The Dynamics of Provincial Growth in China: A Nonparametric Approach
Bulent Unel and Harm Zebregs • 239

Central Bank Autonomy: Lessons from Global Trends
Marco Arnone, Bernard J. Laurens, Jean-François Segalotto, and Martin Sommer • 263

Do Unit Value Export, Import, and Terms-of-Trade Indices Misrepresent Price Indices?
Mick Silver • 297

Why Has the Grass Been Greener on One Side of Hispaniola? A Comparative Growth Analysis of the Dominican Republic and Haiti
Laura Jaramillo and Cemile Sancak • 323

Special Section
Global Reach? Perspectives on U.S. International Spillovers

Introduction
John Lipsky • 350

Foreign Entanglements: Estimating the Source and Size of Spillovers Across Industrial Countries
Tamim Bayoumi and Andrew Swiston • 353

Yen Carry Trade and the Subprime Crisis
Masazumi Hattori and Hyun Song Shin • 384

Rhyme or Reason: What Explains the Easy Financing of the U.S. Current Account Deficit?
Ravi Balakrishnan, Tamim Bayoumi, and Volodymyr Tulin • 410
The objective of *IMF Staff Papers* is to publish high-quality research on a variety of topics of interest to a broad audience including academics and policymakers in the member countries of the Fund. *IMF Staff Papers* is open to outside submissions. The papers selected for publication in the journal are subject to an extensive review process using both internal and external referees. *IMF Staff Papers* also welcomes outside comments, criticisms, and interesting replications of published work. The views presented in published papers are those of the authors and should not be attributed to or reported as reflecting the position of the IMF, its Executive Board, or any other organization mentioned herein.
EDITOR’S NOTE

The Editor invites from contributors outside the IMF brief comments (not more than 1,000 words) on published articles in *IMF Staff Papers*. These comments should be addressed to the Editor, who will forward them to the author of the original article for reply. Both the comments and the reply will be considered for publication.

The data underlying articles published in *IMF Staff Papers* (where available) may be obtained from the journal’s website (www.palgrave-journals.com/imfsp). Readers are invited to use these data to expand on the material in the articles, and the journal will consider publishing such work.

© 2009 by the International Monetary Fund
ISBN 978-1-58906-795-0
International Standard Serial Number: ISSN 1020-7635

This serial publication is catalogued as follows:

International Monetary Fund

*IMF staff papers — International Monetary Fund. v. 1– Feb. 1950–[
Washington] International Monetary Fund.*

v. tables, diagrs. 26 cm.

Three no. a year, 1950–1977; four no. a year, 1978–

Indexes:

ISSN 1020-7635 — *IMF staff papers — International Monetary Fund.*
1. Foreign exchange—Periodicals. 2. Commerce—Periodicals.

HG3810.15 332.082 53-35483

©International Monetary Fund. Not for Redistribution
Contents

The Dynamics of Provincial Growth in China: A Nonparametric Approach
Bulent Unel and Harm Zebregs • 239

Central Bank Autonomy: Lessons from Global Trends
Marco Amone, Bernard J. Laurens, Jean-François Segalotto, and Martin Sommer • 263

Do Unit Value Export, Import, and Terms-of-Trade Indices Misrepresent Price Indices?
Mick Silver • 297

Why Has the Grass Been Greener on One Side of Hispaniola?
A Comparative Growth Analysis of the Dominican Republic and Haiti
Laura Jaramillo and Cemile Sancak • 323

Special Section
Global Reach? Perspectives on U.S. International Spillovers

Introduction
John Lipsky • 350

Foreign Entanglements: Estimating the Source and Size of Spillovers Across Industrial Countries
Tamim Bayoumi and Andrew Swiston • 353

Yen Carry Trade and the Subprime Crisis
Masazumi Hattori and Hyun Song Shin • 384

Rhyme or Reason: What Explains the Easy Financing of the U.S. Current Account Deficit?
Ravi Balakrishnan, Tamim Bayoumi, and Volodymyr Tulin • 410

©International Monetary Fund. Not for Redistribution
This page intentionally left blank
The Dynamics of Provincial Growth in China: A Nonparametric Approach

BULENT UNEL and HARM ZEBREGS*

China’s growth performance since the start of economic reforms in 1978 has been impressive, but the gains have not been distributed equally across provinces. We use a nonparametric approach to analyze the variation in labor productivity growth across China’s provinces. This approach imposes less structure on the data than the standard growth accounting framework and allows for a breakdown of labor productivity into efficiency gains, technological progress, and capital deepening. We have the following results. First, we find that on average capital deepening accounts for about 75 percent of total labor productivity growth, while efficiency and technological improvements account for about 7 and 18 percent, respectively. Second, technical change is not neutral. Third, whereas improvement in efficiency contributes to convergence in labor productivity between provinces, technical change contributes to productivity disparity across provinces. Finally, we find that foreign direct investment has a positive and significant effect on efficiency growth and technical progress. [JEL O1, O2, O3, O4, O53, P2]


*Bulent Unel is a professor in the Department of Economics at Louisiana State University. Harm Zebregs is a senior economist in the European Department of the IMF. This paper is a significantly revised version of the authors’ IMF working paper (Unel and Zebregs, 2006). The authors are grateful to Doug McMillin, two anonymous referees, and the editor, Robert Flood, for their insightful comments. They also thank Wolfgang Keller and the China division of the IMF for helping to collect and construct the data.
Since the start of economics reforms in 1978, China’s growth record has been impressive, but the contribution of its provinces to per capita income growth has been highly uneven. (See, for example, Dayal-Gulati and Husain, 2002 and Aziz and Duenwald, 2003.) Although average annual growth of real per capita GDP has picked up across all regions, coastal provinces have tended to grow faster than northern and western provinces. According to Aziz and Duenwald (2003), real GDP per capita in coastal provinces, such as Fujian, Guangdong, and Zhejiang, grew at an average annual rate of twice that of western provinces, such as Gansu, Ningxia, and Qinghai, during 1978–97. The dispersion of growth rates has not been purely a reflection of different stages of development. Indeed, among the initially poorer provinces those in the west have fallen further behind, while those on or near the coast have caught up with or even surpassed provinces that had the highest per capita incomes at the start of economic reforms. This uneven performance has been reflected in a growing income disparity across regions, posing a key challenge to policymakers in Beijing.

Several studies investigating the differences in economic performance across China’s provinces conclude no tendency toward absolute convergence in terms of real per capita GDP over the past two and a half decades. Bell, Khor, and Kochhar (1993) and Jian, Sachs, and Warner (1996) find that income dispersion has declined between 1981 and 1990 as poorer provinces tended to grow faster than richer ones. When the sample period is extended, this result does not hold. The absence of absolute convergence among China’s provinces is in contrast with the behavior of U.S. states, Japanese prefectures, and selected regions in western Europe, where absolute convergence appears to be the norm rather than the exception over extended periods of time (Barro and Sala-i-Martin, 2004).

However, there is evidence of conditional convergence, with provinces converging to unique steady states distinguished by structural factors and preferential economic policies, which have been part of China’s dual-track approach to economic reforms. Démurger and others (2002) find that, after controlling for openness and proximity to fast-growing economies in East Asia, growth in coastal provinces benefits significantly from preferential policies, which have fostered marketization and internationalization. Dayal-Gulati and Husain (2002) show that the prevalence of state-owned enterprises and a high ratio of bank loans-to-deposits—an indication of large directed lending—are often associated with lower growth. They also find that the coastal and north/northeastern regions were able to attract more foreign direct investment (FDI) because of their relative prosperity and more developed infrastructure, which contributed to the high growth rates of these regions.

Previous studies explore the dynamics of provincial growth using the augmented Solow model. However, in this paper, we examine the evolution of three components of labor productivity growth: efficiency gains (movements toward the production frontier), technological progress (outward shifts of the production frontier), and capital deepening (movements along
the production frontier). This decomposition allows us to investigate how the dynamics of each component affect the growing income disparity across provinces.

For our analysis we use a nonparametric technique known as Data Envelopment Analysis (DEA), pioneered by Farrell (1957) and Afriat (1972). For a given date in our sample period, we construct a production frontier for China as a whole using all observed input-output combinations at the provincial level. The inputs are capital and labor, and the output is GDP. After identifying the frontier, we can measure the efficiency level of each province with respect to the frontier. Having determined the evolution of capital-labor ratios and efficiency indices for each province, we can derive the contribution of technological progress to labor productivity growth in each province.

Using DEA has several advantages over standard growth accounting. First, in this approach the production frontier is directly constructed from the data. Hence, we do not have to impose any restrictions other than a functional form that satisfies a constant returns to scale technology. Second, our approach allows us to identify separately the contributions of efficiency and technological improvements to productivity growth. Finally, our approach does not impose any kind of structure on markets, whereas in the standard growth accounting framework it is assumed that markets are competitive. This assumption is possibly critical in the case of China, where government regulation of markets is still extensive.

Our results can be summarized as follows. First, labor productivity growth in China’s provinces has largely been driven by capital deepening. In particular, we find that on average capital deepening accounts for about 75 percent of total labor productivity growth, whereas efficiency and technological improvements account for about 7 and 18 percent, respectively. The capital deepening is also the driving factor behind the changes in the distributional dynamics of the labor productivity over the past two decades. Second, technical change is not (Hicks) neutral. Third, while improvement in efficiency supports convergence in labor productivity between provinces, technical change contributes to productivity disparity across provinces. Finally, we find that FDI has a positive and significant effect on efficiency growth and technical progress.

This paper is related to a growing literature that develops a link between the DEA literature and the convergence literature. Key studies are Färe and others (1994), Kumar and Russell (2002), Henderson and Russell (2005), and Henderson, Tochkov, and Badunenko (2007). Färe and others were the first to use DEA to analyze the productivity growth in 17 OECD countries, and Kumar and Russell extend the work of Färe and others in a novel way to the tripartite decomposition to analyze the productivity performance across 57 countries. Henderson and Russell extend the Kumar and Russell analysis by incorporating human capital. Our approach is similar to that of Kumar and Russell, except that in constructing the production possibility frontier at time $t$ we follow Diewert (1980) by using all data available up to time $t$, rather
than just the observations at time \( t \). This modification prevents technology from regressing, an undesirable feature in the findings of Kumar and Russell. Henderson and Russell also employ the method suggested by Diewert. However, owing to lack of data on human capital, they focus on two time periods, 1965 and 1990, and changes over this 25-year interval. Thus, in constructing the production frontier in 1990, they use only the base year and the final year data, which makes the frontier less precise.

The study most relevant to our work is Henderson, Tochkov, and Badunenko (2007). They also use the Kumar and Russell (2002) decomposition to analyze provincial growth in China between 1978 and 2000. Their findings are similar to ours: (1) capital accumulation is the prime factor behind the growth performance of Chinese provinces, (2) technical change is not neutral, and (3) technical progress is responsible for disparity across provinces. In addition, they find that human capital is another important factor responsible for divergence across provinces.

However, there are differences between our paper and Henderson, Tochkov, and Badunenko (2007). When we investigate the relationship between the growth rates of the three components of labor productivity growth and the initial level of labor productivity, we also consider other possibly important factors (such as geography, and domestic and foreign investments). When we control for these additional factors, we find that there is support for conditional convergence in output per worker. More interestingly, we find that FDI has a positive and significant effect on efficiency growth and technical progress. On the other hand, Henderson, Tochkov, and Badunenko consider human capital accumulation, whereas we do not. But, incorporating human capital into their analysis does not come without concessions. Data on human capital are available for only three years; consequently, they construct their frontiers using only a few past observations as in Henderson and Russell (2005).

I. A Glimpse of Productivity in China

Table 1 reports summary statistics for labor productivity between 1978 and 1998. Hainan and Tibet Autonomous Region were excluded for lack of data on value-added and fixed-capital investment. The sample is restricted to the period of 1978–98, owing to lack of comparable labor data for recent years. More detailed information about data sources and the construction of variables is provided in Appendix I.

1We are indebted to an anonymous referee for bringing these studies to our attention, especially Henderson, Tochkov, and Badunenko (2007), which was independently written after this paper.

2Furthermore, in constructing human capital they assume that the rate of return to schooling is the same across all provinces and that this return is equal to the average rate of return to education from the Psacharopoulos (1994) world sample. We believe that rates of return to schooling are not the same across provinces and that the returns are different from the rates in Psacharopoulos.
It is interesting to look at the dynamics of productivity change across provinces. All provinces record increases in labor productivity between 1978 and 1998. The average annual growth rate for all provinces is 7.2 percent over this period, but productivity performances vary substantially between subsets of provinces. While labor productivity in the coastal provinces of Fujian, Guangdong, Jiangsu, and Zhejiang grows at an annual rate of about 10 percent, labor productivity in the landlocked provinces of Heilongjiang,

Table 1. Descriptive Statistics for Labor Productivity, 1978–98

<table>
<thead>
<tr>
<th>Province</th>
<th>$y_{1978}$</th>
<th>$y_{1998}$</th>
<th>$g_y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>2,451</td>
<td>10,806</td>
<td>7.4</td>
</tr>
<tr>
<td>Tianjin</td>
<td>2,254</td>
<td>9,564</td>
<td>7.2</td>
</tr>
<tr>
<td>Hebei</td>
<td>868</td>
<td>4,049</td>
<td>7.7</td>
</tr>
<tr>
<td>Shanxi</td>
<td>912</td>
<td>3,392</td>
<td>6.6</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>889</td>
<td>3,619</td>
<td>7.0</td>
</tr>
<tr>
<td>Liaoning</td>
<td>1,828</td>
<td>6,247</td>
<td>6.1</td>
</tr>
<tr>
<td>Jilin</td>
<td>1,270</td>
<td>4,213</td>
<td>6.0</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>1,736</td>
<td>4,404</td>
<td>4.7</td>
</tr>
<tr>
<td>Shanghai</td>
<td>3,907</td>
<td>19,367</td>
<td>8.0</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>897</td>
<td>7,300</td>
<td>10.5</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>689</td>
<td>5,906</td>
<td>10.7</td>
</tr>
<tr>
<td>Anhui</td>
<td>608</td>
<td>2,644</td>
<td>7.3</td>
</tr>
<tr>
<td>Fujian</td>
<td>718</td>
<td>5,358</td>
<td>10.0</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>694</td>
<td>2,942</td>
<td>7.2</td>
</tr>
<tr>
<td>Shandong</td>
<td>759</td>
<td>3,864</td>
<td>8.1</td>
</tr>
<tr>
<td>Henan</td>
<td>580</td>
<td>2,618</td>
<td>7.5</td>
</tr>
<tr>
<td>Hubei</td>
<td>790</td>
<td>4,433</td>
<td>8.6</td>
</tr>
<tr>
<td>Hunan</td>
<td>645</td>
<td>2,292</td>
<td>6.3</td>
</tr>
<tr>
<td>Guangdong</td>
<td>817</td>
<td>6,402</td>
<td>10.3</td>
</tr>
<tr>
<td>Guangxi</td>
<td>521</td>
<td>1,974</td>
<td>6.7</td>
</tr>
<tr>
<td>Sichuan</td>
<td>580</td>
<td>2,323</td>
<td>6.9</td>
</tr>
<tr>
<td>Guizhou</td>
<td>442</td>
<td>1,474</td>
<td>6.0</td>
</tr>
<tr>
<td>Yunnan</td>
<td>526</td>
<td>1,981</td>
<td>6.6</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>754</td>
<td>2,677</td>
<td>6.3</td>
</tr>
<tr>
<td>Gansu</td>
<td>933</td>
<td>2,248</td>
<td>4.4</td>
</tr>
<tr>
<td>Qinghai</td>
<td>1,074</td>
<td>2,397</td>
<td>4.0</td>
</tr>
<tr>
<td>Ningxia</td>
<td>959</td>
<td>2,849</td>
<td>5.4</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>794</td>
<td>4,007</td>
<td>8.1</td>
</tr>
<tr>
<td>Mean</td>
<td>1,068</td>
<td>4,691</td>
<td>7.2</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>752</td>
<td>3,662</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Sources: State Statistical Bureau; China Statistical Yearbook, various issues; and authors’ calculations.

Note: This table reports labor productivity (output per worker) in 1978 and 1998 and its average annual growth rate between 1978 and 1998 for provinces in China.
Gansu, and Qinghai grows at an average annual rate of only 4 to 5 percent. In 1978, the coastal provinces are on average less productive than the landlocked provinces. In a ranking of provinces by level of labor productivity in 1978, with the most productive province at rank 1, Fujian, Guangdong, and Zhejiang rank 17th, 12th, and 16th, respectively, and Qinghai and Gansu rank 8th and 10th, respectively. However, the coastal provinces did not just catch up with the initially more productive landlocked provinces, they surpassed them: by 1998, Fujian, Guangdong, and Zhejiang rank 8th, 5th, and 7th, respectively, and Qinghai and Gansu rank 22nd and 25th, respectively. Although the difference in average growth rates between these two groups of provinces is consistent with their initial levels of labor productivity, there is no convergence in the mean across China as a whole.3

To provide a better understanding of the dynamics, in Figures 1a and 1b we plot the (kernel) distributions of productivity levels in 1978 and 1998.4 In both years, the distribution across provinces is multimodal.5 However, the shape of the distribution has changed over the past two decades. First, in both years, most provinces were clustered around a low productivity level. However, in 1998 the low productivity cluster had become considerably flatter, encapsulating the two intermediate clusters in the 1978 distribution. The result is a more bimodal distribution. Moreover, the mean of the low productivity cluster is higher in 1998, suggesting an increase in average productivity. Second, the peaks are farther apart in 1998 than in 1978, which suggests that although average output per worker has increased over our sample period, the distribution of income across provinces has become more uneven. Our purpose is to identify the factors that are responsible for this change in the overall distribution. But first, we need to introduce a basic framework to analyze this problem.

II. Basic Framework

We begin by constructing production sets (and frontiers). As discussed in the Introduction, our approach to constructing production sets is data-driven. Roughly speaking, we define the production set at time t as the smallest convex set that envelops all available data at time t. The boundary of this set will represent the production frontier. Figure 2 illustrates how the frontier is constructed when there are three input-output combinations A, B, and C. In this figure, the single output, y, is produced from the single input, k, and the production frontier, f(k), that characterizes the boundary of the production

---

3We formally tested for absolute convergence in labor productivity across provinces by running the regression \( g'_{y} = \beta_{0} + \beta_{1} \ln(y_{1978}) + \varepsilon \), where \( g'_{y} \) denotes the average annual growth rate of labor productivity of province \( y \) between 1978 and 1998 and \( \varepsilon \) is the associated error term. The estimate of \( \beta_{1} \) is −0.0038 and is insignificant with a standard error of 0.0047.

4More information on the construction of kernel distributions is provided in Appendix II.

5This is in line with Aziz and Duenwald (2003) and Henderson, Tochkov, and Badunenko (2007).
set exhibits nonincreasing returns to scale. Points $A$ and $B$ are on the frontier, whereas point $C$ is in the interior of the production set (hence, it is inefficient).

More formally, we construct the production frontier as follows. Let $f(k)$ be a nonincreasing returns to scale (NIRS) production function that gives the maximum amount $f_t(k_t)$ of output per worker that can be produced using $k_t$. 

Sources: State Statistical Bureau; China Statistical Yearbook, various issues; and authors’ calculations.

Note: These figures plot the distributions of labor productivity (output per worker) levels in 1978 and 1998. These estimated (kernel) distributions are constructed from observed data.
amount of capital per worker. Then, the production set is constructed from the data as follows.

\[ P_t = \left\{ \left( k_t, y_t \right)^t \in \mathbb{R}^2_+ : y_t \leq \sum_{\tau \leq t} \sum_{i} \theta_{i\tau}^t y_{i\tau}^t, \sum_{\tau \leq t} \sum_{i} \theta_{i\tau}^t k_{i\tau}^t \leq k_t, \theta_{i\tau}^t \geq 0, \right\} \]

where \( \theta_{i\tau}^t \) represents "weights" and \( \left( k_{i\tau}^t, y_{i\tau}^t \right)^t \) represents the intensive form of the input-output vector of province \( i \) at time \( \tau \). As Kumar and Russell (2002) noted, this construction implies that each point in the production set is either a linear combination of observed points or a point dominated by a linear combination of observed points. By imposing the restriction \( \sum_{\tau \leq t} \sum_{i} \theta_{i\tau}^t \leq 1 \), we make the production technology exhibit NIRS (Afriat, 1972). Note that this production technology also

---

6In fact, we have two inputs, capital, \( K \), and labor, \( L \), and the single output \( Y \). The production frontier is characterized by a constant returns to scale (CRS) production function \( F_t \). Because \( F \) is a CRS production function, \( Y_t = F_t(K_t, L_t) \) can be written as \( y_t = f_t(k_t) \), where \( k_t = K_t/L_t \) and \( y_t = Y_t/L_t \). Note that in this case, \( f_t(\cdot) \) exhibits nonincreasing returns to scale.

