0.066 (0.0023)	0.068 (0.0044)	0.082 (0.0045)	0.096 (0.0075)	0.063 (0.0071)	0.032 (0.007)	−45
Agriculture	0.052 (0.0007)	0.041 (0.0014)	0.053 (0.0029)	0.067 (0.0029)	0.065 (0.004)	0.061 (0.0037)	0.066 (0.0051)	27
Transport and communications	0.080 (0.0045)	0.080 (0.0057)	0.098 (0.0082)	0.115 (0.0068)	0.125 (0.0088)	0.120 (0.0025)	0.112 (0.0036)	40
Trade	0.071 (0.0014)	0.078 (0.0025)	0.086 (0.0035)	0.106 (0.0038)	0.136 (0.0042)	0.085 (0.0036)	0.096 (0.0025)	36
Services	0.064 (0.0015)	0.075 (0.002)	0.088 (0.0033)	0.105 (0.0029)	0.126 (0.003)	0.112 (0.003)	0.122 (0.0028)	91
Health and social services	0.058 (0.0006)	0.080 (0.0003)	0.073 (0.0025)	0.097 (0.0014)	0.083 (0.0012)	0.074 (0.0009)	0.079 (0.001)	38
Public services	0.078 (0.0006)	0.108 (0.0005)	0.102 (0.0011)	0.115 (0.0007)	0.113 (0.0011)	0.110 (0.0007)	0.110 (0.0007)	40

Note: Numbers in parentheses are standard errors robust to heteroscedasticity of unknown form. Dependent variable is the log of monthly wages. Estimated returns are from separate regressions for each industry. Sample consists of all firms with 50 or more employees. The remaining results from the estimation of equation (1) are suppressed for brevity. All point estimates for the experience and gender variables are statistically significant. All listed parameters are statistically significant with a $p < 0.001$.

Source: Authors' analysis based on the Wage and Earnings Survey data described in the text.

rewards the value added by labor and is indifferent as to whether the added value is in a physical commodity or a service.

Although there was a large increase in the return to a year of schooling overall during this period, the wage premium to primary and vocational schooling declined between 1986 and 2004 (table 3). Wage earners who completed university, college, or secondary general education experienced the largest percentage changes in the wage premium. These results are consistent with the view that the planned economy undervalued labor used in the production of nonphysical goods and services relative to the market economy.

One indication that students are responding to the changing structure of returns by school type is that the share of students in general education increased from 24 in 1990 to 28 percent in 1997 (Fretwell and Wheeler 2001). This finding provides empirical evidence supporting the theoretical argument of Nelson and Phelps (1966) and Schultz (1975) that general education may enhance an individual's ability to adapt to a changing market environment. In contrast, the value of training in specific technical skills is more dependent on market fluctuations. When skills training is well targeted to the specific demands of the market, returns are high; when market and technology conditions change, there will be a time lag before curricula can adjust to provide the newly demanded mix of skills.

The final issue explored is whether there is evidence of qualitative changes in schooling after 1989. One hypothesis is that after 1989 schools responded to changing market needs and provided more marketable skills. A competing theory is that the quality of education has deteriorated because of the large declines in education budgets for many countries, including Hungary, during the transition period. Total public expenditures on education as a percent of gross domestic product increased in Hungary from 5.7 in 1989 to 6.6 percent in 1992, but then fell by 35 percent during the next 5 years, reaching a low of 4.4 percent in 1997 (Berryman 2000). As a result of the declining expenditures on education after 1992, studies note that many teachers have had to take on second jobs (Fretwell and Wheeler 2001) and that academic performance has been declining (World Bank 1997).

Although the Wage and Earnings Survey data include no direct measures of school quality, it is possible to provide limited supporting evidence.[19] Until 1992, all wage earners acquired their schooling before the transition or while education expenditures were increasing. By 2004, the youngest wage earners in the sample had acquired most of their schooling during the post-1989 years, and much of it during the post-1992 period of declining expenditures. Contrasting the returns for the youngest wage earners in the sample with those

19. There is an extensive literature on school quality in nontransition countries. See, among others, Behrman and Birdsall (1983), Betts (1995), Card and Krueger (1992), and Glewwe (1999).