7For excellent discussions of the construction of production frontiers and DEA, see Farrell (1957), Afriat (1972), and Färe, Grosskopf, and Lovell (1994). In particular, Färe, Grosskopf, and Lovell give a comprehensive account of various extensions of DEA.
satisfies the free-disposal condition that inputs and output can be disposed of at no cost.

It is important to emphasize that in constructing the frontier we follow Diewert (1980) in that we use all available data up to time $t$. This approach is different from the one developed by Kumar and Russell (2002) and Färe and others (1994), who construct the frontier by using only the input-output data observed at time $t$. We incorporated previous observations to prevent the possibility of an implosion of the technological frontier over time.\(^8\)

For a given point $(k_t, y_t)$ in the production set, we define the output-based (or Farrell) efficiency function as follows:

$$E_t(k_t, y_t) = \min \{ \lambda : (k_t, y_t/\lambda) \in \mathcal{P}_t \}. \quad (2)$$

This function is defined as the inverse of the maximum proportional amount that labor productivity $y_t$ can be expanded, while remaining in the production set $\mathcal{P}_t$, given the capital intensity $k_t$. For each province $i$, the efficiency index $\lambda^*_i$ at time $t$ is then calculated by solving a linear programming (LP) problem based on Equation (2) (see Färe, Grosskopf, and Lovell, 1994). Having calculated the efficiency indices, we can decompose productivity growth into efficiency, technological change, and capital deepening components, as in Kumar and Russell (2002).

To illustrate the decomposition of output per worker, Figure 3 depicts two production sets for time periods $s$ and $t$, with $s < t$. Points $(k_s, y_s)$ and $(k_t, y_t)$ represent the input-output combinations of the same economy in periods $s$ and $t$, respectively. Note that these observed input-output combinations are in the interiors of the corresponding production sets; hence, they are inefficient. Given $k_s$ units of input, under the production technology available at time $s$, this economy can produce at most $f_s(k_s) = y_s/\lambda_s$ units of output, where $\lambda_s$ is the efficiency index for the observed production. Similarly, when the input level is $k_t$, the maximum amount of output that can be produced under the production technology available at time $t$ is $f_t(k_t) = y_t/\lambda_t$, where $\lambda_t$ is the efficiency index for the observed production in period $t$. The combination of these two observations yields

$$\frac{y_t}{y_s} = \frac{\lambda_t \times f_t(k_t)}{\lambda_s \times f_s(k_s)}. \quad (3)$$

Multiplying the numerator and denominator on the right-hand side by $f_s(k_t)$, which is the maximum output that can be produced with input level $k_t$ under the first-period production technology, and rearranging

---

\(^8\)Nothing suggests that China has experienced a decline in its technological knowledge since it started economic reforms. Hence, the technology that was available at date $t$ was at least as advanced as the technology available at date $s < t$. However, our method is data-driven and by not including previous observations it could produce an estimate of the production set at date $t$, that does not include all the elements in the production set at date $s < t$. 

©International Monetary Fund. Not for Redistribution
The left-hand side of this equation represents the change in output per worker between periods \( s \) and \( t \). The first term on the right-hand side represents the change in the efficiency index over these two periods. The second term represents the shift in the production frontier at capital intensity \( k_t \). The last term represents the change in maximum output per worker owing to the change in capital intensity between the two periods. Thus, identity (4) decomposes labor productivity into three components: change in the efficiency index, change in technology, and change in capital intensity. Note that this is not the only way to decompose output per worker. Considering again Equation (3), multiplying the numerator and denominator on the right-hand side by \( f_s(k_s) \), which is the maximum output that can be produced with input level \( k_s \) under the second-period production technology, and rearranging terms we get

\[
\frac{y_t}{y_s} = \frac{\lambda_t}{\lambda_s} \cdot \frac{f_t(k_t)}{f_s(k_t)} \cdot \frac{f_s(k_t)}{f_s(k_s)},
\]

(4)

where each term on the right-hand side is interpreted in the same way as in Equation (4). Note that unless the production technology \( F \) is Hicks-neutral, there is no reason to expect that \( f_t(k_t)/f_s(k_s) \) equals \( f_t(k_s)/f_s(k_t) \). Hence, we
have two different representations of technical change (and of the change in potential output owing to the change in capital intensity, which is the third term in Equations (4) and (5)). Following Färe and others (1994) and Kumar and Russell (2002), we avoid having two arbitrary decompositions of output per worker by considering the geometric mean of the right-hand sides of Equations (4) and (5):

\[
\frac{y_t}{y_s} = \frac{\lambda_t}{\lambda_s} \times \left( \frac{f_t(k_t)}{f_s(k_t)} \right)^{1/2} \times \left( \frac{f_t(k_s)}{f_s(k_s)} \right)^{1/2} \times \left( \frac{f_t(k_s)}{f_t(k_s)} \right)^{1/2}. \tag{6}
\]

Taking the logarithms of both sides of Equation (6) and dividing by \( t-s \) (number of years between two periods), we have

\[
g_y = g_{eff} + g_{tech} + g_{cap}, \tag{7}
\]

where \( g_y \) represents the average annual growth rate of output per worker, and \( g_{eff} \), \( g_{tech} \), \( g_{cap} \) are the average annual growth rate of the efficiency index, the average annual growth rate of technical progress, and the average annual growth rate of the potential outputs (due to the change in capital intensity) between two periods, respectively. We use identity (7) in reporting our results, and this presentation is different from that in Kumar and Russell (2002), who use identity (6). Our approach seems more appealing than that based on Equation (6), because in this way we present the average annual growth rate of output per worker as the sum of the average annual growth rates of the efficiency index, technical progress, and capital per worker between two periods.

This completes the theoretical framework of our approach. Let us recap briefly what we have introduced in this section. We started with the construction of a production frontier from the observed data. Then we showed how to measure the associated efficiency indices. Finally, we illustrated how, after having calculated the efficiency indices, growth in output per worker can be decomposed into changes in efficiency, technology, and capital intensity.

At this stage, it is important to highlight the important features of this approach and compare this approach with the standard accounting approach. First, the two approaches are conceptually different and this difference comes from the construction of the production frontier and the positions of economies relative to the frontier. Under the nonparametric approach, we construct a countrywide production frontier with most provinces staying below the frontier; in the standard accounting approach, each province is assumed to be on its own frontier and each province’s performance is compared only with its previous-year performance, not with a common benchmark across all provinces. Because we want to compare the relative performance of the provinces, we think that our nonparametric approach is more suitable.

Second, in the standard accounting approach, it is assumed that all observations share a common production function with different shift
parameters called the Solow Residual (or total factor productivity, TFP). More formally, it is usually assumed that the production function is given by $Y_t = A_t F(K_t, L_t)$, where $A$ represents TFP and $F$ is a CRS function. This can further be written in intensive form as $y = A_t f(k_t)$. Consider two observations at dates $s$ and $t$; then we have

$$\frac{y_t}{y_s} = \frac{A_t f(k_t)}{A_s f(k_s)}. \quad (8)$$

Thus, we can decompose the change in output per worker into two components: change in TFP and change in capital-labor ratio. As also noted by Henderson and Russell (2005), a comparison of the right-hand sides of Equations (6) and (8) suggests that the first two components in Equation (6) are roughly encapsulated by the TFP ratio in Equation (8). Thus, our approach allows for the separation of changes in efficiency from technological progress. Decomposing the change in TFP into finer components and investigating their contributions to labor productivity is another important reason for us to use this nonparametric technique.\(^9\)

Third, our nonparametric approach does not impose any kind of structure on markets as the standard accounting approach does. To see this, note that taking the logarithm of both sides in Equation (8), differentiating with respect to time, and rearranging the terms yields

$$g_{Y/L} = g_A + (1 - \varepsilon_L)g_{K/L},$$

where $\varepsilon_L$ is the elasticity of labor with respect to output and $g_X$ denotes the growth rate of the variable $X$. In practice, we do not know the elasticity $\varepsilon_L$. To overcome this difficulty, it is assumed that markets are competitive, which implies that the labor elasticity can be replaced with the share of labor in total output. For advanced countries with considerable market competition, it may be reasonable to use the labor share as a proxy for $\varepsilon_L$, but in the case

\(^9\) Hall and Jones (1999) advocate a different decomposition than Equation (8). They assume that the production function is Cobb-Douglas, $Y = K^{1-\ell} (AL)^\ell$, and rewrite it as $y = Y/L = A(K/Y)^{(1-\ell)/\ell}$. (Notice that here $A$ equals $A^{1/(1-\ell)}$ in Equation (8).) This presentation is more insightful than the standard approach in Equation (8), because it assigns the long-run effects of changes in capital and TFP entirely to those variables. Consider two observations at dates $s$ and $t$, then their decomposition yields:

$$\frac{y_t}{y_s} = A_t \left( \frac{K_t/Y_t}{K_s/Y_s} \right)^{\frac{1-\ell}{\ell}}. \quad (9)$$

This decomposition is not really comparable to our decomposition in Equation (6), because it contains the capital-output ratio rather than the capital-labor ratio as a measure of capital deepening. However, when we use this decomposition to analyze change in output per worker between 1978 and 1998 in each province, we find that the contribution from the capital-output ratio to output per worker is relatively small (usually less than 20 percent; the results are available upon request). Because the contribution to labor productivity growth from the change in the capital-output ratio is relatively small, a comparison of Equation (6) and the Hall and Jones decomposition implies that the TFP in the Hall and Jones decomposition very roughly encompasses all three components of Equation (6).
of China, where many product and factor markets remain heavily regulated, this is obviously more problematic. DEA therefore seems a more suitable approach for analyzing productivity growth in China’s provinces than the above accounting framework.10

Finally, in the standard accounting approach, calculation of TFP levels requires certain restrictions on the production function. Klenow and Rodriguez-Clare (1997) and Hall and Jones (1999), for example, assume that the production function is Cobb-Douglas, which further implies that technological progress is Hicks-neutral. In our analysis, we do not impose any restriction (other than the CRS assumption) on the shape of the production function, and hence, no restriction on the type of technical change. Indeed, our analysis in the next section suggests that technological progress is not Hicks-neutral.

These appealing features do not come without some limitations. First, the production frontier is constructed from the data and consequently it is defined relative to the best technology of the provinces in our sample. Thus, this frontier may be below the true frontier, which in turn implies that the efficiency indices represent lower bounds of the true inefficiencies. Second, our approach is deterministic and it does not take into account possible measurement errors. These measurement errors can change the shape of the frontier, which can further affect each component of the tripartite decomposition. In this case, the direction of bias in each component can go either way. There is an alternative technique, known as the stochastic frontier approach, to calculate the efficiency indices under possible measurement errors. We did not consider this approach in our study because its implementation imposes additional restrictions on the functional form of the frontier and error terms.

III. Results

Table 2 reports summary statistics for efficiency.11 We note that Heilongjiang, Jiangsu, and Shanghai have efficiency indices of 1 in 1978.12 This result implies that 25 provinces are below the technology frontier. Figure 4a illustrates the positions of the provinces relative to the technology frontier.

---

10We were confronted with two additional problems. First, for most of the provinces we did not have data on labor compensation. Second, for the provinces where data were available, the labor shares were very small, an issue that was also noted by Young (2003). It is clear from the above equation that using small labor shares would exaggerate the contribution of the capital-labor ratio to labor productivity growth.

11These results differ somewhat from those in Unel and Zebregs (2006), because here capital stocks are constructed using longer investment series, which makes estimates more reliable (see Appendix I).

12The efficiency indices are calculated by solving the corresponding linear programming problem for 1978 and 1998. In 1978 we have only 28 observations. In 1998, however, we have 588 observations (28 for each year over 21 years).
frontier in 1978 and suggests considerable dispersion of production activities.  

The second column of Table 2 reports the efficiency indices in 1998. In that year, only Shanghai has an efficiency index of 1. Figure 4b represents the production set and its frontier in 1998. The frontier is shaped by the input-output combinations of Anhui in 1984, Fujian in 1994, and Shanghai in 1985, 1997, and 1998. To clearly show the relative positions of the provinces in 1998, we excluded all other previous observations in the interior of the production set. We note that, compared with Figure 4a, production activities are generally closer to the frontier in 1998 than in 1978. Indeed, the average efficiency index for all provinces increased from 0.686 in 1978 to 0.746 in 1998, while the standard deviation declined from 0.178 to 0.128 over the same period (see also the last column of Table 2). These trends suggest convergence in both the mean and the standard deviation of efficiency indices across provinces over 1978–98. There are two important points to notice in this figure. First, because the input-output combinations of Anhui in 1984, Fujian in 1994, and Shanghai in 1985 and 1997 are on the 1998 frontier, excluding the intermediate years in constructing the frontier, as in Henderson and Russell (2005) and Henderson, Tochkov, and Badunenko (2007), would significantly change the shape of the frontier. Second, technical progress has not shifted the frontier by the same proportion at each capital-labor ratio. For example, between 1994 and 1998 the lower part of the frontier remained the same. This suggests that the technical progress has not been Hicks-neutral.

To determine which factor has played the most significant role in provincial growth dynamics, we now turn to the decomposition of labor productivity into capital deepening, efficiency gains, and technological progress. Table 3 shows the results of this decomposition and the relative contributions of the three factors to productivity growth between 1978 and 1998. Note that average productivity growth is 7.2 percent, of which 5.4 percentage points are accounted for by capital deepening. Thus, about 75 percent of productivity growth across China’s provinces is explained by capital deepening, with technical progress and efficiency changes accounting

---

13Our findings are different from those in Henderson, Tochkov, and Badunenko (2007). They find that only Shanghai is on the frontier. However, this stems from their frontier construction in which they also consider human capital. Hence, \( k = \frac{K}{H} \) and \( y = \frac{Y}{H} \), where \( H \) is the total human capital, in their \((k, y)\) space presentation.

14We have calculated these statistics for each year and we found that Shanghai always remained on the frontier. These results are available from the authors upon request.

15Similar to the labor productivity case, to test for absolute convergence in efficiency across provinces we run the regression \( g_i^e = \beta_0 + \beta_1 \ln(l_{1978}) + e \), where \( g_i^e \) denotes the average annual growth rate of efficiency index of province \( i \) between 1978 and 1998 and \( e \) is the associated error term. The estimate of \( \beta_1 \) is \(-0.0243\) and is significant with a standard error of 0.0042, supporting our contention of absolute convergence in efficiency indices.
The high contribution of capital accumulation to labor productivity growth is consistent with the standard growth accounting studies of the sources of overall GDP growth in China (Chow and Li, 1999; and Heytens and Zebregs, 1999).

16This conclusion remains broadly the same for subperiods. Between 1978 and 1990, for example, about 78 percent of countrywide productivity growth is explained by capital deepening. Contributions of technical progress and efficiency changes, on the other hand, are about 13 and 9 percent, respectively. These results are available from the authors upon request.

Sources: State Statistical Bureau; China Statistical Yearbook, various issues; The Gross Domestic Product of China, 1952–95; and authors’ calculations.

Note: These figures represent production sets and their frontiers in 1978 and 1998, respectively. Output per worker, \( y \), is produced with capital per worker, \( k \), and the production frontier is the boundary of the smallest convex set that envelops all available data. Any observed input-output combination below a frontier is inefficient.

Figure 4. Production Sets and Frontiers in 1978 and 1998

```
Sources: State Statistical Bureau; China Statistical Yearbook, various issues; The Gross Domestic Product of China, 1952–95; and authors’ calculations.

Note: These figures represent production sets and their frontiers in 1978 and 1998, respectively. Output per worker, \( y \), is produced with capital per worker, \( k \), and the production frontier is the boundary of the smallest convex set that envelops all available data. Any observed input-output combination below a frontier is inefficient.
```
2003), and with studies of the sources of GDP growth in other East Asian economies (Young, 1995).

Although on average most of the productivity improvement is attributable to capital deepening, provincial-level decompositions show some different trends. We find, for example, that the relative contribution of capital deepening to average annual labor productivity growth in

<table>
<thead>
<tr>
<th>Province</th>
<th>$\lambda_{1978}$</th>
<th>$\lambda_{1998}$</th>
<th>$g_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>0.969</td>
<td>0.894</td>
<td>−0.4</td>
</tr>
<tr>
<td>Tianjin</td>
<td>0.843</td>
<td>0.859</td>
<td>0.1</td>
</tr>
<tr>
<td>Hebei</td>
<td>0.687</td>
<td>0.759</td>
<td>0.5</td>
</tr>
<tr>
<td>Shanxi</td>
<td>0.517</td>
<td>0.637</td>
<td>1.0</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>0.594</td>
<td>0.671</td>
<td>0.6</td>
</tr>
<tr>
<td>Liaoning</td>
<td>0.918</td>
<td>0.794</td>
<td>−0.7</td>
</tr>
<tr>
<td>Jilin</td>
<td>0.710</td>
<td>0.758</td>
<td>0.3</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>1.000</td>
<td>0.732</td>
<td>−1.6</td>
</tr>
<tr>
<td>Shanghai</td>
<td>1.000</td>
<td>1.000</td>
<td>0.0</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>1.000</td>
<td>0.906</td>
<td>−0.5</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>0.658</td>
<td>0.865</td>
<td>1.4</td>
</tr>
<tr>
<td>Anhui</td>
<td>0.859</td>
<td>0.754</td>
<td>−0.7</td>
</tr>
<tr>
<td>Fujian</td>
<td>0.723</td>
<td>0.949</td>
<td>1.4</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>0.601</td>
<td>0.761</td>
<td>1.2</td>
</tr>
<tr>
<td>Shandong</td>
<td>0.778</td>
<td>0.782</td>
<td>0.0</td>
</tr>
<tr>
<td>Henan</td>
<td>0.585</td>
<td>0.694</td>
<td>0.9</td>
</tr>
<tr>
<td>Hubei</td>
<td>0.654</td>
<td>0.846</td>
<td>1.3</td>
</tr>
<tr>
<td>Hunan</td>
<td>0.826</td>
<td>0.804</td>
<td>−0.1</td>
</tr>
<tr>
<td>Guangdong</td>
<td>0.611</td>
<td>0.871</td>
<td>1.8</td>
</tr>
<tr>
<td>Guangxi</td>
<td>0.576</td>
<td>0.723</td>
<td>1.1</td>
</tr>
<tr>
<td>Sichuan</td>
<td>0.437</td>
<td>0.645</td>
<td>1.9</td>
</tr>
<tr>
<td>Guizhou</td>
<td>0.460</td>
<td>0.534</td>
<td>0.7</td>
</tr>
<tr>
<td>Yunnan</td>
<td>0.443</td>
<td>0.563</td>
<td>1.2</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>0.500</td>
<td>0.559</td>
<td>0.6</td>
</tr>
<tr>
<td>Gansu</td>
<td>0.573</td>
<td>0.631</td>
<td>0.5</td>
</tr>
<tr>
<td>Qinghai</td>
<td>0.541</td>
<td>0.558</td>
<td>0.2</td>
</tr>
<tr>
<td>Ningxia</td>
<td>0.590</td>
<td>0.641</td>
<td>0.4</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>0.541</td>
<td>0.697</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.686</td>
<td>0.746</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Std. Dev.</strong></td>
<td>0.178</td>
<td>0.127</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Sources: State Statistical Bureau; China Statistical Yearbook, various issues; The Gross Domestic Product of China, 1952–95; and authors’ calculations.

Note: This table reports efficiency indices in 1978 and 1998, and their average annual growth rate between 1978 and 1998 for provinces in China. The efficiency index is calculated as a relative distance to the production frontier constructed in $(k, y)$ space.
Heilongjiang, Anhui, Hunan, and Shandong during 1978–98 is at least 90 percent, whereas it is less than 65 percent in Beijing, Tianjin, Sichuan, and Shanghai. We also see that while technical progress has been an important driver of productivity growth in Beijing, Tianjin, Liaoning, Heilongjiang, and

<table>
<thead>
<tr>
<th>Province</th>
<th>Productivity Growth $g_p$</th>
<th>Change in Efficiency $g_{eff}$</th>
<th>Change in Technology $g_{tech}$</th>
<th>Capital Deepening $g_{cap}$</th>
<th>Relative Contribution of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>7.4</td>
<td>-0.4</td>
<td>3.2</td>
<td>4.6</td>
<td>-5.4</td>
</tr>
<tr>
<td>Tianjin</td>
<td>7.2</td>
<td>0.1</td>
<td>3.0</td>
<td>4.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Hebei</td>
<td>7.7</td>
<td>0.5</td>
<td>1.0</td>
<td>6.2</td>
<td>6.5</td>
</tr>
<tr>
<td>Shanxi</td>
<td>6.6</td>
<td>1.0</td>
<td>1.0</td>
<td>4.6</td>
<td>15.9</td>
</tr>
<tr>
<td>Inner</td>
<td>7.0</td>
<td>0.6</td>
<td>1.0</td>
<td>5.4</td>
<td>8.7</td>
</tr>
<tr>
<td>Mongolia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liaoning</td>
<td>6.1</td>
<td>-0.7</td>
<td>2.0</td>
<td>4.8</td>
<td>-11.8</td>
</tr>
<tr>
<td>Jilin</td>
<td>6.0</td>
<td>0.3</td>
<td>1.1</td>
<td>4.6</td>
<td>5.5</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>4.7</td>
<td>-1.6</td>
<td>1.3</td>
<td>4.9</td>
<td>-33.5</td>
</tr>
<tr>
<td>Shanghai</td>
<td>8.0</td>
<td>0.0</td>
<td>4.3</td>
<td>3.7</td>
<td>0.0</td>
</tr>
<tr>
<td>Jiangsu</td>
<td>10.5</td>
<td>-0.5</td>
<td>2.1</td>
<td>8.9</td>
<td>-4.7</td>
</tr>
<tr>
<td>Zhejiang</td>
<td>10.7</td>
<td>1.4</td>
<td>1.7</td>
<td>7.6</td>
<td>12.7</td>
</tr>
<tr>
<td>Anhui</td>
<td>7.3</td>
<td>-0.7</td>
<td>0.7</td>
<td>7.3</td>
<td>-8.9</td>
</tr>
<tr>
<td>Fujian</td>
<td>10.0</td>
<td>1.4</td>
<td>1.2</td>
<td>7.4</td>
<td>13.5</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>7.2</td>
<td>1.2</td>
<td>0.6</td>
<td>5.5</td>
<td>16.3</td>
</tr>
<tr>
<td>Shandong</td>
<td>8.1</td>
<td>0.0</td>
<td>0.9</td>
<td>7.2</td>
<td>0.3</td>
</tr>
<tr>
<td>Henan</td>
<td>7.5</td>
<td>0.9</td>
<td>0.6</td>
<td>6.0</td>
<td>11.3</td>
</tr>
<tr>
<td>Hubei</td>
<td>8.6</td>
<td>1.3</td>
<td>1.0</td>
<td>6.3</td>
<td>14.9</td>
</tr>
<tr>
<td>Hunan</td>
<td>6.3</td>
<td>-0.1</td>
<td>0.7</td>
<td>5.7</td>
<td>-2.1</td>
</tr>
<tr>
<td>Guangdong</td>
<td>10.3</td>
<td>1.8</td>
<td>1.8</td>
<td>6.7</td>
<td>17.2</td>
</tr>
<tr>
<td>Guangxi</td>
<td>6.7</td>
<td>1.1</td>
<td>0.7</td>
<td>4.9</td>
<td>17.1</td>
</tr>
<tr>
<td>Sichuan</td>
<td>6.9</td>
<td>1.9</td>
<td>0.6</td>
<td>4.4</td>
<td>28.1</td>
</tr>
<tr>
<td>Guizhou</td>
<td>6.0</td>
<td>0.7</td>
<td>0.6</td>
<td>4.7</td>
<td>12.4</td>
</tr>
<tr>
<td>Yunnan</td>
<td>6.6</td>
<td>1.2</td>
<td>0.6</td>
<td>4.8</td>
<td>18.1</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>6.3</td>
<td>0.6</td>
<td>0.8</td>
<td>4.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Gansu</td>
<td>4.4</td>
<td>0.5</td>
<td>0.6</td>
<td>3.3</td>
<td>11.0</td>
</tr>
<tr>
<td>Qinghai</td>
<td>4.0</td>
<td>0.2</td>
<td>0.6</td>
<td>3.2</td>
<td>3.9</td>
</tr>
<tr>
<td>Ningxia</td>
<td>5.4</td>
<td>0.4</td>
<td>0.5</td>
<td>4.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>8.1</td>
<td>1.3</td>
<td>1.2</td>
<td>5.6</td>
<td>15.7</td>
</tr>
<tr>
<td>Mean</td>
<td>7.2</td>
<td>0.5</td>
<td>1.3</td>
<td>5.4</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Sources: State Statistical Bureau; China Statistical Yearbook, various issues; The Gross Domestic Product of China, 1952–95; and authors’ calculations.

Note: This table shows the decomposition of labor productivity (output per worker) growth, $g_p$, into change in efficiency, $g_{eff}$, change in technology, $g_{tech}$, and capital deepening, $g_{cap}$, so that $g_p = g_{eff} + g_{tech} + g_{cap}$. The last three columns show the relative contributions of these components to productivity growth between 1978 and 1998. Change in efficiency represents movements toward or away from the production frontier over time; technical change measures a shift of the production frontier; and capital deepening represents change in maximum output per worker owing to a change in capital intensity between the two periods.
(in particular) Shanghai, it was not as important as improvements in efficiency in Jiangxi, Guangxi, Sichuan, and Yunnan.

At this point it will be interesting to investigate the effects of each factor on the distributional dynamics of labor productivity. To isolate the effects of changes in efficiency on the initial productivity distribution, we construct counterfactual labor productivity, \( y_E \), in 1998 by multiplying each labor productivity observation in 1978 by the corresponding change in the efficiency index over 1978–98, that is, \( y_E = \left( \lambda_{98}/\lambda_{78} \right) \times y_{78} \).

The kernel distribution of \( y_E \) is shown by the dashed line in Figure 5; notice that this transformation changes the initial shape of the labor productivity distribution a little compared to Figure 1a, but dispersion between the poorer mode and the richer ones remains almost the same. To see the effect of technical progress, we further multiply \( y_E \) by the second term in Equation (6). This effect is illustrated by the solid line in Figure 5. This operation has shifted the distribution slightly to the right and made the middle mode thicker, but the overall shape and dispersion among modes remain mostly unchanged. This analysis shows that capital deepening is also the driving factor for changes in the distributional dynamics of labor productivity. Indeed, if we multiply the second distribution by the last term (that is, capital deepening) in Equation (6), we obtain Figure 1b.

An important remaining question is whether there is any systematic relationship between the growth rates of the three components of labor productivity growth and the initial level of labor productivity. To investigate this, we regress the average annual growth rate of each variable on initial labor productivity along with other variables such as FDI, domestic investment, and geography. Our regressions are different from those in Kumar and Russell (2002) and Henderson, Tochkov, and Badunenko (2007), who only consider the initial level of labor productivity as a regressor. We also consider other factors, because they might have possible effects on the growth rates of the three components.\(^{17}\) For example, the existence of foreign firms may foster competition among domestic firms, which in turn may increase their efficiency. Moreover, foreign firms may help technical progress by

\(^{17}\)One may worry that if these variables can affect efficiency, why are they not included in the production function described in Section I? We must point out that FDI is indeed included in the production function, because the capital stock is constructed from investment data that are the sum of domestic and foreign investment series. The geographical setting, on the other hand, is not included, simply because we do not know how to incorporate the geographical settings into the production function. One possible approach is to divide the sample into two, and construct one production frontier for the coastal provinces, and another for inland provinces; then, we can calculate efficiency indices with respect to each production frontier. This approach, however, is not satisfactory for two reasons. First, each frontier would be constructed using fewer data points, which makes estimates less precise. Second, we want to compare the relative performance of all provinces with respect to a benchmark, and we can achieve this only by constructing a countrywide production frontier.
bringing new technologies to the country. The regression results are presented in Table 4.18

Column 1 in Table 4 represents results where the dependent variable is labor productivity. Here the coastal dummy is significant at the 10 percent level, whereas the FDI-GDP ratio and the initial productivity level are significant at the 5 percent level. The negative and significant coefficient on initial labor productivity supports the conditional convergence hypothesis. There is a positive and significant correlation between FDI and labor productivity growth, which is in line with Zebregs’ (2003) results.

Column 2 shows the results when the dependent variable is the average annual growth rate of the efficiency index. The coefficient on initial productivity is negative and statistically significant. This suggests that improvement in efficiency was higher in initially less advanced provinces than in richer ones, which is consistent with our earlier observation. This together with decomposition (8) implies that improvements in efficiency support convergence across provinces. We also see that FDI had a positive and significant effect on efficiency growth.

The causality may run in the other direction as well. For example, initially more efficient provinces might attract more domestic and foreign investment. The best way to address the second issue is to use an instrumental variables approach. Unfortunately, there is no good instrument to control for this reverse effect.

Source: Authors’ calculations.

Note: This figure shows the effects of changes in efficiency and technology on the distributional dynamics of labor productivity (output per worker). The dashed line represents the distribution of output per worker when only the change in the efficiency index over 1978–98 is considered, that is, change in efficiency \( \times y_{78} \); where \( y_{78} \) is output per worker in 1978. The solid line, on the other hand, represents the combined effects of changes in efficiency and technology, that is, change in technology \( \times \) change in efficiency \( \times y_{78} \).
When we regress changes in technology on the initial productivity level and other control variables, we find that the coefficient on initial productivity is positive and statistically significant (see Table 4, column 3). This suggests that there has been more technical progress in the initially more productive provinces than the less productive provinces. Combined with Equation (8), this further implies that technical change contributes to productivity disparity across provinces. This result supports theories of technological diffusion that conjecture that the cost of adopting new technologies declines with the level of economic development or the abundance of human capital in the receiving location (see, for example, Nelson and Phelps, 1966, and Findlay, 1978). Note that the coefficient of FDI is positive and statistically significant.

The positive and significant effects of FDI on efficiency and technical change reflect increased competition, better management of resources, marketing channels, and new technologies brought by FDI. For example, the technology transfer to production facilities in China by foreign multinationals is now larger than all other forms of domestic technology development (Naughton, 2007). FDI has also played an extremely important role in China’s rapid expansion in world trade. It has, for example, forced an increasing number of domestic manufacturers to compete globally, which has further integrated China into global production (Chen, Chang, and Zhang, 1995).
Finally, column 4 in Table 4 represents results when the dependent variable is the growth rate of capital deepening. The negative and significant coefficient on initial labor productivity suggests that capital deepening was higher in initially less developed provinces.\textsuperscript{19} Surprisingly, neither FDI nor domestic investment had any significant effects on the growth rate of capital deepening.

### IV. Conclusion

We have used a nonparametric approach to decompose labor productivity growth in China’s provinces into three components: efficiency gains, technological progress, and capital deepening. This decomposition has allowed us to investigate the contribution of each of the three factors to productivity growth across provinces. We find that capital deepening is by far the biggest source of labor productivity growth in China’s provinces between 1978 and 1998. Moreover, capital deepening is the prime factor for the change in the dynamics of labor productivity. Whereas improvement in efficiency contributes to convergence in labor productivity between provinces, technical change contributes to productivity disparity across provinces. Finally, we find that FDI has a positive and significant effect on efficiency growth and technical progress.

Improvements in efficiency between 1978 and 1998—especially in the initially least productive provinces, which often had the largest agricultural sectors—are almost certainly a reflection of China’s economic reforms, which have facilitated a profound transformation of the country’s economic structure, including a large reallocation of labor from unproductive farming and state-owned enterprises to more productive industries in the nonstate sector. Positive effects of FDI on efficiency gains and technical change, on the other hand, reflect competition, technology transfers, and a more efficient allocation of resources associated with large FDI inflows.

### APPENDIX I

**Data**

This appendix provides additional information about our data sources and the construction of capital stocks. We obtained provincial-level output (GDP) data from various issues of the *China Statistical Yearbook*.

Labor data reported in the *China Statistical Yearbook* contain large swings and do not take into account the possible changes in employment due to migration between provinces. For example, according to the reported series there was a substantial decline in employment levels from the mid-1980’s onward. We instead used a data set compiled by

\textsuperscript{19}The effects of the initial productivity level on the growth rates of the three components are in line with Kumar and Russell (2002) and Henderson, Tochkov, and Badunenko (2007). Although there is no absolute convergence in labor productivity as in their results, we find that after controlling for other factors there is convergence in labor productivity across provinces.
Young (2000). We found the employment trends of this data set to be quite reasonable: for example, the overall average annual growth rate of employment between 1978 and 1998 was 2.4 percent.

Physical capital is accumulated according to

\[ K_{t+1} = I_t + (1 - \delta)K_t, \quad K_0 > 0, \]

where \( I_t \) and \( K_t \) denote investment and capital stocks, respectively, at time \( t \); \( \delta > 0 \) represents the depreciation rate and \( K_0 \) is the initial capital stock. Thus, to compute capital stocks at time \( t \) we need investment data, depreciation rates, and estimates of initial capital stocks. We compiled investment data from *The Gross Domestic Product of China, 1952–95*. Unfortunately, the observations before 1965 seem problematic because they show greater variation and are considerably lower than observations from the post-1965 period. Furthermore, we found that the reported investment deflators were very volatile and implausible.\(^{20}\) As a result, we used the GDP deflator to deflate the investment series.\(^{21}\) We assumed that the depreciation rate \( \delta \) is 5 percent. We calculated initial capital stocks by

\[ K_{65} = \frac{I_{65}}{(g + \delta)}, \]

where \( g \) is the annual growth rate of the capital stocks before 1965,\(^{22}\) which we also assumed to be 5 percent. Finally, we constructed the FDI series with data from the *China Statistical Yearbook*.

**APPENDIX II**

**Kernel Estimator of a Distribution Function**

A kernel estimator of a set of observations is an estimated distribution function from which the observations were likely drawn. Specifically, a kernel-based estimator \( \hat{f}(x) \), of a density function \( f(x) \) of a random variable \( x \) is given by

\[
\hat{f}(x) = \frac{1}{Nh} \sum_{i=1}^{N} \psi \left( \frac{x_i - x}{h} \right),
\]

(A.1)

where \( \int_{-\infty}^{\infty} \psi(s)ds = 1 \) with \( s = (x_i - x)/h \), and \( h \) is called optimal window width (or smoothing parameter). Here \( \psi \) is a weighting function and in this paper, following Kumar

\(^{20}\) For example, using these investment deflators we found that in some provinces in some years investment-to-GDP ratios were greater than 1.

\(^{21}\) Even in this case we found some anomalies in the series. For example, the investment-GDP ratio in Shanghai is on average less than 15 percent before the 1980s. In that case, we assumed that the investment-output ratio between 1965 and 1978 is the same as the average of the investment-output ratios of other provinces in the region. Similarly, we further noted that the investment data for Qinghai and Ningxia were relatively high over 1978–98. For example, their investment-to-GDP ratios were above 50 percent and in some years even reached 70 percent. Given that there are no significant changes in their output trends, we concluded that measurement errors could be one possible reason for these high investment levels. Consequently, we assumed that the investment-output ratio in each of these provinces is the same as the average of the investment-output ratios of other provinces in the region. These adjustments do not have any impact on either the position of the frontier or the efficiency levels of other provinces. Without these adjustments, we estimated lower efficiency indices for these provinces.

\(^{22}\) Implicit in this formula is the assumption that the capital series had been growing at a constant rate before the investment data became available. Young (1995) and Hall and Jones (1999) also used the same technique to estimate initial capital stocks.
and Russell (2002) and Aziz and Duenwald (2003), we assume that $\psi$ is a standard normal density function. Following Silverman (1986), the optimal window width is chosen to be given by $h = 0.9 \frac{AN}{C0.2}$, where $A = \min\{\text{standard deviation, interquartile range}/1.34\}$. For a more detailed discussion on kernel estimators, see Silverman (1986).

REFERENCES


Central Bank Autonomy: Lessons from Global Trends

MARCO ARNONE, BERNARD J. LAURENS, JEAN-FRANÇOIS SEGALOTTO, and MARTIN SOMMER

This paper calculates indices of central bank autonomy (CBA) for 163 central banks as of end-2003, and comparable indices for a subgroup of 68 central banks as of the end of the 1980s. The results confirm strong improvements in both economic and political CBA over the past couple of decades, although more progress is needed to boost political autonomy of the central banks in emerging market and developing countries. Our analysis confirms that greater CBA has on average helped to maintain low inflation levels. The paper identifies four broad principles of CBA that have been shared by the majority of countries. Significant differences exist in the area of banking supervision where many central banks have retained a key role. Finally, we discuss the sequencing of reforms to separate the conduct of monetary and fiscal policies. [JEL E58, E52]


A large body of research has suggested that central bank autonomy (CBA) may have significant benefits for macroeconomic performance.¹

¹The literature often uses terms “autonomy” and “independence” interchangeably. However, there is a difference between the two concepts as autonomy entails operational...
CBA may help countries achieve lower average inflation, cushion the impact of political cycles on economic cycles, enhance financial system stability, and boost fiscal discipline without any real additional costs or sacrifices in terms of output volatility or reduced economic growth.\(^2\)

Although several studies have documented recent trends in CBA for selected groups of countries, no analysis of worldwide trends has yet been carried out.\(^3\) In an effort to fill this gap, we calculate indexes of de jure CBA for 163 central banks, representing 181 countries, as of end-2003.\(^4\) We also construct comparable indexes of CBA for a subgroup of 68 central banks as of the end of the 1980s. The cross-country and time-series dimensions of this new data set enable us to draw several important lessons from global trends in CBA over the past couple of decades:

- Central banks in advanced economies continue to enjoy greater CBA than those in emerging markets and developing countries. However, at the end of 2003, all country groups exhibit a higher level of CBA than that reached by advanced economies in the late 1980s.
- A vast majority of central banks have been mandated to set price stability as one of the objectives of monetary policy. In addition, most central banks have autonomy with respect to setting the policy rate and are not required to extend direct credit to the government.
- There is divergence among central banks on the issue of financial supervision. Many central banks in emerging markets and developing countries have retained their key role in supervisory activities; in addition, central banks in a few large advanced countries have also retained some form of involvement in financial supervision. In fact, it is not infrequent for central bank laws to prescribe the soundness of the financial system as an objective that is subordinated to medium-term price stability.
- Participation in currency unions has helped to enhance the autonomy of central banks, both among advanced economies (as in the case of the European System of Central Banks—ESCB) and developing countries (Central Bank of West African States—BCEAO; the Bank of Central...
African States—BEAC; and the Eastern Caribbean Central Bank—ECCB) In the group of developing countries, this is because participation in a currency union has been beneficial for the development of financial markets, which in turn had been a prerequisite for the elimination of direct central bank credit to the government (or central bank participation in the primary market for government securities).

A number of emerging market and developing countries continue to strengthen their instrument autonomy. However, looking forward, the main challenge will be to further boost the political autonomy of central

---


- **Political autonomy** is defined as the ability of central banks to select the final objectives of monetary policy, based on the following eight criteria: (1) governor is appointed without government involvement; (2) governor is appointed for more than five years; (3) board of directors is appointed without government involvement; (4) board is appointed for more than five years; (5) there is no mandatory participation of government representative(s) in the board; (6) no government approval is required for formulation of monetary policy; (7) central bank is legally obliged to pursue monetary stability as one of its primary objectives; and (8) there are legal provisions that strengthen the central bank’s position in the event of a conflict with the government.

- **Economic autonomy** aims at assessing the central bank’s operational autonomy on the basis of the following seven criteria: (1) there is no automatic procedure for the government to obtain direct credit from the central bank; (2) when available, direct credit facilities are extended to the government at market interest rates; (3) this credit is temporary; (4) and for a limited amount; (5) the central bank does not participate in the primary market for public debt; (6) the central bank is responsible for setting the policy rate; and (7) the central bank has no responsibility for overseeing the banking sector (two points) or shares responsibility (one point).

Cukierman (1992) proposed a measure of CBA for 50 countries based on the following 16 criteria:

- **Chief executive officer:** (1) length of governor’s term; (2) entity delegated to appoint him/her; (3) provisions for dismissal; and (4) ability to hold another office in the government.

- **Policy formulation:** (5) whether the central bank is responsible for monetary policy formulation; (6) rules concerning resolution of conflicts between the central bank and government; and (7) the degree of central bank participation in the formulation of the government’s budget.

- **Objectives of the central bank:** (8) monetary stability as one of the primary policy objectives.

- **Limitations on central bank lending to the government:** (9) advances and (10) securitized lending; (11) authority having control over the terms (maturity, interest rate, and amount) of lending; (12) width of circle of potential borrowers from the central bank; (13) types of limitations on loans, where limits exist; (14) maturity of possible loans; (15) limitations on interest rates applicable to lending; and (16) prohibitions on central bank participation in the primary market for government securities.
banks, mainly by ensuring that central bank governing bodies are appointed without much political interference and for longer terms.