TABLE 3. Selection-corrected Wage Premiums by School Type, 1986–2004: Spatial and Industry Fixed-effects Estimation of Equation (1)

School type	1986	1989	1992	1995	1998	2001	2004	Change 1986–2004 (percent)
Primary	0.085 (0.0049)	−0.025 (0.0058)	0.068 (0.0114)	0.074 (0.0127)	0.101 (0.0192)	0.166 (0.01832)	0.048 (0.0161)	−44
Secondary, vocational	0.209 (0.0053)	0.087 (0.0063)	0.226 (0.0156)	0.209 (0.0132)	0.222 (0.0203)	0.296 (0.0189)	0.163 (0.0169)	−33
Secondary, technical	0.381 (0.0054)	0.388 (0.0063)	0.207 (0.0126)	0.519 (0.0136)	0.546 (0.0201)	0.552 (0.0184)	0.421 (0.0162)	11
Secondary, general	0.303 (0.0059)	0.259 (0.0064)	0.464 (0.0122)	0.475 (0.0141)	0.507 (0.0202)	0.514 (0.0184)	0.391 (0.0160)	29
College	0.554 (0.0068)	0.531 (0.0063)	0.765 (0.0128)	0.835 (0.0136)	0.869 (0.0199)	0.989 (0.0185)	0.939 (0.0163)	69
University	0.720 (0.0057)	0.741 (0.0067)	0.981 (0.0145)	1.055 (0.0153)	1.166 (0.0218)	1.260 (0.0191)	1.195 (0.0166)	66

Note: Numbers in parentheses are standard errors robust to heteroscedasticity of unknown form. Dependent variable is the log of monthly wages. Sample consists of all firms with 50 or more employees. The remaining results from the estimation of equation (1) are suppressed for brevity. All point estimates for the experience and gender variables are statistically significant. The firm-size and industry dummy variables and the county fixed effects are jointly significant. All listed parameters are statistically significant with a $p < 0.001$. The point estimate for primary schooling in 1992 has the smallest t-statistic, with a value of 10.6.

Source: Authors' analysis based on the Wage and Earnings Survey data described in the text.

for all others permits observation of whether the market considers schooling attained in the transition years more or less highly (table 4).

In 1986, the returns to schooling for wage earners, 20 years old and younger, were about 61 percent less than the returns for wage earners more than 20 years old. In the early years of transition, this gap narrowed, and by 1992 the difference stood at 17 percent. The difference in returns increased over the next 6 years, and by 1998 wage earners who were schooled in the post-1989 years had returns that were 163 percent less than the returns for those who received most of their schooling before 1989. During the first few years of transition, the youngest wage earners experienced the largest increases in the returns to schooling; after 1992, the returns to education stagnated for the youngest workers whereas it continued to increase for older workers.[20] This is consistent with the hypothesis of declining school quality and, if correct, could have negative repercussions for future economic growth and the earnings potential of the generation that received its education during the post-transition years.[21]

There are, however, additional plausible explanations for this finding. It might be that over time young people are increasingly likely to pursue post-secondary schooling. If so and if these are the most able, then it would likely be that the more able youth were sorted out of the under-20 cohort earnings equation. Another possibility is that the higher estimated returns for the older group may be due to the increasing share of more educated (college and university) workers in this group. A third possible explanation is that the results reflect changes in returns to experience that are difficult to distinguish from changes in the quality of education. Finally, young workers may be the most adversely affected by market regulations that constrain job creation, and the slowdown and slight reversal of liberalization in the late 1990s could be taken as support for this hypothesis. Although the data do not permit discriminating among these hypotheses, none appear to suggest that young workers are natural winners from market reforms.

III. Conclusions

This article analyzed the effects of the introduction of economic reform—the transition from a centrally planned to a market economy—on the labor market. It tried to improve on the existing reform literature by focusing on a highly effective reform, defined broadly and covering the periods before, during, and after its implementation. One important result found in the analysis is that returns to schooling are relatively large throughout the transition in

20. As the number of graduates from institutions of higher education in Hungary increased over the transition period, an alternative explanation for the decline in returns to education for the young is a simple supply-side story.

21. See Fan, Overland, and Spagat (1999) for a theoretical discussion of this possibility.

TABLE 4. Comparison of Selection-Corrected Returns to Education by Age: Spatial and Industry Fixed-effects Estimation of Equation (1)

	1986	1989	1992	1995	1998	2001	2004
≤20 years	0.038 (0.0040)	0.051 (0.0062)	0.070 (0.0112)	0.075 (0.0114)	0.040 (0.0152)	0.074 (0.0167)	0.061 (0.0165)
>20 years	0.061 (0.0004)	0.073 (0.0004)	0.082 (0.0010)	0.099 (0.0009)	0.105 (0.0012)	0.108 (0.0012)	0.107 (0.0010)
R^2							
≤20 years	0.22	0.24	0.17	0.17	0.24	0.25	0.28
>20 years	0.43	0.39	0.38	0.38	0.38	0.40	0.42

Note: Numbers in parentheses are standard errors robust to heteroscedasticity of unknown form. Dependent variable is the log of monthly wages. Sample consists of all firms with 50 or more employees. Listed point estimates are significant with all $p < 0.01$. The remaining results from the estimation of equation (1) are suppressed for brevity.

Source: Authors' analysis based on the Wage and Earnings Survey data described in the text.

Hungary (which is a standard example of gradual reform), at around 10 percent and above since 1995. The returns to a year of schooling increased by 75 percent, from 6.1 in 1986 to 10.7 percent in 2004, according to our preferred (selection-corrected) estimates. Although these returns are larger than those available for other transition economies and for Western Europe, they are credible estimates for several reasons.

Although many Eastern European countries have education levels that are on par with those in Western Europe, average wages continue to be lower. Since estimated returns to schooling are measured as percentage changes in wages, if Western and Eastern European markets were to provide similar returns to schooling in wage levels, this would mean higher returns from estimating Mincer equations such as equation (1). The prior assumption here is that if markets are truly liberalized, rates of return will be higher in transition economies than in Western Europe until there is some convergence in wage levels.

The difference found in estimates may be in part due to some unique characteristics of the survey. The data were collected using the same survey instrument over the years 1986–2004, covering the pre-transition as well as the transition years. Studies that are based on multiple survey instruments for temporal analysis face the difficult question of whether the observed change results from changes in the examined population or changes in the survey instrument. Further, the data were recoded to current standard international classifications to minimize errors in comparisons over time.

The unique characteristics of the Wage and Earnings Survey data allow for the exploration of the important issue of school quality. Because the sample sizes are large, wage equations for a small sub-sample of very young workers in each of the 7 years can be estimated. The analysis reveals that the returns to education for the generation that received much of its schooling after 1989 declined during the mid and late 1990s, while returns for older workers continued to increase.

Wage and Earnings Survey data impose difficult estimation issues, however, that are similar to those that arise with any labor force survey data when estimating returns to schooling. As with essentially all labor force surveys, the researcher has no information on the population that chose not to participate in the wage market and therefore cannot control for sample-selection bias. The approach used in this article to correct for this potential bias has been to exploit the somewhat unusual availability of representative data from 1986, well before the transition began and when workers had very limited choice about whether to participate in the wage sector. The estimation strategy was to use the demographic composition (based on 84 sex-age-schooling classifications) of the 1986 data as a basis for identifying which types of people disproportionately select in or out of the sample in later years.

The analysis showed that the 75 percent increase in returns to a year of schooling between 1986 and 2004 is evidence that the planned economy

undervalued education and that liberalization has allowed markets to correct this. Examining returns by type of schooling rather than an aggregate measure of years of schooling sheds further light on whether the type of schooling received in pre-transition Hungary proved to be appropriate for the liberalized, post-1989 market. The common assumption is that socialist economies undervalued and undersupplied general education. The analysis strongly supports this view. Since 1989 an increasing proportion of students have been choosing to attend general school over vocational and technical school. Despite the increasing supply of students in general schooling, the estimated wage premiums to university and college education increased more than 60 percent between 1986 and 2004, whereas the premiums to secondary vocational training decreased 33 percent.

The empirical evidence in this article supports the belief that the liberalized economy has responded to market forces and is providing large returns for human capital investments. The evidence also suggests that wage earners are responding to the changes in the market and making better investment choices. All of this bodes well for future growth. The potential caveat to this conclusion, though, is that the declines in public expenditures on education may have resulted in a decline in the quality of this investment, and the markets seem to have responded to this.

Supplementary Material

Supplementary material is available online at http://wber.oxfordjournals.org/

References

Behrman, Jere, and Nancy Birdsall. 1983. "The Quality of Schooling: Quantity Alone is Misleading." *American Economic Review* 73(5):928–46.

Berryman, Sue. 2000. *Hidden Challenges to Education Systems in Transition Economies.* World Bank, Washington, D.C.