I. Methodology for Assessing CBA

Our assessment of CBA and its evolution over time is based on the methodologies developed by Grilli, Masciandaro, and Tabellini (GMT) in a paper published in 1991, and the methodology used by Cukierman in a paper published a year later (see Box 1). GMT distinguished the political (that is, ability of the central bank to select the objectives of monetary policy) and economic (that is, ability of the central bank to select its instruments) dimensions of autonomy, but Cukierman looked at the provision in central bank legislation with regard to the central bank’s chief executive officer; policy formulation by the central bank and its objectives; and the limitations on central bank lending to the government.

The matrix presented in Table 1 summarizes the different samples and indexes that are used in this paper. Our assessment of CBA at the end of the 1980s is based on the GMT index for the 18 OECD countries analyzed in GMT (1991), thereafter referred to as the “full index;” and the Cukierman (1992) data converted into the GMT index for the remaining 50 countries assessed in that paper, thereafter referred to as the “narrow index.” Our assessment of CBA at the end of 2003 relies on the “full index.” To ensure comparability we standardize results by dividing the absolute values by the maximum potential score. Due to the method we use to transpose Cukierman’s data into the narrow index, some qualification is warranted regarding our assessment of CBA evolution over time.5 This caveat is discussed in Section III, which presents a comparison across countries.

II. Literature on the Benefits of CBA

A number of authors have used the indices developed by Cukierman and GMT in their work on CBA and its benefits. Arnone, Laurens, and Segalotto

---

5 In technical terms, the narrow index is defined as a subset of 11 variables, with 10 of those in Cukierman matching the same subset of 10 variables contained in the full index, and the 11th one from Cukierman substituting one in GMT. See conversion table in Arnone and others (2007).
(2006a) provide a detailed overview of this work. Here, we summarize the main results on the benefits of CBA for inflation performance:

- Alesina and Summers (1993) define an index of CBA as the average of the GMT and Cukierman indexes. They use the index to test the correlation between CBA and average inflation and its variability, unemployment, and the level of real interest rates. They find a significant negative correlation between CBA and the level and variation of inflation.
- de Haan and Kooi (1997) use the indexes of CBA developed by GMT and Cukierman to distinguish the concepts of conservatism and autonomy. They assess the relationships between these two concepts and inflation performance and the variability of output. They find that CBA, especially central bank instrument autonomy, has considerable impact on inflation performance and little on output variability.
- Mangano (1998) ranks existing most widely used indicators, including GMT and Cukierman indexes, and regresses them on inflation and output. He finds that GMT’s CBA has a significant impact on inflation.
- Oatley (1999) investigates the robustness of the relationships found in previous research between CBA and macroeconomic performance by analyzing eight indicators of CBA, including those developed by GMT and Cukierman. He finds that CBA reduces inflation even when economic, political, or institutional aspects are accounted for.
- However, some researchers have found little or no evidence for the macroeconomic benefits of CBA—see Banaian, Burdekin, and Willett (1995); Posen (1995 and 1998); Campillo and Miron (1997); Fuhrer (1997); and Crosby (1998).

III. CBA: Comparison across Countries and Evolution Over Time

Table A1 reports the summary indices of CBA, and detailed results can be found in Arnone and others (2007). The snapshot of CBA at the end of the 1980s is based on GMT and Cukierman data for 68 central banks, of which 25 are in advanced economies, 22 in emerging markets, and 21 in developing countries. The CBA scores at the end of 2003 are based on our reading of legal documents for 163 central banks, of which 28 are in advanced economies, 32 in emerging markets, and 103 in developing countries. In total, the sample for end-2003 covers 181 countries.

6The historical CBA scores of Bosnia, Croatia, Macedonia, Slovenia, and Serbia are those of Yugoslavia.

7The country classification dates to the end of 2003. Emerging markets include upper-middle-income countries; and some lower-middle-income countries classified as such by The Economist, as well as other countries with a sustained financial reform process. Developing countries include lower- and lower-middle-income countries, plus some countries with upper-middle- and high-income but with a degree of financial sector development that did not match, as of end of 2003, their income levels. Any such classification includes an unavoidable degree of subjectivity, especially in times of globalization and fast changes in financial markets.
Table 2 provides a broad overview of CBA scores for the main country groups. We present aggregate indexes for central banks in advanced economies, emerging markets, and developing countries; scores for monetary unions are also reported separately.

Assessment of CBA in the Late 1980s

Our snapshot of CBA in the late 1980s is based on the results of GMT (1991) and Cukierman (1992) for central banks in advanced economies, and Cukierman (1992) for central banks in emerging markets and developing countries. For all country groups, overall autonomy was rather low (that is, below 0.50) at that time, with economic autonomy being generally greater than political autonomy (Figure 1). Advanced economies exhibited the highest scores of overall autonomy. However, countries in the euro area showed levels of political and economic autonomy significantly lower than those in the other advanced economies (Figure 2). Developing countries exhibited slightly higher scores of overall autonomy than emerging market economies. However, excluding economies in transition, levels of CBA in those two groups were comparable.

Assessment of CBA as of End-2003

Comparison by income groups

The indexes of CBA have sharply increased from their late 1980s levels, but with notable cross-country differences. On average, CBA averages across the main income groups now exceed 0.50, with central banks in advanced economies achieving greater autonomy than central banks in emerging markets and developing countries (Figure 3). That said, some advanced countries in the Asia and the Pacific region score low relative to their peers, especially due to their limited political autonomy.

Central banks of countries in transition have reached CBA scores that are comparable with, and sometimes even higher than, CBA in the advanced economies (Figure 4). Clearly, the countries in transition have taken advantage of changes in the political regime to adopt central bank legislations reflecting the best practices in the advanced economies. In the case of Baltic and Central European countries, the proximity of the European Union together with the process of establishing the euro zone with the highly independent European Central Bank (ECB) have strengthened incentives for introducing autonomous central banks.

Interestingly, central banks of the countries operating in a monetary union exhibit autonomy that is significantly greater than the average of their income group. The average reached by the central banks in the ESCB is close to the maximum level of autonomy (see Figure 4). In the group of developing countries, the three regional central banks (BCEAO, BEAC, and ECCB) also show CBA levels that are considerably higher in both dimensions of autonomy than those of their peers (Table A1).
Table 2. Scores of Central Bank Autonomy in the Late 1980s and 2003

<table>
<thead>
<tr>
<th>Central Banks (number)</th>
<th>Late 1980s (narrow index Cukierman sample)</th>
<th>2003 (narrow index)</th>
<th>2003 (full index)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Political</td>
<td>Economic</td>
<td>Overall</td>
</tr>
<tr>
<td><strong>All income levels</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All central banks (163)</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>GMT sample (18)</td>
<td>0.36</td>
<td>0.59</td>
<td>0.48</td>
</tr>
<tr>
<td>Cukierman sample (50)</td>
<td>0.28</td>
<td>0.39</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>Advanced economies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All central banks (28)</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>GMT sample (18)</td>
<td>0.36</td>
<td>0.59</td>
<td>0.48</td>
</tr>
<tr>
<td>Cukierman sample (7)</td>
<td>0.33</td>
<td>0.21</td>
<td>0.28</td>
</tr>
<tr>
<td>ESCB (13)1</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td><strong>Emerging markets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All central banks (32)</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Cukierman sample (22)</td>
<td>0.27</td>
<td>0.38</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>Developing countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All central banks (103)</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Cukierman sample (21)</td>
<td>0.27</td>
<td>0.45</td>
<td>0.35</td>
</tr>
<tr>
<td>Monetary unions (3)2</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Sources: Grilli, Masciandaro, and Tabellini (GMT) (1991); Cukierman (1992); and authors’ calculations.

1The European System of Central Banks (ESCB) includes the European Central Bank and the 12 central banks of countries that were participating in the single currency in 2003.

2Includes the Central Bank of West African States (BCEAO), the Bank of Central African States (BEAC), and the Eastern Caribbean Central Bank (ECCB). Unlike in the ESCB, member countries do not have a national central bank.
Noteworthy is also the dichotomy in the political autonomy scores across countries. As discussed above, advanced economies (especially in Europe) and economies in transition have, with some notable exceptions, politically autonomous central banks. By contrast, many developing countries continue to score much worse on the criteria underpinning the political index (see the next subsection). The cross-country dispersion of economic autonomy scores is considerably lower (Figures 5 and 6).

**Detailed discussion of the CBA subcomponents**

What are the main reasons for cross-country differences in the CBA scores? Most of the differences in political autonomy are related to the legal provisions for appointing governing bodies of central banks (Table 3). In developing countries, governments often continue to be involved in the
selection of central bank boards and the tenures tend to be short (criteria 1–4); the government is generally represented on the board (criterion 5); and central banks have a limited legal protection in the event of a conflict with the government (criterion 8). Cross-country differences for the other subcomponents of political autonomy are smaller; interestingly, most central banks have adopted monetary stability as one of their primary objectives (criterion 7). However, in many countries, governments continue to be involved in the monetary policy implementation (criterion 6).

The key features of the central bank economic autonomy are as follows (Table 4):

- Few governments, even in developing countries, have automatic access to the central bank credit (criterion 1); when this type of credit is available,
the interest rate charged by the central bank is often close to the market rates but practices differ, especially in the developing countries (criterion 2).\(^8\)

- Many central banks in developing countries are allowed to participate in the primary markets for government securities (criterion 5). This clearly represents an inflation risk but, as discussed below, this arrangement can merely reflect the insufficient development of financial markets in some countries.
- Most central banks set their policy rates freely (criterion 6).
- With the exception of advanced economies, the majority of central banks have retained their key role in banking supervision (criterion 7bis).

**Regional patterns**

Looking across geographical regions, central banks in Europe have the highest CBA scores in terms of both economic and political autonomy, even

---

\(^8\)For example, in the United Kingdom, the interest rate charged on government overdrafts is the central bank’s bank rate plus a premium that is negotiated between the Debt Management Office and the Bank of England.
after disaggregating the scores by income groups (Table 5, row EUR). In the group of emerging markets, overall CBA is the lowest in Middle East and Central Asia (MCD) and sub-Saharan Africa (AFR) regions. Among developing countries, the differences in CBA across geographical regions are not particularly large; however, the central banks in the Asia and Pacific (APD) and sub-Saharan Africa (AFR) regions rank the lowest on average.
<table>
<thead>
<tr>
<th>Region</th>
<th>Political Autonomy</th>
<th>Economic Autonomy</th>
<th>Overall Autonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Advanced</td>
<td>Emerging</td>
</tr>
<tr>
<td>AFR</td>
<td>0.33</td>
<td>—</td>
<td>0.25</td>
</tr>
<tr>
<td>APD</td>
<td>0.35</td>
<td>0.27</td>
<td>0.44</td>
</tr>
<tr>
<td>EUR</td>
<td>0.79</td>
<td>0.85</td>
<td>0.73</td>
</tr>
<tr>
<td>MCD</td>
<td>0.45</td>
<td>—</td>
<td>0.25</td>
</tr>
<tr>
<td>WHD</td>
<td>0.40</td>
<td>0.50</td>
<td>0.54</td>
</tr>
<tr>
<td>All</td>
<td>0.49</td>
<td>0.70</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations.

Note: The regional classification follows the organization of IMF area departments: AFR = African Department; APD = Asia and Pacific Department; EUR = European Department; MCD = Middle East and Central Asia Department; WHD = Western Hemisphere Department.
Developments in CBA Over Time

Trends by income groups

The main trends in the developments of CBA over time are as follows:

- Average CBA scores for our global sample of 163 central banks have increased significantly over the last couple of decades: overall CBA (political and economic autonomy) has about doubled. The economic element of autonomy continues to be significantly ahead of the political component.9
- Advanced economies started off from relatively high levels of autonomy in the late 1980s but continued to strengthen their CBA in the subsequent years. Since the economic autonomy was already quite high, most progress has been done—in absolute terms—on boosting the political autonomy. That said, the political component of autonomy still lags somewhat behind the scores for economic autonomy.10
- In the group of emerging markets, overall CBA has more than doubled over time and has surpassed CBA typical in the advanced countries in the late 1980s. The measures of economic and political autonomy show similar levels of improvement, with the economic autonomy remaining higher than the political autonomy.11
- The development of CBA in the group of developing countries is harder to assess given data limitations. Based on CBA scores from the Cukierman sample (which represents about 20 percent of developing countries), political autonomy of central banks in developing countries has improved only marginally and remains low. However, political autonomy increased to some extent according to the “narrow” definition of our CBA index (Table 2). On balance, our reading of the data is that political autonomy of central banks in developing countries is certainly much lower than in emerging markets and advanced economies, although it is not possible to quantify precisely the evolution of political independence over time. As for the economic autonomy of central banks in developing countries, the picture emerging from the data is much clearer: economic CBA has increased significantly over the past couple of decades.

---

9This assessment is based on the CBA scores for the Cukierman sample of 50 central banks in the late 1980s and the global sample of 163 central banks at the end of 2003. Since the scores for the Cukierman and global samples are very similar at the end of 2003 (Table 2), the Cukierman sample is likely to be a good proxy for the global CBA scores in the late 1980s.

10For the late 1980s, the average CBA score for advanced economies is approximated using the GMT sample of 18 central banks in the OECD area. Note that the scores based on the GMT sample at the end of 2003 are close to those obtained for the complete sample of 28 advanced economies (Table 2).

11Similarly as in the case of global CBA, we proxy the average CBA scores of emerging markets for the late 1980s using the Cukierman sample.
To get a broader sense of CBA evolution for a range of countries over time, it is useful to transform the CBA data into the four-quadrant framework of GMT (1991) (Figures 7–9). In each figure, the horizontal and vertical axes correspond to the economic and political components of CBA, respectively.

- For all country groups, one can observe a general shift of the plotted observations upward and to the right, which confirms the broad-based strengthening in both economic and political components of CBA. The shift is clearly more uniform in the case of advanced economies, as most observations have become crowded in the top-right quadrant (Figure 7).
- The data points for emerging market and developing countries also show an upward shift to the right (that is, CBA scores have been increasing), but the dispersion of observations is higher than that for advanced economies.

Figure 7. Trends in the Distribution of Central Bank Autonomy in 18 Countries in the Organization for Economic Cooperation and Development

![Figure 7](image1.png)

Source: Authors’ calculations.
Note: Grilli, Masciandaro, and Tabellini (1991) sample. The dot size represents the number of central banks with a given combination of central bank autonomy scores.

Figure 8. Trends in the Distribution of Central Bank Autonomy in Emerging Markets

![Figure 8](image2.png)

Source: Authors’ calculations.
Note: Cukierman (1992) sample. The dot size represents the number of central banks with a given combination of central bank autonomy scores.
That said, it is interesting to note that scores for emerging market and developing countries at the end of 2003 are more concentrated and located to the right than was the case for advanced economies in the late 1980s. This is a corollary to the earlier finding that, at the end of 2003, developing and emerging market economies have achieved a degree of CBA which is higher than the level attained by the more advanced economies in the late 1980s.

Moreover, the figures confirm that most of the cross-country differences in CBA scores are currently due to the differences in political autonomy.

Regional trends

The increase in CBA is a worldwide phenomenon: central banks in all regions of the world have been granted increased political and economic autonomy (Table 6). But the increase in CBA has been uneven among regions. Central banks in Europe have gained greatly in terms of both economic and political autonomy. In the Western Hemisphere, much of the progress has been focused in the area of economic autonomy. By contrast, central banks in sub-Saharan Africa and the Middle East and Central Asia regions have seen relatively modest gains in their autonomy over the past couple of decades.

IV. CBA and Inflation

In this section, we return to the old debate about the benefits of CBA for maintaining a low-inflation environment. Of course, inflation outcomes

---

reflect actual monetary and fiscal policies, the external environment, and the general attitudes of policymakers toward inflation, which may, or may not, be reflected in central bank laws. This section therefore examines to what extent the stronger legal frameworks for CBA may have contributed to the reduction in average inflation levels, after controlling for other determinants of inflation.13

Our analysis focuses on the group of emerging markets and developing economies because these are the countries where the volatility in inflation outcomes has been most significant (Figure 10). During the mid-1970s to the mid-1990s, recurring episodes of loose fiscal and monetary policies, combined with commodity price shocks, kept inflation high. By contrast, average inflation in emerging market economies has fallen dramatically since the early 1990s—in many cases from double- and triple-digit levels—to about 5 percent at the present time.14

A number of factors have contributed to the reduction of inflation in emerging markets. As discussed in IMF (2006), the improving inflation performance has generally reflected policymakers’ increasing preference for low and stable inflation. This policy shift in part resulted from the earlier experience with high and variable inflation in both emerging markets and advanced economies. In the early 1980s, the perceived costs of double-digit inflation increased, as high inflation coincided with low growth and rising

---

**Table 6. Regional Trends in Central Bank Autonomy, 1980s–2003**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AFR</td>
<td>0.17</td>
<td>0.37</td>
<td>0.52</td>
<td>0.72</td>
<td>0.33</td>
<td>0.53</td>
</tr>
<tr>
<td>APD</td>
<td>0.21</td>
<td>0.54</td>
<td>0.41</td>
<td>0.73</td>
<td>0.30</td>
<td>0.63</td>
</tr>
<tr>
<td>EUR</td>
<td>0.32</td>
<td>0.79</td>
<td>0.27</td>
<td>0.98</td>
<td>0.30</td>
<td>0.88</td>
</tr>
<tr>
<td>MCD</td>
<td>0.25</td>
<td>0.40</td>
<td>0.36</td>
<td>0.68</td>
<td>0.30</td>
<td>0.53</td>
</tr>
<tr>
<td>WHD</td>
<td>0.36</td>
<td>0.50</td>
<td>0.36</td>
<td>0.88</td>
<td>0.36</td>
<td>0.67</td>
</tr>
<tr>
<td>All</td>
<td>0.28</td>
<td>0.56</td>
<td>0.38</td>
<td>0.84</td>
<td>0.32</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations.

Note: The average CBA scores are based on the Cukierman sample and the “narrow” CBA index. The regional classification follows the organization of IMF area departments: AFR = African Department; APD = Asia and Pacific Department; EUR = European Department; MCD = Middle East and Central Asia Department; WHD = Western Hemisphere Department.

---

13 De facto autonomy of central banks differs from de jure autonomy measured by our index. In any case, it is interesting to verify whether the de jure index has some predictive ability for inflation outcomes, even after controlling for a variety of other inflation determinants.

14 In the Central and Eastern European countries, inflation spikes were associated with the initial stage of economic transformation.
unemployment. Governments in the advanced economies were the first to respond by strengthening institutional and policy frameworks to foster monetary stability—including by boosting CBA and transparency and—in some countries—adopting an explicit inflation target. The combination of falling external inflation, learning from successful policies elsewhere, and public dissatisfaction with inflation explains much of the subsequent shift to low-inflation policies in emerging market and developing countries. Moreover, the gradual deepening of domestic financial markets and greater CBA have made inflationary financing of fiscal deficits less common. Aside from these factors, globalization may also have strengthened policymakers’ incentives to conduct prudent monetary policy (Rogoff, 2003). For instance, international capital markets may have had a disciplining effect on monetary policy, including through the risk of a reduction in foreign investment (Tytell and Wei, 2004).  

Source: IMF, World Economic Outlook.

For a detailed analysis, see IMF’s April 2006 World Economic Outlook.
In sum, the low-inflation environment in emerging markets and developing countries has resulted from a variety of factors. But has greater CBA contributed to better inflation outcomes after controlling for all the other important explanations of low inflation? To provide a tentative answer to this question, we have estimated an econometric model that links the likelihood of good inflation performance—defined as annual inflation below 10 percent—to the various determinants of inflation discussed above. Specifically, the model specification includes trade openness, inflation in advanced economies, the fiscal balance scaled by the depth of the domestic financial sector, the exchange rate regime, and two alternative measures of CBA.

The estimation results (Table 7) suggest that CBA has indeed helped to keep inflation low. On average, a move from no autonomy to full autonomy increases the likelihood of maintaining low inflation by about 50 percent. In our sample, the average autonomy of central banks in emerging markets increased from 0.3 to about 0.7 over the past couple of decades, which implies an average increase in the likelihood of low inflation by about 20 percentage points. We also examine how the measure of CBA calculated in this paper performs compared with an alternative measure of autonomy, turnover of central bank governors (see Cukierman, Webb, and Neyapti, 1992), which has been traditionally used in panel regressions. Both autonomy measures are correlated so the horserace regression in specification (4) does not produce statistically conclusive results. However, it is worth noting that the coefficient on CBA is reduced only by one-third when turnover of central bank governors is included (see specifications (1) and (3)), but the coefficient on turnover of central bank governors falls by about two-thirds in the specification that also includes CBA (specifications (3) and (4)).

16 The probit model is estimated for 24 emerging market economies over 1960–2004. The data are five-year averages. For the purposes of this section, the group of emerging markets includes Argentina, Brazil, Chile, China, Colombia, Czech Republic, Dominican Republic, Ecuador, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, and Venezuela.

17 See Catao and Terrones (2005) and the IMF’s May 2001 World Economic Outlook for an analysis of the relationship between fiscal deficits and inflation. Alesina and Summers (1993) document the broad correlation between measures of CBA and average inflation. Boschen and Weise (2003) find that U.S. inflation is a useful predictor of inflation spurs in the OECD countries. Ghosh and others (1997) provide evidence that the fixed exchange rate regime can help reduce inflation, although in the long term, the currency peg may incur large output and inflation costs if it is not supported by appropriate policies and breaks down (Mishkin, 1999).

18 The time series data on central bank autonomy were constructed as follows. First, we identified years in which there was a significant change in the CBA-related legislation in each country. Subsequently, we took the simplifying assumption that CBA before the break-year was the same as autonomy as of the end of the 1980s; and CBA after the break-year equals actual autonomy as of 2003. This assumption introduces measurement error into our CBA variable, but the size of this measurement error is limited by the fact that most changes in CBA occurred over the past couple of decades (Cukierman, 2005) and our regressions use five-year data averages.
The model confirms the very important role of the inflation determinants other than CBA. Because average openness in the sample increased from approximately 30 to 60 percent over the past four decades, globalization has increased the probability of low inflation by about 20 percentage points in the whole group of emerging markets. The model also attributes a significant weight to the inflation performance in advanced economies. The disinflation that took place there in the early 1980s is estimated to have increased the likelihood of low inflation in emerging markets by 30 percentage points or more. Fiscal policy—a traditional source of inflation pressure—is also identified as an important determinant of inflation. Finally, a fixed exchange rate regime can on an average improve chances of attaining low inflation.

Table 7. Inflation in Emerging Markets (Probit Estimates, Five-Year Averages)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Probability of Achieving Low Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Central bank autonomy</td>
<td>0.57*</td>
</tr>
<tr>
<td>Turnover of central bank governors(^2)</td>
<td>...</td>
</tr>
<tr>
<td>Openness(^3)</td>
<td>0.88***</td>
</tr>
<tr>
<td>Fiscal balance/financial depth(^4)</td>
<td>0.21</td>
</tr>
<tr>
<td>Inflation in advanced economies(^5)</td>
<td>-7.29***</td>
</tr>
<tr>
<td>Pegged exchange rate regime(^6)</td>
<td>57.4***</td>
</tr>
<tr>
<td>Number of observations(^1)</td>
<td>107</td>
</tr>
</tbody>
</table>


\(^1\)Low inflation is defined as annual inflation below 10 percent. The probability is scaled between 0 and 100. All data are five-year averages. Explanatory variables are lagged by one period (that is, by one five-year average), except in specification (2) where the fiscal balance/financial depth ratio is contemporaneous. \(^*\)denotes statistical significance at the 1 percent level, \(^**\)denotes significance at the 5 percent level, and \(^*\)denotes statistical significance at the 10 percent level.

\(^2\)Turnover of the central bank governors. Higher turnover may be associated with lower central bank autonomy.

\(^3\)Trade in percent of GDP.

\(^4\)Central government balance relative to the depth of financial sector (measured by narrow money).

\(^5\)Expressed as a percentage. The group of advanced economies consists of Australia, Canada, France, Germany, Italy, the United Kingdom, and the United States.

\(^6\)The dummy takes value of 1 (peg) or 0 (otherwise) and is calculated from the Reinhart-Rogoff (2002) data set.

The model confirms the very important role of the inflation determinants other than CBA. Because average openness in the sample increased from approximately 30 to 60 percent over the past four decades, globalization has increased the probability of low inflation by about 20 percentage points in the whole group of emerging markets. The model also attributes a significant weight to the inflation performance in advanced economies. The disinflation that took place there in the early 1980s is estimated to have increased the likelihood of low inflation in emerging markets by 30 percentage points or more. Fiscal policy—a traditional source of inflation pressure—is also identified as an important determinant of inflation. Finally, a fixed exchange rate regime can on an average improve chances of attaining low inflation.

In some countries, fiscal deficits may have fallen after greater CBA constrained the ability of governments to monetize. In our empirical analysis, however, we assume that any changes to the fiscal deficit are exogenous. This assumption reduces the likelihood that we will indeed find a relationship between CBA and inflation.
inflation, although sustaining currency pegs in emerging markets has proven difficult in the long term.20

V. Lessons Emerging from Global Trends

The analysis of disaggregated CBA scores has revealed that legal frameworks for most central banks in our sample share several common principles. We have identified four such broad principles that seem to represent the consensus view among policymakers, irrespective of the level of economic development of the countries in which they operate. All four principles discussed below are consistent with the academic views on how policymakers should achieve separation between monetary and fiscal policies, and more broadly limit the impact of political cycle on the conduct of monetary policy.21

Consensus Views

**Principle 1: Set price stability as the primary objective of monetary policy**

Almost all central banks are legally obliged to pursue price stability as one of their primary objectives. Central banks in some countries have been assigned more than one objective, but price stability has often been given priority status. Typically, the central bank law formulates the objectives of the central bank in a manner that identifies price stability as the most effective way in which the central bank can contribute to economic growth.22 This approach is in sharp contrast with policies of the 1970s in a number of countries, whereby central banks were expected to channel financial resources to priority sectors, thereby making them akin to development banks. The current approach to CBA acknowledges that governments may have several competing economic objectives, particularly in the short term. Accordingly, they may tend to ignore the medium-term inflationary effects of an expansionary monetary policy. This time-inconsistency causes a credibility problem. Therefore, entrusting price stability to an autonomous agency (that is, the central bank) helps strengthen credibility.

---

20See the September 2004 issue of the IMF’s *World Economic Outlook* for a discussion of recent developments in exchange rate regimes in emerging markets.


22China is of particular interest as a country where the objective of monetary policy is to maintain the stability of the currency and thereby promote economic growth (see Laurens and Maino, forthcoming). The United States is another example of a country that does not have clearly ranked macroeconomic objectives at the statutory level. However, it is well understood that price stability is a precondition for achieving this mix of objectives.
**Principle 2: Curtail direct lending to governments**

Most central banks have provisions in place that limit their ability to provide unrestricted credit to the government. Today, almost all central bank laws stipulate that lending to the government, if allowed at all, cannot be automatic, and must be temporary and subject to quantitative limits. Furthermore, the ban on central bank participation in the primary market for public debt—a ban that was not applied on a wide scale in the late 1980s—has now spread to a large group of countries and is a distinctive characteristic of the most recent legislation. In addition, the provision that, when available, central bank credit to the government should be at market rates, has also become a widespread practice.

Therefore, a consensus view has emerged that strong monetary policy requires direct central bank lending to the government be limited in nature, that is, generally short term (or temporary) with restrictions on the amount. Setting the interest rate on such borrowing with reference to market interest rates strengthens the autonomy of the central bank. That said, direct central bank credit is intended to facilitate short-term cash management by the treasury in countries with shallow money markets or a weak public debt management framework (Laurens, 2005).

**Principle 3: Ensure full autonomy for setting the policy rate**

Most central banks have been granted full autonomy for setting their policy rate. At the most basic level, this condition is necessary for the central bank to pursue its goals. But from another angle, such a practice also suggests that most policymakers have accepted the view that a policy rate (typically a short-term interbank interest rate) is the appropriate operational target of monetary policy. Therefore, the central bank should be granted full autonomy to set its policy rate. A corollary to that consensus view is the desire to ensure that the central bank has full autonomy for the design of its monetary policy instruments, that is, the tools to achieve the operational target of monetary policy.

**Principle 4: Ensure no government involvement in policy formulation**

That no government approval should be required for the formulation of monetary policy is a fourth principle that has been adopted by the majority of central banks around the world. A corollary to that principle is the existence of procedures to resolve conflicts between the central bank and the government, as is apparent from the high degree of correlation between the scores on these two criteria among countries. Furthermore, when such procedures for conflict resolution are in place, government representation in

---

23 The operational target can be defined as the variable that the central bank aims at controlling and indeed can control to a very large extent on a day-by-day basis through the use of its monetary policy instruments.
a policymaking board (that is, the central bank board) is not necessary. This observation is also supported by the high correlation of scores for this criterion with the two preceding ones (that is, no government approval for policy formulation and existence of conflict resolution procedures).

**Departure from the Literature: The Role of Central Banks in Bank Supervision**

The analysis in Section III revealed that central banks in many emerging market and developing countries have retained their key role in the area of banking supervision. Although less pervasive, such practice is also observed in a few large advanced economies. This practice goes against the argument often made in the literature that implementation of monetary policy and banking supervision are two separate functions and that underlying structural problems in the financial sector should be addressed directly by a specialized agency. This argument is based on the experience in some countries that relaxing monetary policy to mitigate financial sector problems, which the central bank may be more tempted to do if it is in charge of banking supervision, may aggravate the financial sector problems and undermine monetary policy.

However, practical considerations have led to a departure from these conceptual arguments. In emerging markets and developing countries, the greater availability of skilled staff and resources at the central bank has often played a role in deciding whether supervisory functions should be retained at the central bank. There is also the view that, given the increased CBA, in particular in emerging markets and developing countries, locating financial supervisory functions in the central bank allows supervisors to “piggyback” and enjoy the same degree of autonomy. The considerations that have led a number of central banks to increase their focus on financial stability issues also support a departure from the conceptual arguments presented in the literature.

In addition, recent empirical evidence by Arnone and Gambini (2007) shows that a higher degree of compliance with the Basel Core Principles is achieved by those countries implementing an integrated supervision of banks together with securities and/or insurance companies; they also find some statistically significant results in favor of placing both banking supervision and an integrated supervision inside the central bank.

Finally, price stability and financial sector soundness may be compatible, at least in the longer term. Hence, entrusting monetary policy implemen-
tation and financial supervision to the central bank could be desirable, particularly if the central bank has a clear objective and enjoys a high degree of autonomy and accountability and, therefore, will not be tempted to use second-best instruments (in our case monetary policy) to achieve financial stability objectives.\textsuperscript{28} Therefore, the argument presented in much of the literature that central banks should not be involved in supervisory functions is open to question, and it is not infrequent for central bank laws to prescribe the soundness of the financial system as an objective that is subordinated to medium-term price stability.

**Sequencing of Reforms**

Historical trends suggest a possible sequencing of reforms to enhance CBA, which associates the two subcomponents of CBA (that is, economic and political) with structural changes in the economy and financial system. The process of improvement in CBA generally starts with establishing the political foundations of an autonomous central bank; this is followed by steps to strengthen operational autonomy; and the process ends in the political autonomy area in terms of increased autonomy for policy formulation and the appointment of senior management.

**Step 1: Clarify objectives and establish basic instrument autonomy**

Establishing clear objectives early on in the process of central bank modernization is critical for setting a legal framework for the central bank, which ensures a proper allocation of responsibilities between government agencies. Conceptual considerations as well as practice point to price stability as the most desirable primary objective for the central bank.

Concomitantly, a minimum level of economic autonomy is required. In this process, instrument autonomy (that is, the ability for the central bank to conduct liquidity management independently of budget financing considerations) is an important first step toward establishing an autonomous central bank. In particular, early on in the process, limits must be placed on the ability of the government to obtain central bank credit, or on the ability of commercial banks to have discretionary access to central bank credit, so that the central bank can control its balance sheet. Such measures are critical for enhancing the control of the central bank over the money supply.\textsuperscript{29}

\textsuperscript{28}See, in particular, Bernanke (2007, p. 2) indicating that the “Fed’s ability to deal with diverse and hard-to-predict threats to financial stability depends critically on the information, expertise and powers that it holds by virtue of being both a bank supervisor and a central bank.”

\textsuperscript{29}See Laurens (2005) for a review of country experiences in this area and Fry (1998) for the relationship between the central bank’s instrument autonomy and its ability to promote fiscal discipline.
Step 2: Strengthen further instrument autonomy

In the early stages of financial market development, establishing a clear separation between liquidity management by the central bank and the financing of the budget may not be feasible. However, as already discussed, direct central bank credit to the government should be at market rates, and intended to facilitate short-term cash management by the treasury. There are several conditions for moving toward full autonomy for monetary policy and public debt management, which will allow separation of monetary and fiscal policy responsibilities. Especially important is the development of a government securities market, where market forces determine the conditions under which a budget deficit may be financed, and a public debt management capacity at the treasury. This makes it possible to phase out direct central bank credit to the government.

Step 3: Strengthen further political autonomy

The last stage in the process of building an autonomous central bank has to do with strengthening further political autonomy. As evidenced in the results in Table 3, only advanced economies have achieved high levels of political autonomy (that is, above 50 percent) with regard to the appointment of their management of governing bodies. Therefore, the last stage in CBA involves strengthening further the legal provisions that deal with the potential for political interference in the operations of the central bank, including having the governor and the central bank board appointed more autonomously and for longer terms, and with even less political interference.

Such provisions help to establish a total separation between monetary and fiscal policies. In such an environment, financial markets are expected to react to monetary policy signals, and the credibility of monetary policy is critical for maintaining orderly market conditions. However, in view of the conditions that are required to establish such separation (most importantly efficient money markets and the market for government securities), not all countries can reach this ultimate stage of CBA. For countries that cannot establish a complete separation, there is an even stronger case for establishing coordination mechanisms to supplement the role of the markets as a means to ensure financial discipline.31

---

30 See Laurens (2005) for the benefits that participation in a monetary union can bring to help reach the critical stage for the emergence of an active money market.

31 Financial programming frameworks can be instrumental in preventing inconsistencies in the macroeconomic policy mix. Committees for the coordination of liquidity management at the central bank and government cash management play a useful role for the day-to-day implementation of monetary and fiscal policies—the microperspective. See Laurens and de la Piedra (1998) for a discussion.
VI. Conclusions

Building on extensive theoretical and empirical research that highlights the macroeconomic advantages of CBA, central banks in most countries have been granted higher levels of autonomy over the past couple of decades, irrespective of the country’s income level. Central banks in advanced economies continue to enjoy greater autonomy than those in emerging markets and developing countries, but at the end of 2003 all country groups exhibited indexes of political and economic autonomy that were higher than those reached by advanced economies in the late 1980s.

Almost all central banks have been mandated to set price stability as one of the objectives of monetary policy, are free to set the policy rate, and are not required to provide automatically direct credit to the government. These trends reflect what can be considered as the consensus view about CBA among policymakers. However, in contrast to the theoretical views on CBA, many central banks—especially in emerging markets and developing countries, but also in a few advanced economies—have retained their responsibilities in the area of financial supervision.

Our analysis also suggests that the movement toward greater CBA has paid off in terms of sustained low average inflation levels in many emerging market and developing countries. This result holds up even after the analysis accounts for the other determinants of inflation such as fiscal deficits or price movements abroad.

It is also worth noting the higher scores of CBA among regional central banks, whether they operate in advanced economies (such as the ESCB) or in developing countries (such as the BCEAO, BEAC, and ECCB). Given that participation in a currency union can be beneficial for market development, and that an active money market is required to eliminate direct central bank credit to the government (or central bank participation in primary markets for government securities), currency unions can help enhance the autonomy of the central bank.

A number of emerging market and developing countries, but also some advanced economies, continue to strengthen their instrument autonomy. However, looking forward, the main challenge will be to further boost political autonomy of central banks, mainly by ensuring that central bank governing bodies are appointed without much political interference and for longer terms. The final stage in the evolution of CBA implies a de jure complete separation between fiscal and monetary policies. However, that does not rule out the relevance of mechanisms for monetary and fiscal policy coordination to supplement the role of markets as a means to ensure financial discipline, although such mechanisms will play a greater role in those countries that have not yet reached the ultimate stage of CBA.
<table>
<thead>
<tr>
<th>Central Banks (number)</th>
<th>Late 1980s (Narrow index for Cukierman, 1992)</th>
<th>End-2003</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Full index for GMT, 1991)</td>
<td>Narrow index</td>
<td>Political</td>
<td>Economic</td>
<td>Overall</td>
</tr>
<tr>
<td><strong>All central banks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full sample (163)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMT sample (18)</td>
<td>0.36</td>
<td>0.59</td>
<td>0.48</td>
<td>0.74</td>
<td>0.81</td>
</tr>
<tr>
<td>Cukierman (1992)sample (50)</td>
<td>0.28</td>
<td>0.39</td>
<td>0.33</td>
<td>0.52</td>
<td>0.82</td>
</tr>
<tr>
<td><strong>Advanced economies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Central Bank</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>0.38</td>
<td>0.75</td>
<td>0.56</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Austria</td>
<td>0.38</td>
<td>0.75</td>
<td>0.56</td>
<td>1.00</td>
<td>0.88</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.13</td>
<td>0.75</td>
<td>0.44</td>
<td>1.00</td>
<td>0.88</td>
</tr>
<tr>
<td>Canada</td>
<td>0.50</td>
<td>0.88</td>
<td>0.69</td>
<td>0.38</td>
<td>0.88</td>
</tr>
<tr>
<td>Cyprus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>0.38</td>
<td>0.63</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Finland</td>
<td>0.40</td>
<td>0.00</td>
<td>0.22</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>France</td>
<td>0.25</td>
<td>0.63</td>
<td>0.44</td>
<td>1.00</td>
<td>0.88</td>
</tr>
<tr>
<td>Germany</td>
<td>0.75</td>
<td>0.88</td>
<td>0.81</td>
<td>1.00</td>
<td>0.75</td>
</tr>
<tr>
<td>Greece</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Hong Kong</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>0.50</td>
<td>0.20</td>
<td>0.36</td>
<td>0.33</td>
<td>1.00</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Italy</td>
<td>0.50</td>
<td>0.13</td>
<td>0.31</td>
<td>1.00</td>
<td>0.63</td>
</tr>
<tr>
<td>Japan</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
<td>0.13</td>
<td>0.75</td>
</tr>
<tr>
<td>Korea</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.50</td>
<td>0.80</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>0.40</td>
<td>0.20</td>
<td>0.31</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.75</td>
<td>0.50</td>
<td>0.63</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Country</td>
<td>0.00</td>
<td>0.38</td>
<td>0.19</td>
<td>0.25</td>
<td>0.63</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>0.33</td>
<td>0.20</td>
<td>0.27</td>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.13</td>
<td>0.25</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.50</td>
<td>0.40</td>
</tr>
<tr>
<td>Spain</td>
<td>0.25</td>
<td>0.38</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>0.25</td>
<td>0.40</td>
<td>0.32</td>
<td>0.83</td>
<td>1.00</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0.63</td>
<td>0.88</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>0.63</td>
<td>0.88</td>
<td>0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full sample (27)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMT (1991) sample (18)</td>
<td>0.36</td>
<td>0.59</td>
<td>0.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cukierman (1992) sample (7)</td>
<td>0.33</td>
<td>0.21</td>
<td>0.28</td>
<td>0.67</td>
<td>0.89</td>
</tr>
<tr>
<td>ESCB (13)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Emerging markets**

<table>
<thead>
<tr>
<th>Country</th>
<th>0.33</th>
<th>0.60</th>
<th>0.45</th>
<th>0.83</th>
<th>1.00</th>
<th>0.91</th>
<th>0.75</th>
<th>0.75</th>
<th>0.75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
<td>0.33</td>
<td>1.00</td>
<td>0.64</td>
<td>0.50</td>
<td>0.75</td>
<td>0.63</td>
</tr>
<tr>
<td>Bulgaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>0.17</td>
<td>0.20</td>
<td>0.18</td>
<td>0.50</td>
<td>1.00</td>
<td>0.73</td>
<td>0.50</td>
<td>0.88</td>
<td>0.69</td>
</tr>
<tr>
<td>China</td>
<td>0.25</td>
<td>0.40</td>
<td>0.32</td>
<td>0.33</td>
<td>1.00</td>
<td>0.64</td>
<td>0.38</td>
<td>0.75</td>
<td>0.56</td>
</tr>
<tr>
<td>Croatia ¹</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.88</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>0.50</td>
<td>0.60</td>
<td>0.55</td>
<td>0.17</td>
<td>0.80</td>
<td>0.45</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Estonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.88</td>
<td>1.00</td>
<td>0.94</td>
</tr>
<tr>
<td>India</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.50</td>
<td>0.60</td>
<td>0.55</td>
<td>0.25</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.17</td>
<td>0.40</td>
<td>0.27</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.63</td>
<td>0.75</td>
<td>0.69</td>
</tr>
<tr>
<td>Israel</td>
<td>0.33</td>
<td>0.20</td>
<td>0.27</td>
<td>0.33</td>
<td>0.80</td>
<td>0.55</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Jordan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.50</td>
<td>0.80</td>
<td>0.64</td>
<td>0.25</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>Malta</td>
<td>0.50</td>
<td>0.40</td>
<td>0.45</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.50</td>
<td>0.88</td>
<td>0.69</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.50</td>
<td>0.20</td>
<td>0.36</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.63</td>
<td>0.75</td>
<td>0.69</td>
</tr>
<tr>
<td>Morocco</td>
<td>0.00</td>
<td>0.40</td>
<td>0.18</td>
<td>0.50</td>
<td>0.80</td>
<td>0.64</td>
<td>0.25</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>Pakistan</td>
<td>0.17</td>
<td>0.20</td>
<td>0.18</td>
<td>0.67</td>
<td>0.80</td>
<td>0.73</td>
<td>0.38</td>
<td>0.63</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Table A1. (continued)