Betts, Julian. 1995. "Does School Quality Matter? Evidence from the National Longitudinal Survey of Youth." *Review of Economics and Statistics* 77(2):231–50.

Boeri, Tito, and Katherine Terrell. 2002. "Institutional Determinants of Labor Reallocation in Transition." *Journal of Economic Perspectives* 16(1):51–76.

Card, David. 1999. "The Causal Effect of Education on Earnings." In O. Ashenfelter, and D. Card eds., *Handbook of Labor Economics.* Vol. 3. Amsterdam: Elsevier.

Card, David, and Alan Krueger. 1992. "Does School Quality Matter? Returns to Education and the Characteristics of Public Schools in the United States." *Journal of Political Economy* 100(1):1–40.

Campos, Nauro, and Dana Žlábková. 2001. "The Wrong Mix: A First Look at Occupational Mobility during the Hungarian Transition." Discussion Paper 59. Prague, Czech Republic: Center for Economic Research and Graduate Education of Charles University, Economics Institute.

Campos, Nauro, and Roman Horvath. 2006. "Reform Redux: Measurement, Determinants and Reversals." Discussion Paper 2093. Bonn, Germany: Institute for the Study of Labor.

DiNardo, John. 2002. "Propensity Score Reweighting and Changes in Wage Distributions." Ann Arbor, Mich.: University of Michigan, Department of Economics.

DiNardo, John, Nicole Fortin, and Thomas Lemieux. 1996. "Labor Market Institutions and the Distribution of Wages, 1973–1992: A Semiparametric Approach." *Econometrica* 64(5):1001–44.

Fan, Simon, Jody Overland, and Michael Spagat. 1999. "Human Capital, Growth and Inequality in Russia." *Journal of Comparative Economics* 27(4)618–43.

Fazekas, Karoly, and Jeno Koltay eds. 2006. *The Hungarian Labour Market: Review and Analysis.* Budapest, Hungary: Institute of Economics.

Fleisher, Belton M., Klara Sabirianova, and Xiaojun Wang. 2005. "Returns to Skills and the Speed of Reforms: Evidence from Central and Eastern Europe, China, and Russia." *Journal of Comparative Economics* 33(2):351–70.

Fretwell, David, and Anthony Wheeler. 2001. *Hungary: Secondary Education and Training.* World Bank, Washington, D.C.

Glewwe, Paul. 1999. *The Economics of School Quality Investments in Developing Countries: An Empirical Study of Ghana.* New York: St. Martin's Press.

Harrison, Ann, and Gordon Hanson. 1999. "Who Gains from Trade Reform? Some Remaining Puzzles." *Journal of Development Economics* 59(1):125–54.

Horvath, Reka, Arpad Abraham, Tibor Horvath, and Tams Kopeczi-Bocz. 1999. *Background Study on Employment and Labour Market in Hungary.* Barcelona: European Training Foundation.

Hunt, Jennifer. 2002. "The Transition in East Germany: When is a Ten Point Fall in the Gender Wage Gap Bad News?" *Journal of Labor Economics* 20(1):148–69.

Jolliffe, Dean, and Nauro Campos. 2005. "Does Market Liberalisation Reduce Gender Discrimination? Econometric Evidence from Hungary, 1986–1998." *Labour Economics* 12(1):1–22.

Kauermann, Göran, and Raymond Carroll. 2001. "A Note on the Efficiency of Sandwich Covariance Matrix Estimation." *Journal of the American Statistical Association* 96(456):1387–496.

Munich, Daniel, Jan Svejnar, and Katherine Terrell. 2002. "Returns to Human Capital under the Communist Wage Grid and during the Transition to a Market Economy." Working Paper 272a. Ann Arbor, Mich.: University of Michigan, Stephen M. Ross Business School, William Davidson Institute.

Nelson, Richard, and Edmund Phelps. 1966. "Investment in Humans, Technological Diffusion, and Economic Growth." *American Economic Review* 56(2):69–75.