<table>
<thead>
<tr>
<th>Central Banks (number)</th>
<th>Political</th>
<th>Economic</th>
<th>Overall</th>
<th>Political</th>
<th>Economic</th>
<th>Overall</th>
<th>Political</th>
<th>Economic</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peru</td>
<td>0.50</td>
<td>0.60</td>
<td>0.55</td>
<td>0.50</td>
<td>1.00</td>
<td>0.73</td>
<td>0.38</td>
<td>1.00</td>
<td>0.69</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.33</td>
<td>0.60</td>
<td>0.45</td>
<td>0.83</td>
<td>0.80</td>
<td>0.82</td>
<td>0.63</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Poland</td>
<td>0.00</td>
<td>0.20</td>
<td>0.09</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>Romania</td>
<td>0.33</td>
<td>0.20</td>
<td>0.27</td>
<td>0.83</td>
<td>1.00</td>
<td>0.91</td>
<td>0.63</td>
<td>0.75</td>
<td>0.69</td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.50</td>
<td>0.38</td>
<td>0.44</td>
</tr>
<tr>
<td>Slovak Rep.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.50</td>
<td>0.75</td>
<td>0.63</td>
</tr>
<tr>
<td>Slovenia(^1)</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.88</td>
<td>0.75</td>
<td>0.81</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.00</td>
<td>0.20</td>
<td>0.09</td>
<td>0.17</td>
<td>0.40</td>
<td>0.27</td>
<td>0.13</td>
<td>0.38</td>
<td>0.25</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.33</td>
<td>0.40</td>
<td>0.36</td>
<td>0.33</td>
<td>0.40</td>
<td>0.36</td>
<td>0.50</td>
<td>0.38</td>
<td>0.44</td>
</tr>
<tr>
<td>Turkey</td>
<td>0.50</td>
<td>0.60</td>
<td>0.55</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.63</td>
<td>1.00</td>
<td>0.81</td>
</tr>
<tr>
<td>Venezuela</td>
<td>0.33</td>
<td>0.20</td>
<td>0.27</td>
<td>0.67</td>
<td>1.00</td>
<td>0.82</td>
<td>0.50</td>
<td>0.88</td>
<td>0.69</td>
</tr>
<tr>
<td>Full sample (32)</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.56</td>
<td>0.75</td>
<td>0.65</td>
</tr>
<tr>
<td>Cukierman (1992) sample (22)</td>
<td>0.27</td>
<td>0.38</td>
<td>0.32</td>
<td>0.56</td>
<td>0.87</td>
<td>0.70</td>
<td>0.47</td>
<td>0.75</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Developing countries

<p>| Afghanistan            | 0.00      | 0.63     | 0.81    | 0.50      | 0.75     | 0.63    |
| Albania                | 0.75      | 0.75     | 0.75    | 0.75      | 0.75     | 0.75    |
| Algeria                | 1.00      | 0.63     | 0.81    | 0.75      | 0.50     | 0.63    |
| Angola                 | 0.25      | 0.38     | 0.31    | 0.75      | 0.50     | 0.63    |
| Armenia                | 0.88      | 0.75     | 0.81    | 0.75      | 0.50     | 0.63    |
| Aruba                  | 0.75      | 0.50     | 0.63    | 0.75      | 0.50     | 0.63    |
| Azerbaijan             | 0.20      | 0.60     | 0.38    | 0.33      | 0.60     | 0.45    |
| Bahamas                | 0.20      | 0.60     | 0.38    | 0.33      | 0.60     | 0.45    |
| Bahrain                | 0.25      | 0.63     | 0.44    | 0.25      | 0.63     | 0.44    |
| Bangladesh             | 0.00      | 0.38     | 0.19    | 0.13      | 0.63     | 0.38    |
| Barbados               | 0.17      | 0.40     | 0.27    | 0.17      | 0.80     | 0.45    |
| BCEAO(^2)            | 0.17      | 0.40     | 0.27    | 0.17      | 0.80     | 0.45    |
| BEAC(^3)            | 0.50      | 0.88     | 0.69    | 0.50      | 0.88     | 0.69    |</p>
<table>
<thead>
<tr>
<th></th>
<th>0.50</th>
<th>0.38</th>
<th>0.44</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belarus</td>
<td>0.50</td>
<td>0.38</td>
<td>0.44</td>
</tr>
<tr>
<td>Belize</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Bermuda</td>
<td>0.13</td>
<td>0.75</td>
<td>0.44</td>
</tr>
<tr>
<td>Bhutan</td>
<td>0.13</td>
<td>0.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Bolivia</td>
<td>0.33</td>
<td>0.40</td>
<td>0.36</td>
</tr>
<tr>
<td>Bosnia &amp; Herz.</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
</tr>
<tr>
<td>Botswana</td>
<td>0.00</td>
<td>0.60</td>
<td>0.27</td>
</tr>
<tr>
<td>Burundi</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>Cambodia</td>
<td>0.38</td>
<td>0.75</td>
<td>0.56</td>
</tr>
<tr>
<td>Cape Verde</td>
<td>0.38</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Cayman Islands</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>0.17</td>
<td>0.40</td>
<td>0.27</td>
</tr>
<tr>
<td>Comoros</td>
<td>0.13</td>
<td>0.75</td>
<td>0.44</td>
</tr>
<tr>
<td>Cuba</td>
<td>1.00</td>
<td>0.60</td>
<td>0.82</td>
</tr>
<tr>
<td>Dominican Rep.</td>
<td>0.38</td>
<td>0.25</td>
<td>0.31</td>
</tr>
<tr>
<td>ECCB</td>
<td>0.63</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Ecuador</td>
<td>0.88</td>
<td>1.00</td>
<td>0.94</td>
</tr>
<tr>
<td>El Salvador</td>
<td>0.63</td>
<td>1.00</td>
<td>0.81</td>
</tr>
<tr>
<td>Eritrea</td>
<td>0.38</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>0.20</td>
<td>0.60</td>
<td>0.38</td>
</tr>
<tr>
<td>Fiji</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Georgia</td>
<td>0.17</td>
<td>0.40</td>
<td>0.27</td>
</tr>
<tr>
<td>Ghana</td>
<td>0.38</td>
<td>0.88</td>
<td>0.63</td>
</tr>
<tr>
<td>Guatemala</td>
<td>0.25</td>
<td>0.75</td>
<td>0.50</td>
</tr>
<tr>
<td>Guinea Rep.</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Guyana</td>
<td>0.00</td>
<td>0.75</td>
<td>0.38</td>
</tr>
<tr>
<td>Haiti</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Honduras</td>
<td>1.00</td>
<td>0.60</td>
<td>0.55</td>
</tr>
<tr>
<td>Iran</td>
<td>0.13</td>
<td>0.88</td>
<td>0.50</td>
</tr>
<tr>
<td>Iraq</td>
<td>0.00</td>
<td>0.75</td>
<td>0.38</td>
</tr>
<tr>
<td>Jamaica</td>
<td>0.50</td>
<td>0.75</td>
<td>0.63</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Kenya</td>
<td>0.63</td>
<td>0.88</td>
<td>0.75</td>
</tr>
<tr>
<td>Kuwait</td>
<td>1.00</td>
<td>0.75</td>
<td>0.88</td>
</tr>
<tr>
<td>Kyrgyz Rep.</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Laos</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Central Banks (number)</td>
<td>Political</td>
<td>Economic</td>
<td>Overall</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>Lebanon</td>
<td>0.40</td>
<td>0.60</td>
<td>0.49</td>
</tr>
<tr>
<td>Lesotho</td>
<td>0.25</td>
<td>0.63</td>
<td>0.44</td>
</tr>
<tr>
<td>Libya</td>
<td>0.25</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Macau</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Macedonia¹</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
</tr>
<tr>
<td>Madagascar</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Malawi</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Maldives</td>
<td>0.25</td>
<td>0.50</td>
<td>0.38</td>
</tr>
<tr>
<td>Mauritius</td>
<td>0.38</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>Moldova</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Mongolia</td>
<td>0.00</td>
<td>0.20</td>
<td>0.09</td>
</tr>
<tr>
<td>Mozambique</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>Myanmar</td>
<td>0.13</td>
<td>0.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Namibia</td>
<td>0.13</td>
<td>0.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Nepal</td>
<td>0.40</td>
<td>0.60</td>
<td>0.49</td>
</tr>
<tr>
<td>Netherlands Ant.</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.13</td>
<td>0.50</td>
<td>0.31</td>
</tr>
<tr>
<td>Oman</td>
<td>0.40</td>
<td>0.00</td>
<td>0.22</td>
</tr>
<tr>
<td>Palestine</td>
<td>0.38</td>
<td>0.63</td>
<td>0.50</td>
</tr>
<tr>
<td>Panama</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>0.25</td>
<td>0.38</td>
<td>0.31</td>
</tr>
<tr>
<td>Paraguay</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
</tr>
<tr>
<td>Qatar</td>
<td>0.13</td>
<td>0.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Rwanda</td>
<td>0.25</td>
<td>0.38</td>
<td>0.31</td>
</tr>
<tr>
<td>São Tomé &amp; Principé</td>
<td>0.63</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Table A1. (concluded)
<table>
<thead>
<tr>
<th>Country</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seychelles</td>
<td>0.13</td>
<td>0.38</td>
<td>0.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>0.50</td>
<td>0.63</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>0.50</td>
<td>0.63</td>
<td>0.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sudan</td>
<td>0.00</td>
<td>0.63</td>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suriname</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syrian Arab Rep.</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tajikistan</td>
<td>1.00</td>
<td>0.63</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.33</td>
<td>0.80</td>
<td>0.55</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>0.75</td>
<td>0.63</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonga</td>
<td>0.25</td>
<td>0.38</td>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td>0.63</td>
<td>0.75</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>0.63</td>
<td>0.75</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uganda</td>
<td>0.33</td>
<td>0.60</td>
<td>0.45</td>
<td>0.67</td>
<td>0.80</td>
<td>0.73</td>
<td>0.50</td>
<td>0.63</td>
<td>0.56</td>
</tr>
<tr>
<td>Ukraine</td>
<td>0.88</td>
<td>0.75</td>
<td>0.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Arab Emir.</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uruguay</td>
<td>0.17</td>
<td>0.00</td>
<td>0.09</td>
<td>0.67</td>
<td>0.80</td>
<td>0.73</td>
<td>0.63</td>
<td>0.63</td>
<td>0.63</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>0.75</td>
<td>0.63</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanuatu</td>
<td>0.13</td>
<td>0.63</td>
<td>0.38</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yemen Rep.</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zambia</td>
<td>0.33</td>
<td>0.40</td>
<td>0.36</td>
<td>0.67</td>
<td>0.60</td>
<td>0.64</td>
<td>0.38</td>
<td>0.50</td>
<td>0.44</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.17</td>
<td>0.60</td>
<td>0.36</td>
<td>0.25</td>
<td>0.63</td>
<td>0.44</td>
</tr>
<tr>
<td>Full sample (103)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cukierman (1992) sample (21)</td>
<td>0.27</td>
<td>0.45</td>
<td>0.35</td>
<td>0.42</td>
<td>0.75</td>
<td>0.57</td>
<td>0.29</td>
<td>0.67</td>
<td>0.48</td>
</tr>
<tr>
<td>Monetary unions (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


1Indexes for Bosnia, Croatia, Slovenia, Serbia Montenegro, and Macedonia for the late 1980s are those of Yugoslavia at the time.
2The Central Bank of West African States (BCEAO) includes Benin, Burkina Faso, Côte d’Ivoire, Guinée Bissau, Mali, Niger, Senegal, and Togo.
3The BEAC (Bank of Central African States) includes Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea, and Gabon.
4The ECCB and (Eastern Caribbean Central Bank) includes Anguilla, Antigua-Barbuda, Dominica, Grenada, Montserrat, St. Kitts-Nevis, St. Lucia, and St. Vincent and the Grenadines.
REFERENCES


Do Unit Value Export, Import, and Terms-of-Trade Indices Misrepresent Price Indices?

MICK SILVER*

Unit value export and import indices compiled from returns to customs authorities are often used as surrogates for price indices in the analysis of inflation transmission, terms of trade (effects), and to deflate import and export value series to derive volume series. Their widespread use is mainly due to their low cost relative to establishment price surveys. This paper provides evidence of substantial errors and bias in their representation of such price changes. Their continued use would mislead economic analysis. The paper considers the efficacy of alternative strategies for their improvement, and argues for a move to establishment-based price surveys. [JEL C43, C82, E31, O47]


Export and import unit value indices (UVIs) are based on data from customs documentation and are so named because they take as their building blocks, for individual commodity groups, the ratio of the unit value

---

*Mick Silver is a senior economist in the IMF’s Statistics Department. This paper was originally prepared as a background paper to the draft “Export and Import Price Index (XMPI) Manual” developed under the aegis of the United Nations Inter-Secretariat Working Group on Price Statistics to update the existing United Nations (1981) guidelines. Acknowledgments are due to Renaud Decoster for providing summary statistics from the PLANISTAT Report, Mbaye Gueye (IMF) for aggregate International Financial Statistics data, and Klaus Pöttsch (Statistisches Bundesamt) for disaggregated data on Germany. The paper benefited from useful comments by Bert Balk (Statistics Netherlands), Matt Berger (ABS), Erwin Diewert (University of British Columbia), Carsten Hansen (UN ECE), Peter Hill, Johannes Hoffmann (Deutsche Bundesbank), Hans-Albert Leifer (Deutsche Bundesbank), Ronald Johnson (U.S. BLS), Kim Zieschang (IMF), and an anonymous referee.
in the current to the reference period. They measure, for individual commodity groups, the change over time in the total value of shipments divided by the corresponding total quantity. These elementary-level unit value ratios—also, and hereafter, referred to as (elementary) UVIs—are subsequently aggregated across commodity groups using standard weighted index number formulas where the weights are the relative shares of the commodity group in total exports/imports. Export and import price indices (PIs) have as their building blocks, at the elementary level, the price change of well-defined representative items derived from establishment surveys. Export and import UVIs by necessity differ from PIs because of their source data.

This paper considers whether export and import UVIs derived from customs data, and commonly used as surrogates for export and import PIs, represent or misrepresent such price changes. UVIs as measures of price changes of imported and exported goods serve economic analysis in many important ways. They are used as short-term indicators of inflation transmission, to measure changes in a country’s terms of trade (ToT) (effect), and as deflators of export and import values to yield measures of changes in export and import volumes. Yet, in spite of their widespread use they are subject to well-recognized errors and bias.1 The issue of concern is whether such bias misleads economists in their economic analysis to the extent that their compilation and use should not be recommended. Also of importance is to consider what might be done by statistical agencies if UVIs are found wanting.

Bias in UVIs is mainly attributed to changes in the mix of the heterogeneous items recorded in customs documents, but may also arise from the poor quality of recorded data on quantities. The former is particularly important given the increasing differentiation of products and turnover of differentiated products that is a feature of modern markets. UVIs may suffer further due to an increasing irrelevance of the source data with first, increasing proportions of trade being in services and by e-commerce, and hence not covered by customs data, and second, a constraint on the coverage of such data for countries in customs and monetary unions, for which intra-union trade date may no longer be regularly collected.

Few deny, including United Nations (1981),2 that narrow specification PIs provide the best measures of relative price change and that, a priori, there are potentially significant biases in using customs unit values to measure price

---

1The empirical evidence is of substantial volatility with unit value indices, on aggregate, generally falling below their corresponding PIs.

2The main rationale for unit value indices was the limited resources required to compile them. United Nations (1981) laid down a strategy for countries with a tight budget; they should only use unit value indices, with disaggregation by county of origin/destination, where deemed appropriate. Well-endowed countries were advised to use establishment-based price surveys, possibly jointly with unit value indices. United Nations (1983) provided case studies on the development and implementation of price and unit value indices.
developments in international goods trade. Yet, unit value proxies for narrow specification price data collected from establishments are still used because they are by-products of existing customs administration systems and have relatively low incremental cost compared with the price surveys of establishments needed for narrow specification prices.

The concern over bias in UVIs is not new. Early critical studies of unit value bias as measures of import and export price changes and ToT include Kravis and Lipsey (1971 and 1985). The United States discontinued publication of unit value trade indices in 1989 due to the concern over bias and introduced trade PIs based on establishment surveys. A move away from UVIs based on customs documentation has also been prompted by the introduction of a customs union for the euro area.  

I. UVIs and Their Bias

This section first outlines the nature of the bias in a unit value index (UVI) arising from changes in the compositional product mix, then considers it more formally by means of the properties of the UVI in relation to the main axiomatic tests used in index number theory to justify formulas, and finally in relation to economic theory.

A UVI, \( P_U \), for commodity group \( i \), for period 1 relative to a reference period 0 is given for comparison over \( m = 1, \ldots, M \) prices, \( p^1_m \), and quantities, \( q^1_m \), in period 1 and over \( n = 1, \ldots, N \) prices, \( p^0_n \), and quantities, \( q^0_n \), in period 0, where \( m \in i \) and \( n \in i \), by

\[
P_U(i)(p^0, p^1, q^0, q^1) = \left( \frac{\sum_{m=1}^{M} p^1_m q^1_m}{\sum_{m=1}^{M} q^1_m} \right) / \left( \frac{\sum_{n=1}^{N} p^0_n q^0_n}{\sum_{n=1}^{N} q^0_n} \right).
\]

Higher level indices aggregate \( P_U(i) \) over the \( i \) commodity groups using standard index number formulas such as Laspeyres and Fisher indices (ILO and others, 2004a, Chapter 15).

Unit Value Bias Illustrated

Consider, for example, trade in refrigerators. With the exception of the “size” of the refrigerator, assume the mix of all price-determining characteristics remains constant over the periods compared, or is proxied by “size.” Assume further that there is a meaningful division of “size” into the three groups of “small,” “medium,” and “large,” and a change in purchasing patterns toward smaller refrigerators. In an illustrative example below, adapted from United Nations (1981, p. 15), refrigerator prices, \( p \), double for each size group and there is a shift to the quantities, \( q \), sold now, in proportion to 2, 3, 4.
and 5 going from largest to smallest, from what was then 5, 3, 2, although total quantity remains the same over time. The value, \( v \), is given as \( p \times q \).

As prices in each size group have doubled, a weighted average of these price changes, \( \sum_{i} w_i \frac{p_i^{\text{Now}}}{p_i^{\text{Then}}} \), over the \( i \) size groups is 2.0. But the change in the unit value is \( 3.4/2.3 = 1.478 \). There is a downward bias in the UVI due to the change in the product mix toward cheaper refrigerators.

<table>
<thead>
<tr>
<th>Size of Refrigerator</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>All sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>( q )</td>
<td>( p )</td>
<td>( v )</td>
<td>( q )</td>
</tr>
<tr>
<td>Now</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Then</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

UVIs: The Test Approach

The test or axiomatic approach to index number formula choice is well established and is used with regard to elementary index numbers in ILO and others (2004a, Chapter 20). If the items whose prices are being aggregated are identical—that is, perfectly homogeneous—a UVI has desirable properties. Consider the case where the exact same item is sold at different prices during the same period, say lower sales and higher prices in the first week of the month and higher sales and lower prices in the last week of the month. The unit value for the monthly index solves the time aggregation problem and appropriately gives more weight to the lower prices than the higher ones in the aggregate. If the elementary UVI in Equation (1) is used as a price index (PI) to deflate a corresponding change in the value, the result is a change in total quantity which is intuitively appropriate, that is

\[
\frac{\sum_{m=1}^{M} p_{m} q_{m}^{1}}{\sum_{n=1}^{N} p_{n}^{0} q_{n}^{0}} = \frac{\left( \frac{\sum_{m=1}^{M} p_{m}^{1} q_{m}^{1}}{\sum_{m=1}^{M} q_{m}^{1}} \right)}{\left( \frac{\sum_{n=1}^{N} p_{n}^{0} q_{n}^{0}}{\sum_{n=1}^{N} q_{n}^{0}} \right)}
\]

Note that the summation of quantities in the top and bottom of the right-hand side of Equation (2) must be of the exact same items for the expression to make sense.