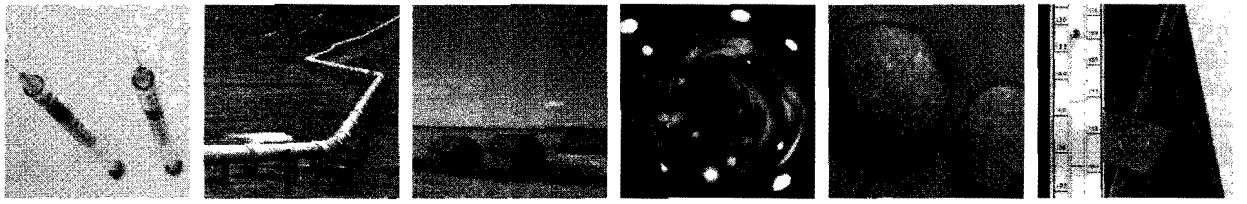
Noorkôiv, Rivo, Peter Orazem, Allan Puur, and Milan Vodopivec. 1998. "Wage Dynamics in Estonia, 1989–1995." *Economics of Transition* 6(2):481–503.

Rodrik, Dani. 1996. "Understanding Economic Policy Reform." *Journal of Economic Literature* 34(1):19–41.

Schultz, Theodore. 1975. "The Value of the Ability to Deal with Disequilibria." *Journal of Economic Literature* 13(3):827–46.

Svejnar, Jan. 1999. "Labor Markets in the Transitional Central and East European Economies." In Orley Ashenfelter, and David Card eds., *Handbook of Labor Economics.* Vol. 3. Amsterdam: Elsevier.

World Bank. 1997. "The Effect of Education Decentralization Reforms on Resource Allocation, Quality, and Equity in Hungarian Schools." In *Abstracts of Current Studies: Labor Markets and Education.* World Bank, Washington, D.C.



OXFORD JOURNALS COLLECTION

Content with impact

ARE YOU LOOKING TO FIND INFORMATION IN YOUR SUBJECT AREA QUICKLY AND EASILY FROM A WEALTH OF DIFFERENT SOURCES?

Oxford Journals publishes around 200 internationally-acclaimed journal titles online in the areas of:

Medicine
Life Sciences
Mathematics and Physical Sciences
Law
Humanities
Social Sciences

Encourage your institution to subscribe

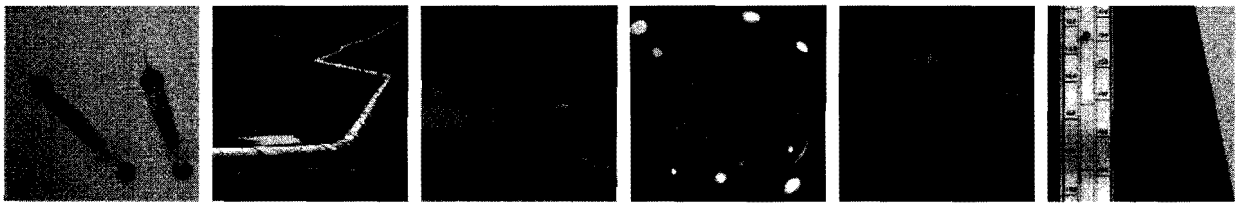
Flexible purchasing – your library can subscribe to the Oxford Journals Collection (which includes over 180 titles), or opt for a tailor-made package, a particular subject area, or even a single title

Advanced online functionality – including contents alerting, CiteTrack, RSS, OpenURL, Counter-compliant usage statistics

Pass this information to your librarian and encourage them to visit **www.oxfordjournals/for_librarians**

www.oxfordjournals.org

OXFORD JOURNALS
OXFORD UNIVERSITY PRESS



ENHANCED LINKING

TOLL-FREE LINKING ADDS GREATER FUNCTIONALITY TO THE PAPERS PUBLISHED IN THIS JOURNAL

The benefits are:

References link to articles from other journals hosted by HighWire Press – which you can view at no extra cost

References link to ISI, PubMed abstracts, and to other journals via Crossref

Links jump from an article of interest to those that have cited it

'Cited by' information is provided alongside each article

Visit your favourite Oxford Journal at **www.oxfordjournals.org** and discover for yourself..

www.oxfordjournals.org

OXFORD JOURNALS
OXFORD UNIVERSITY PRESS

Forthcoming papers in

THE WORLD BANK ECONOMIC REVIEW

A SYMPOSIUM ISSUE ON POST-CONFLICT TRANSITIONS

- **World Bank Lending and Financial Sector Development**
  Robert Cull and Laurie Effron
- **Does Aid for Education Educate Children? Evidence from Panel Data**
  Axel Dreher, Peter Nunnenkamp, and Rainer Thiele

THE WORLD BANK
1818 H Street, NW
Washington, DC 20433, USA
World Wide Web: http://www.worldbank.org/
E-mail: wber@worldbank.org

ISBN 0-19-922935-X