**Heterogeneous items**

The very nature of an index number problem is that the desired measure is the change in price or volume of an aggregate over different items, or items of different qualities. It is well established in index number theory that the superlative class of index number formula, which includes the Fisher, Törnqvist, and Walsh index number formulas, are appropriate (ILO and others, 2004a, Chapters 15–8). The component product groups of UVIs
derived from customs data cannot a priori be assumed to aggregate over homogeneous items.

- The UVI fails the Proportionality Test: $P(p, \lambda p, p^0, p^1) = \lambda$ for $\lambda > 0$; that is, if all prices are multiplied by the positive number $\lambda$, then the new PI is $\lambda$. The UVI only satisfies the proportionality test in the unlikely event that relative quantities do not change.

- It follows from the failure of the proportionality test that the UVI also fails the Identity or Constant Prices Test: $P(p, p, p^0, p^1) = 1$; that is, if the price of every good is identical during the two periods, then the PI should equal unity, no matter what the quantity vectors are. It only satisfies the identity test if relative quantities—that is, the composition of the products compared—do not change.

- The UVI, however, satisfies the proportionality in current period prices test, $P(p^0, \lambda p^1, p^0, p^1) = \lambda P(p^0, p^1, p^0, p^1)$ for $\lambda > 0$; that is, if all period 1 prices are multiplied by the positive number $\lambda$, then the new PI is $\lambda$ times the old PI.

- The UVI fails the Invariance to Changes in the Units of Measurement (commensurability) Test: $P(x_1 p^0_1, \ldots, x_n p^0_n; x_1 p^1_1, \ldots, x_n p^1_n; x_1^{-1} q^0_1, \ldots, x_n^{-1} q^0_n; x_1^{-1} q^1_1, \ldots, x_n^{-1} q^1_n) = P(p^0_1, \ldots, p^0_n; p^1_1, \ldots, p^1_n; q^0_1, \ldots, q^0_n; q^1_1, \ldots, q^1_n)$ for all $x_1 > 0, \ldots, x_n > 0$; that is, the PI does not change if the units of measurement for each product are changed. For example, if the measurement of one of the products changed from pounds weight to kilograms, the index should not change.

UVIs pass the other main index number tests, including the time reversal test, the circularity test, and the product test. However, that it is affected by changes in the composition of products, and (changes in) its units of measurement—that is, it fails the proportionality and commensurability tests—is critical to conclude that it is an inappropriate measure.

That a PI can be affected by changes in relative quantities is a serious deficiency. The essence of the fixed basket concept of PIs is the need to hold quantities constant over time. There is a very real sense in which a UVI should not be properly described as a PI unless applied to transactions for homogeneous products and thus, by definition, the composition of products cannot change.

A particular instance of the effect of the failure in the commensurability test impacting adversely on the UVI is one in which the quality of products imported/exported changes. When this occurs, the actual units of measurement may not change, but the implicit unit of productive service or utility would change, and bias the index. Accounting for the effects of quality changes on prices is difficult enough for index number work based on price surveys (ILO and others, 2004a). Customs data on quality characteristics are likely to fall well short of the corresponding information that would normally be available from establishments producing for export, or purchasing as imports.
Balk (1998) compares UVIs with a Fisher “ideal” index (though see also Silver (2008)), and draws the following conclusion: the unit value bias will be equal to zero for a comparison between periods 0 and 1 if one or more of the following conditions are met:

1. All base period prices \( p_m^0 \) are equal to each other and all current period 1 prices \( p_n^1 \) are equal to each other.
2. All quantity relatives \( q_m^1/q_m^0 \) are equal to each other.
3. There is no correlation between \( p_m^0 \) and \( q_m^1/q_m^0 \), and also no correlation between \( p_n^1 \) and \( q_m^1/q_m^0 \).

These are all highly restrictive conditions. The first condition defeats the purpose of a PI, in that if all prices were equal in each period, then the price change of a single product would suffice. The second condition is the assumption required above for satisfaction of the identity and proportionality tests. If all quantity relatives were equal, and this were known, the PI number problem would be solved by dividing the total outlays by this single quantity relative. The third condition arises from the fact that if price relatives and quantity relatives are uncorrelated, then a change in prices would not affect quantity relatives and vice versa, and there will be no change in the composition mix due to relative price changes. There may be some markets in which there is market failure or temporal inconsistencies, but for the large part the laws of economics cannot be assumed away.

UVIs: Economic Theoretic Approach

Bradley (2005) takes a cost-of-living index defined in economic theory and compares the bias that results from using unit values as “plug-ins” for prices. Bradley (2005) finds that if there is no price dispersion in either the current or reference period compared, the unit value (plug-in) index will not be biased against the theoretical index. But this is equivalent to the case of a single item and the index number problem arises because we are aggregating across more than one item. He also finds that if there is price dispersion in the current period but not the reference period, a unit value “plug-in” would have a downward bias; if prices are dispersed in the reference period but not in the current period, there will be an upward bias in the index; and if there is price dispersion in both periods, there is a guarantee (there is a zero probability that the condition of no bias will hold for any arbitrary data generating process) that there will be a bias in the “plug-in” UVI, but one cannot sign that bias.

4Economic theory allows a theoretically “true” index to be defined under assumptions of (competitive) optimizing behavior on the part of economic agents and related (not independent) prices and quantities. Actual index number formulas can be evaluated against their theoretical counterparts and also against a class of superlative indices that have good approximation properties to a well-defined theoretical economic index. This approach is based on the theory of the cost of living index developed by Konuüs (1924) and used in the consumer price index (CPI) and PPI counterparts to this manual, ILO and others (2004a and 2004b).
UVIs: The Cause for Concern

UVIs derived from data collected by customs authorities are mainly used by some countries as surrogates for price changes at the elementary level of aggregation. The following are the grounds upon which UVIs can be deemed unreliable:

- Bias arises from compositional changes in the quantity and quality mix of what is exported and imported. Even with best practice stratification, the scope for reducing such bias is limited due to the sparse variable list—class of (quantity) size of the order and country of origin/destination—available on customs documents. Indeed, Párniczky (1974) shows that it does not follow that such breakdowns are always beneficial to a UVI.
- For unique and complex goods, model pricing can be used in establishment-based surveys where the respondent is asked to price each period a product, say a machine with fixed specified characteristics. This possibility is not open to UVIs.
- Methods for appropriately dealing with quality change, temporarily missing values, and seasonal goods can be employed with establishment-based surveys to an extent that is not possible with UVIs.
- The information on quantities in customs returns, and the related matter of choice of units in which the quantities are measured, has been found in practice to be seriously problematic.
- With customs unions, countries may simply have limited intra-area trade data to use.
- An increasing proportion of trade is in services and by e-trade, and not subject to customs documentation.
- UVIs rely to a large extent on outlier detection and deletion. Given the stickiness of many price changes, such deletions run the risk of missing the large price catch-ups when they take place and understating inflation.
- Valuation requirements for the deflation of the aggregates of the 2008 System of National Accounts (2008 SNA) are determined for UVIs by customs procedures that are not in accord with the accrual principle of the 2008 SNA (see Chapter 3, paragraphs 3.161–5).

A main advantage of the use of UVIs is held to be their coverage and relatively low resource cost. However, the unit values used are drawn as

---

5 Von der Lippe (2007) shows that adjustment for quality change is one reason why price indices are less volatile than unit value indices.

nonrandom samples and exclude products traded irregularly; that have no quantity reported (especially for parts and machinery); have low-value shipments; and erratic month-to-month changes. The extent of such exclusions is substantial, as illustrated later in this paper. Establishment-based surveys can be quite representative. Often a small number of wholesalers or establishments are responsible for much of the total value of imports or exports and, assuming cooperation, will be a cost-effective source of reliable data. Further, good sampling, can, by definition, realize accurate price change measures and finally, the value shares of exports and imports, obtained from customs data, will form the basis of information for weights for establishment-based surveys.

II. Evidence

We adopt for brevity the terminology of PI to refer to an establishment-survey-based PI as distinguished from a customs data-based unit value index, UVI. The evidence is presented here first at the aggregate level. Results at a more disaggregated level are then considered. Given the above reasons to expect that UVIs will not be suitable surrogates for PIs, it is necessary to consider the empirical evidence available on the nature and extent of any differences. The evidence is presented in this section first at the aggregate level for some existing studies and then for Germany and Japan as new results. Results at a more disaggregated level will be considered later in the section for Germany and some other European countries.

Some Existing Studies

Angermann (1980) compared PI number changes with unit value changes for exports from and imports to the Federal Republic of Germany. Between 1970 and 1976, the (Paasche-ized, to be consistent with the UVI) PI for exports increased by 38.6 percent compared with 34.3 percent measured by (Paasche) UVIs. The discrepancy between such import PIs and UVIs was greater, at 45.8 and 33.1 percent, respectively. He also found that when UVIs were used to calculate the ToT effect there was a gain in 1976 of 1.4 billion deutsche marks to real income, at 1970 prices, compared with a loss of 6.6 billion deutsche marks when using a Paasche-ized PI.

Alterman (1991) compared price changes between March 1985 and June 1989 for the United States as measured by UVIs and PI based on establishment surveys that replaced them. For imports, over this period, the PI increased by 20.8 percent and the UVI increased by 13.7 percent. For exports, the figures were much closer, 13.0 and 12.2 percent for the PI and UVI, respectively. Some of the difference between the two series may be attributed to their use of different periods for weights. However, when PIs were recalculated using the same weights as the UVIs, the differences were exacerbated: a 20.6 and 16.4 percent increase for the import and export PIs, respectively. The average (absolute quarter-on-quarter) UVI change for imports and exports, respectively, were 27 and 70 percent greater than the
corresponding PI changes. One method of considering whether such
differences matter is to evaluate the implications of such discrepancies for
deflation of the foreign trade component of the national accounts. Alterman
(1991) found that the annualized second-quarter 1989 “real” trade deficit in
March 1985 dollars would have been $128.4 billion if deflated by a UVI, but
just $98.8 billion, 23 percent less, if deflated by a PI.

A review in 1992 of the unit value methodology used by the United
Kingdom for its trade PIs led to their change in May 1996 to trade PIs,
following similar changes in methodology by the United States, Japan, and
Germany (Ruffles and Williamson, 1997). The annual averages of export
prices in 1995 compared with 1994 increased by 6.6 percent using PIs
compared with 8.1 percent using UVIs.

Such findings are not new. Kravis and Lipsey (1971) found that the prices
of manufactured goods exported by developed countries to developing
countries had risen over about 20 years by 75 percent, as compared with the
14 percent of the shown by UVIs. Kravis and Lipsey (1985) found a decrease
in the ToT of manufactures relative to all primary products between 1953
and 1976 of over 36 percent, using PIs, almost a quarter greater than that
suggested by the UVIs (28 percent). With a further correction for quality
change, the price data suggested a fall in manufactures ToT of over 45
percent, more than 50 percent greater than UVIs.

Comparison of UVIs and PIs for Germany and Japan

This study compares UVIs and PIs for both Germany and Japan for exports
and imports using monthly data for 1996:7–2006:9 from the IMF’s
International Financial Statistics (IFS). Results are presented to ascertain
the magnitude of the discrepancies between UVIs and PIs for measures of
export and imports price changes as short-run indicators (month-on-month
and month-on-12-month comparisons); long-run cointegration; and
predictive ability (leading indicators). Export and import UVIs are also
used for the measurement of changes in ToT and discrepancies between UVIs
and PIs used for this purpose are also considered, as is the use of UVIs for the
measurement of the ToT effect and as a long-run deflator.

Short-run indicator

Figure 1 compares month-on-month changes between UVIs and PIs for
exports for Germany and identifies substantial volatility for UVIs. Silver
(2007), upon which this paper is based, includes similar figures for exports
and imports in both countries finding substantial discrepancies between PIs
and UVIs. Although, for Japan in some periods, especially the earlier years,
UVIs and PIs appear to track each other, this cannot be relied upon and
breaks down in later periods.

Table 1 provides summary statistics on the magnitude of the (absolute
value of the) discrepancies: the ratio of UVIs to PIs for exports and
imports in both countries along with the root mean squared deviation
between the UVIs and PIs. The mean month-on-month discrepancy is calculated as $\sum_{t=2}^{T} [((UVI_t/UVI_{t-1})/(PI_t/PI_{t-1})) - 1]/(T-1)$ (where $|$ denotes the modulus—absolute value) and other summary measures are defined accordingly. The mean discrepancy for imports to Germany was 1.1 percent. A need exists to draw a line as to the extent to which a discrepancy is acceptable, in the sense that on empirical grounds the matter of choice between a UVI and PI is of little consequence. A discrepancy of 0.011 implies that if the month-on-month change in the PI was unity, no change, then the UVI would take a value of a 1.1 percent change on average; or if the PI was a 1 percent change, the UVI would be $1.01 \times 1.011 = 1.021$, a 2.1 percent change. Such discrepancies can be regarded as seriously misleading for economists. The discrepancy for individual months can of course be much larger than this mean, as reflected by the standard deviation of 1.0 percent and maximum of 7.3 percent points for these month-on-month changes. The month-on-12-month changes benefit from some positive and negative discrepancies over the 12 months compared canceling. Yet, with a mean 12-month PI change for German imports of 4.75 percent, a discrepancy of 1.8 percent on average and standard deviation of 1.6 percent (Table 1) provide no cause for complacency.

Such discrepancies might be argued to be a problem of magnitude rather than direction. Table 2 shows the extent to which positive (and negative) changes in UVI indices are mirrored by positive (and negative) ones in PIs. For about 25 percent of month-on-month comparisons, the signs differ; that is in one-quarter of comparisons the economist would read prices were rising (falling) when they were falling (rising). The results are better for month-on-12-month comparisons, but this cannot be relied upon, as German exports demonstrate.

---

7Von der Lippe (2007) in a study of German data uses $\sum_{m=1}^{M} (UVI_m - PI_m)/M$, that is differences in the index number levels which understate the mean differences as positive and negative differences to some extent cancel. With inflation, it also gives more importance to later period data (higher index levels) than data from earlier periods. Yet, it contains interesting information on the higher levels of volatility of unit value indices compared with that of price indices.
### Table 1. Average Discrepancy between Import Unit Value and Price Indices

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Japan</th>
<th>Germany</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Month-on-month</td>
<td>Month-on-month</td>
<td>Month-on-12-month</td>
<td>Month-on-12-month</td>
</tr>
<tr>
<td>Absolute value of ratio of UVI to PI$^1$</td>
<td>Import</td>
<td>Export</td>
<td>Import</td>
<td>Export</td>
</tr>
<tr>
<td>Mean</td>
<td>0.011</td>
<td>0.009</td>
<td>0.015</td>
<td>0.013</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.010</td>
<td>0.007</td>
<td>0.015</td>
<td>0.010</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.073</td>
<td>0.045</td>
<td>0.060</td>
<td>0.055</td>
</tr>
<tr>
<td>Root mean squared error</td>
<td>0.014</td>
<td>0.011</td>
<td>0.018</td>
<td>0.016</td>
</tr>
<tr>
<td>Mean absolute deviation</td>
<td>0.011</td>
<td>0.009</td>
<td>0.015</td>
<td>0.013</td>
</tr>
</tbody>
</table>

$^1$Summary measures of the absolute value of the discrepancy [($UV/PI$)−1].
Cointegration

It may be argued that the concern should be with the long-run equilibrium between the alternative measures and the extent of any short-run error correction. Unit root tests for Germany and Japan’s import and export UVIs, and corresponding PIs were conducted for month-on-month changes, month-on-12-month changes, and the index. The null hypothesis of a unit root was rejected at a 5 percent level for all month-on-month comparisons, and for all month-on-12-month comparisons, with the exception of German exports (for detailed results, see Silver, 2007). The UVIs and PIs were generally not I(1) and thus it was not possible to establish cointegrating relationships. Although it is the changes that are the concern of economic analysts, we considered the series themselves. The index series, not subject to differencing, were all I(1) and the cointegration test statistics all had p-values that exceeded 0.05; the null hypothesis of a unit root in the cointegrating regression could not be rejected at this level and we thus concluded at this level that the linear combination of the unit value and PI was not I(0), so they were not cointegrated.

Prediction

A further question is whether UVIs have any information content useful to predict next month’s PI. Changes in the past UVIs may be used as indicators of future trade price changes. We estimated for each PI series:

\[ PI_t = \alpha_0 + \sum_{j=1}^{n} \beta_{1j} UVI_{t-j} + \varepsilon_{1t}, \]  

(3)
and tested the null hypothesis that $\beta_{1j} = 0$ for all $j$ and observed the sign if the null hypothesis was rejected (the signs were all positive when significant).

Table 3 shows the $F$-test for this null hypothesis to be rejected in three out four cases for the month-on-month indices and in all cases for month-on-12-month changes. Thus, for most cases UVIs have some predictive power in relation to PIs. However, when they have, it is of little substance. Table 3 provides the means of the PIs and standard errors of the regression. It can be seen that the predictive intervals are quite wide—for example, the 95 percent interval for German imports is ±1.8 percent. Although lagged UVIs have some predictive power regarding PIs, there is the question as to whether lagged UVIs have any contribution to predictive power over and above that of lagged values of the PIs themselves—that the UVIs Granger-Cause the PIs; that lagged UVIs better predict the PIs than lagged PIs would themselves. The test requires ordinary least squares (OLS) (given the stationarity) estimates of

$$PI_t = \alpha_{10} + \sum_{j=1}^{n} \alpha_{1j} PI_{t-j} + \sum_{j=1}^{n} \beta_{1j} UVI_{t-j} + \varepsilon_{1t}$$

and

$$UVI_t = \alpha_{20} + \sum_{j=1}^{n} \alpha_{2j} PI_{t-j} + \sum_{j=1}^{n} \beta_{2j} UVI_{t-j} + \varepsilon_{2t},$$

and tests for the joint hypothesis that $\beta_{1j} = 0$ and $\alpha_{2j} = 0$ for all $j$. The Granger-causality (GC) tests in Table 3 find that in half the cases lagged UVIs contain no predictive power over and above lagged PIs, but this is not to demonstrate that in the cases where there is some such power UVIs GC PIs, as the GC tests reject the null hypothesis that PIs GC UVIs.

The above evidence is that UVIs are misleading proxies for PIs: they mislead in the sense that the relative and absolute errors can be substantial and that in many cases the signs of changes are wrong. There is no evidence of long-run (cointegrating) relationships and UVIs are of little further help for predicting PIs.

**ToT indices**

The concern above was with bias in UVIs as indicators of import and export price inflation, as measured by PIs. Yet, another use of UVIs is in the measurement of changes in the ToT of a country, determined as the ratio of the PI of exports to the PI of imports. If export and import UVIs are used as surrogates for export and import PIs, and export and import UVIs are biased to the same extent and direction, the UVIs will provide a correct indication of changes in the ToT as the bias cancels. However, if the export and import UVIs are biased in different directions, then the ToT UVI bias will compound. Our analysis is similar to that used above, but for ToT measured using UVIs instead of PIs.
Table 3. Predictive Ability of UVIs in Relation to PIs

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Japan</th>
<th>Germany</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Month-on-month</td>
<td>Month-on-month</td>
<td>Month-on-12-month</td>
<td>Month-on-12-month</td>
</tr>
<tr>
<td></td>
<td>Import</td>
<td>Export</td>
<td>Import</td>
<td>Export</td>
</tr>
<tr>
<td>Prediction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>5.911</td>
<td>7.549</td>
<td>6.263</td>
<td>1.475</td>
</tr>
<tr>
<td>p-value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.13</td>
</tr>
<tr>
<td>Standard errors of the regression</td>
<td>0.009</td>
<td>0.003</td>
<td>0.023</td>
<td>0.016</td>
</tr>
<tr>
<td>Mean of PI change</td>
<td>0.001</td>
<td>0.001</td>
<td>0.000</td>
<td>−0.001</td>
</tr>
<tr>
<td>Granger causality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic UVI GC PI</td>
<td>0.339</td>
<td>2.491</td>
<td>2.571</td>
<td>0.781</td>
</tr>
<tr>
<td>p-value</td>
<td>0.98</td>
<td>0.00</td>
<td>0.00</td>
<td>0.67</td>
</tr>
<tr>
<td>F-statistic PI GC UVI</td>
<td>9.133</td>
<td>5.969</td>
<td>17.505</td>
<td>18.258</td>
</tr>
<tr>
<td>p-value</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Table 4 shows the average discrepancy between the UVI and PI measures of ToT. The discrepancies are generally larger than the substantial discrepancies found in Table 1 for the export and import indices. For example, the mean month-on-month discrepancy for ToT changes for Germany was 1.3 percent compared with 1.1 and 0.9 percent, respectively, for imports and exports. For month-on-12-month changes, the ToT discrepancy for Japan was 3.7 percent compared with 2.4 and 2.5 percent for imports and exports, respectively. The ToT discrepancy for Japan implies that if the TOT PI change was unity, the ToT UVI would on average show a month-on-month change of 3.7 percent with, given its standard deviation over time of 10 percent (0.10) and maximum of 70 percent (0.70), the possibility of very misleading results.

Table 5 presents the results on the percentage of months in which ToT UVIs have the same sign to their change as ToT PIs. ToT indices perform worse on average than export and import indices, Table 2, in this respect.
The month-on-month ToT indices had the wrong sign in over one-third of the month-on-month comparisons. Japan’s month-on-12-month series had the wrong sign in 22 percent of cases, but the export and import series had the wrong sign in 15 and 4 percent, respectively (Table 2).

In order to establish whether the ToT indices measured by UVIs and PIs were cointegrated as a first step, we undertook unit root tests finding that they did not have unit roots and thus are not cointegrated (for detailed results, see Silver, 2007). The ToT indices measured as lagged UVIs were found to have some predictive information in relation to ToT PIs but it was very weak, as demonstrated by the relatively large standard errors of the regression in relation to the means of the ToT, given in Silver (2007). In the case of Germany, lagged ToT UVIs had no predictive ability over ToT PIs, but in Japan, lagged UVIs had some such ability; PIs were found to have a similar predictive effect for UVIs, so we could not establish that ToT UVIs Granger-cause ToT PIs.

ToT effect

ToT effect, or trading gain (loss), is a measure of the effect on income of changes in the ToT of a country, the relative price change of imports against exports. The 2008 SNA (Chapter 15, Section D) outlines the method of calculation as

\[ T = \frac{X - M}{P} - \left( \frac{X}{P_X} - \frac{M}{P_M} \right), \]

(5)

where the first term is a measure of the goods and services balance (exports of goods and services \(X\) less imports of goods and services \(M\)) using a single deflator, \(P\), and the second term is the goods and services balance by taking the difference between a volume (say, constant price) measure of exports and a volume measure of imports, that is after \(X\) and \(M\) have been deflated by respective PIs for exports and imports, \(P_X\) and \(P_M\). Note in the second term how, for example, as export prices increase more slowly than import prices, the larger the sum deducted from the first term is, and hence the smaller the ToT effect is. Note also that the magnitude of the ToT effect is contingent on the deflator in the first term. There is no agreement as to the best deflator to use for this component (Silver and Mahdavy, 1989). The interpretation of the trading gain would be in terms of the gain in purchasing power with regard to the bundle of such goods and services to which \(P\) relates.

Table 6 shows the annual ToT effects for Germany and Japan in each case measured in terms of the change in prices for the preceding year and in terms of the purchasing power of imports, \(P = P_M\), although a similar conclusion arises from using exports or some average of the two. Data are also provided for each year on the country’s trade balance. The effect of using UVIs to calculate the ToT effects as against PIs is most marked. Note how, for example, in 2005 Japan’s trade balance of 6,956 billion yen is
eliminated by the adverse change in its ToT when using PIs, but only halved when using UVIs.

**Long-run changes and deflation**

Table 7 is concerned with comparing long-run changes between UVIs and PIs. One way of considering this is in terms of the use of such indices as deflators. In Table 7, the values of exports and imports of Germany and Japan are deflated over the period from 1999 to 2005 by corresponding UVIs and PIs, and the results are compared. The volume of exports by Japan can be seen to have increased by 50 percent over this period when a UVI deflator is used, but the increase is halved when a PI is used. The volume of imports by Germany is about constant over this period when a UVI deflator is used, but fell by about 10 percent using a PI deflator.

The evidence is that export and import UVIs are inadequate surrogates for their PI counterparts when used in economic analysis. Such analysis includes their use in the measurement of short- and long-run inflation, prediction, ToT, ToT effects, and as deflators. Indeed, the evidence is that they are seriously misleading.

### III. What Is to Be Done?

Given what should be grave concern over the use of UVIs, there is the practical matter of what should be done. UVIs are used by most countries and a move to PIs has resource consequences.

One possibility is to identify whether there are particular products less prone to UV bias and utilize UVIs for these subaggregates in a hybrid overall index. This has the resource advantage of undertaking price surveys only for

<table>
<thead>
<tr>
<th>Terms-of-trade effect</th>
<th>Unit value indices</th>
<th>Price indices</th>
<th>Trade balance¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany (billion of euros)</td>
<td>1999</td>
<td>2.1</td>
<td>-0.2</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-43.7</td>
<td>-46.0</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>13.7</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>19.4</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>20.8</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>0.2</td>
<td>-4.5</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>-16.4</td>
<td>-26.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Terms-of-trade effect</th>
<th>Unit value indices</th>
<th>Price indices</th>
<th>Trade balance¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan (billion of yen)</td>
<td>1999</td>
<td>2,663.6</td>
<td>-518.9</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-2,866.6</td>
<td>-5,174.5</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>3,743.1</td>
<td>289.7</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>-2,016.8</td>
<td>183.2</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>960.1</td>
<td>-1,998.8</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>-1,420.9</td>
<td>-3,548.3</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>-3,614.7</td>
<td>-7,001.2</td>
</tr>
</tbody>
</table>

¹National accounts estimates of exports minus imports of goods and services (IMF, *International Financial Statistics*).
products for which they are necessary. The efficacy of such advice depends on the extent to which reliable UVIs will be available at a disaggregated level.

Use Unit Value Subindices for Homogeneous Product Groups: The Reliability of Subindices

**Disaggregated export and import UVIs and PIs for Germany**

We extend the study to disaggregated monthly data for Germany. Such data are for export and import UVIs and PIs for the period from January 2000 to November 2006 and cover 150 series for which comparable data are available at the four-digit level of the Statistical Classification of Products by Activity in the European Economic Community, 2002 version (CPA). They are Paasche index numbers whose elementary aggregate building blocks are UVIs as opposed to PIs.

The results in Table 8 are for the 15 series that have the least difference between the PI and UVI series. The results for these “best” groups have an average discrepancy and volatility in excess of that for the weighted aggregate import PI found for Germany above. On aggregation, there must be some smoothing of these fluctuations, though not to an extent, as revealed in the previous section, that renders them as suitable surrogates for PIs. Had the results been more favorable, it would have been useful to attempt to characterize these “best” product classes for use in the compilation of UVIs in hybrid UVI/PI indices. Unexpectedly, they include three heterogeneous classes composed of “other” and “n.e.c.” products. There is also some concentration around plastic products and motor vehicle-related activities. But given the size of the discrepancies, these are not useful groupings.

<table>
<thead>
<tr>
<th>Table 7. Comparison of Deflated Exports and Imports by UVIs and PIs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germany</strong></td>
</tr>
<tr>
<td><strong>Billions of euros at constant 1999 prices</strong></td>
</tr>
<tr>
<td>1999</td>
</tr>
<tr>
<td><strong>Exports</strong></td>
</tr>
<tr>
<td>Unit values</td>
</tr>
<tr>
<td>Price indices</td>
</tr>
<tr>
<td><strong>Imports</strong></td>
</tr>
<tr>
<td>Unit values</td>
</tr>
<tr>
<td>Price indices</td>
</tr>
</tbody>
</table>
### Table 8. CPA Four-Digit Classes in Percentile with the Least Discrepancy for Month-on-Month UVIs and PIs

<table>
<thead>
<tr>
<th>Month-on-Month Discrepancy: UVI and PI</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPA-3410 Manufacture of motor vehicles</td>
<td>0.0197</td>
<td>0.0601</td>
<td>0.0009</td>
<td>0.0153</td>
</tr>
<tr>
<td>CPA-2111 Manufacture of pulp</td>
<td>0.0197</td>
<td>0.0664</td>
<td>0.0003</td>
<td>0.0148</td>
</tr>
<tr>
<td>CPA-3430 Manufacture of motor vehicles parts and accessories</td>
<td>0.0260</td>
<td>0.1266</td>
<td>0.0001</td>
<td>0.0212</td>
</tr>
<tr>
<td>CPA-2521 Manufacture of plastic plates, sheets, tubes, and profiles</td>
<td>0.0278</td>
<td>0.0920</td>
<td>0.0000</td>
<td>0.0202</td>
</tr>
<tr>
<td>CPA-2416 Manufacture of plastics in primary forms</td>
<td>0.0282</td>
<td>0.0898</td>
<td>0.0001</td>
<td>0.0209</td>
</tr>
<tr>
<td>CPA-2112 Manufacture of paper and paper board</td>
<td>0.0296</td>
<td>0.0916</td>
<td>0.0000</td>
<td>0.0217</td>
</tr>
<tr>
<td>CPA-2875 Manufacture of other fabricated metal products n.e.c.</td>
<td>0.0325</td>
<td>0.1289</td>
<td>0.0005</td>
<td>0.0257</td>
</tr>
<tr>
<td>CPA-2522 Manufacture of plastic packing goods</td>
<td>0.0344</td>
<td>0.1139</td>
<td>0.0001</td>
<td>0.0245</td>
</tr>
<tr>
<td>CPA-1533 Processing and preserving of fruit and vegetables n.e.c</td>
<td>0.0350</td>
<td>0.1281</td>
<td>0.0004</td>
<td>0.0280</td>
</tr>
<tr>
<td>CPA-1740 Manufacture of made up textile articles, except apparel</td>
<td>0.0368</td>
<td>0.1048</td>
<td>0.0012</td>
<td>0.0269</td>
</tr>
<tr>
<td>CPA-2710 Manufacture of basic iron and steel and ferrous-alloys (ECSC)</td>
<td>0.0370</td>
<td>0.1591</td>
<td>0.0002</td>
<td>0.0312</td>
</tr>
<tr>
<td>CPA-2511 Manufacture of rubber tire and tubes</td>
<td>0.0371</td>
<td>0.1490</td>
<td>0.0000</td>
<td>0.0305</td>
</tr>
<tr>
<td>CPA-2524 Manufacture of other plastic products</td>
<td>0.0380</td>
<td>0.1193</td>
<td>0.0021</td>
<td>0.0282</td>
</tr>
<tr>
<td>CPA-1823 Manufacture of underwear</td>
<td>0.0387</td>
<td>0.1115</td>
<td>0.0009</td>
<td>0.0284</td>
</tr>
<tr>
<td>CPA-2415 Manufacture of fertilizers and nitrogen compounds</td>
<td>0.0395</td>
<td>0.1524</td>
<td>0.0001</td>
<td>0.0330</td>
</tr>
</tbody>
</table>

1Not elsewhere classified.
2European Coal and Steel Community.
The PLANISTAT Report

Also of particular help in examining UVI and PI discrepancies at a disaggregated level is the extensive study *PLANISTAT Europe Reports* (Decoster, 2003a and 2003b) commissioned by Eurostat for European Member States. In particular, the second report provided a comparative analysis of import PIs and UVIs for Finland, Germany, the Netherlands, and Sweden. The monthly import indices used are those provided by these countries to Eurostat. The UVIs were extracted from the Comext database. The series are available at a three-digit level CPA and while results at aggregated levels are provided, they are unweighted and are not useful for our purposes. The series are monthly from January 1995 (=100) to September 2001. Some of the results are provided and discussed in Silver (2007). For example, for Finland, of the 77 product groups at the three-digit level CPA for which import data were available, 17 percent had an average discrepancy between UVIs and XMPIs of less than 2.5 percent, and about another 40 percent between 2.5 and 5 percent. There was less difference between UVIs and PIs for Sweden with about one-third of three-digit product groups having a discrepancy of less than 2.5 percent. Bear in mind that a discrepancy of 0.025 implies that if the month-on-month change in the PI was zero, no change, then the UV index would take a value of a 2.5 percent change on average. The results in Silver (2007) demonstrate, as did Decoster (2003a and 2003b), that the average monthly discrepancy was unacceptable for any product group. Decoster (2003a, p. 9) found that PIs are more stable over time than UVIs, and that UVIs often display erratic behavior that PIs do not, concluding that

Any list of CPA categories for which UVIs are a priori acceptable as proxies for SPIs [import price indices] would be very short, especially as regards monthly data. It would include almost only aggregates and raw materials, even if sizable discrepancies between UVIs and SPIs are deemed acceptable. Apparently, any list of product categories for which short term UVIs are acceptable proxies for SPIs seems country specific. For a few low-tech products, for which quality changes are slow, UVI changes over the long term (several years) may be acceptable proxies for SPIs.

---

8 Data were not available at a detailed level of aggregation for Germany.

9 UVIs are subject to outlier detection and revision and the series available in Comext may differ from those available from the individual countries in this regard.

10 The PLANISTAT report was undertaken by Renaud Decoster. The results provided here are based on the worksheets of summary measures for the individual series, provided to the author of this chapter by Mr. Decoster. The author acknowledges Mr. Decoster’s help and advice. The above tables do not appear in the report, but are based on the data series used for the report. The conclusions drawn here and in the report are very similar and differ only in that a less favorable consideration is given in the report to UVIs than here.
Use a More Detailed Stratification of Unit Values

A second possibility is to improve UVIs by more detailed stratification of the customs data. United Nations (1981) emphasized the need to stratify unit values to the (limited) extent possible and drew attention to doing so where possible by country of destination and size of batch, though see Pá‘rniczky (1974) on the limitations to this. Stratification is also possible for shipments by/to (major) establishments to/from given countries. However, the absence of highly detailed criteria by which to stratify unit values precludes any benchmark as to what is a reliable UVI. However, such experiments can be undertaken for consumer goods using highly detailed bar-code scanner data. Bradley (2005) examined the issue in some detail and found that even for detailed data of sales of cereal in 169 selected stores by 1,369 brands, aggregating unit values that distinguish a brand of tuna according to the week of purchase and store in which it is sold, as against simply aggregating unit values for the self-same brand and item, leads to substantial differences in the results. Silver and Webb (2002) took (brand and) model numbers for washing machines, dishwashers, vacuum cleaners, television sets, cameras, and personal computers, and compared unit value changes for the same models over different store types, finding quite different results when aggregating with and without store type as a variable. Haan and Opperdoes (1999) undertook a similar study on coffee, further apportioning their data according to the week of the month the data relates to, again finding unit value bias. Given such bias at this fine level of detail for aggregating identical items, it is hard to imagine disaggregated unit values based on customs returns being robust to unit value bias.

Use Other Country Data or Global Product PIs

An alternative to using UVIs is to use corresponding series from other countries, for example, an export PI of personal computers from the United States to proxy an import PI, or global commodity PIs to proxy exports or imports. The assumption is that there is a global market in which countries are price takers with little to no price discrimination between countries. In advocating stratification by country of origin/destination United Nations (1981) implicitly argued against this as a general strategy. However, there may well be product areas for which this is useful. It will not, of course, be a panacea for the measurement of trade PIs.

Different Formulas

PIs and UVIs are compiled in two stages. The first stage is the price relative (PIs) or unit value change (UVIs) at the elementary level of aggregation, to form elementary indices. The second stage is the weighted aggregation of these elementary indices. PIs and UVIs may be compiled using different formulas at this second stage, so differences in the results may in part be due to formula differences. Data were not available to recompile the indices to
identify the effect of such formulas’ differences. Some insights are available for Germany.\textsuperscript{11} Germany is in the fortunate position of having import PIs, import deflators of the national accounts, and UVIs.\textsuperscript{12} The import PIs are of the Laspeyres type and refer to the year 2000. The Laspeyres principle is applied, however, only to the basket of goods, but not to the countries of origin, meaning that any shifts to low-cost producers will not be captured by the import PI. The national accounts deflators are annually chained Paasche indices, and the UVIs are Paasche indices referring to the year 2000. The product-specific PIs used for the compilation of the national accounts deflators are taken from the price statistics. Hence, the main difference between the import PI and the import deflator is to be found in the index formula.

In the years 2000–05, the UVI displayed a decline of 1.8 percent pa, whereas the import PI increased slightly and the import deflator decreased less strongly (\(+\ 0.3\) and \(-0.8\), respectively). Taking the geometric average of the change in the import price deflator and the import PI gives an estimate of 0.2 percent as the “true” annual change in import prices, implying that the German UVI is significantly distorted downward.

Bear in mind, we are comparing Paasche UVIs with Laspeyres PIs. Von der Lippe (2007) demonstrates how the components of such formula discrepancy may cancel and any differences would be the result of unit value bias.

\textbf{Lack of Customs Data and UVIs within Monetary Unions and for Services}

There remains a potential problem of customs data itself becoming unsuitable for measuring trade flows for some countries. Countries with customs/monetary unions may abandon or limit the requirements on trade within the union to be documented. Furthermore, with services and e-commerce making up an increasing share of trade, customs data on merchandise trade will be unsuitable as the sole data source. Establishment-based sources for external trade price data have become the only practical option in these cases (though trade within customs unions may well be measured as a by-product of administering, for example, value-added taxes).

\textbf{Use Deletion Routines for Unusual Price Changes}

Of widespread use in the compilation of UVIs are deletion routines. This is because much of the data from customs records on unit value changes are extreme outliers and have to be discarded. Some of these arise from absent or

\textsuperscript{11}UVIs are compiled in Japan using a Fisher index and the trade price indices (from their Corporate Goods Price Index) using a chained Laspeyres index, although there is some lag in the adoption of the most recent period’s weights.

\textsuperscript{12}Data and this account on Germany are from private correspondence with Johannes Hoffmann and Hans-Albert Leifer, Deutsche Bundesbank, December 2006.
poor quantity data. In other cases, it is due to unit value bias. Alterman (1991) estimated that the United States UVIs produced in 1985 were calculated for only 56 percent of the value of imports and 46 percent of the value of exports. For capital goods, the respective figures for imports and exports fell to 30.3 and 26.1 percent. The problems of such deletions are two-fold. First, the implicit effect on the sample representativeness and coverage. PIs are based on selected items from selected establishments with the purpose in mind that they are representative. Second, is that the deletion removes signal as opposed to noise. There is much evidence in CPI compilation, for example Hoffmann and Kurz-Kim (2006), that price changes can be substantial, and irregular, with long periods of constant prices followed by relatively large catch-up price changes. These large price increases may be deleted by outlier detection routines, resulting in UVIs that are unduly stable.

The Resource Constraint

A main reason why countries do not compile PIs is the cost of doing so. United Nations (1981) recognized the superiority of PIs by recommending well-endowed countries compile them, while advising countries with limited resources to compile UVIs. Countries require PIs not only for trade flows but also for the deflation of output, intermediate, and final consumption of goods and services by resident units. In particular, an output producer price index (PPI) is required that measures the changes in the prices of output of resident establishments. PPIs are compiled by selecting representative items from major/representative establishments and comparing the prices of like with like over time. Such output covers the domestic and export market (ILO and others, 2004b). For a self-standing export PI, there would be a need to identify price changes from such establishments for foreign markets as well as overall output and, as necessary, expand the sample size to ensure those establishments serving foreign markets are included in a representative manner. In some instances, specialist import/export wholesalers may be an efficient contact. Poorer countries have fewer establishments serving foreign markets with large proportions of exports usually being the responsibility of a relatively small number of establishments. Similar arguments apply to imports. Establishment-based trade PIs are but an extension of establishment-based price surveys for producer prices. There are resource costs to both PPIs and, by extension, to trade PIs. But they have their benefits that are the proper measurement of the major economic flows affecting the country, to allow for appropriate policy responses when necessary.

IV. Conclusions

There has been a long-held view that UVIs based on customs data can seriously misrepresent price changes as measured by PIs. The evidence in Section II of this paper supports that view: UVIs were found to seriously
mislead in the sense that discrepancies between UVIIs and PIs were substantial; changes could not be relied upon to have the same sign; there was no evidence of long-run (cointegrating) relationships between PIs and UVIIs; and UVIIs were of little help in predicting PIs. The findings held both for month-on-month and month-on-12-month changes. The marked unreliability of UVIIs as measures of export and import price inflation was surpassed by the unreliability of the ToT indices based upon them. ToT indices based on UVIIs failed with regard to the substantial magnitude of the discrepancy with PI-based ones, the wrong sign, absence of long-run relationship, and poor predictive value.

The results from using UVIIs to measure the ToT effect, as part of a measure of real national income, and to deflate import and export current period values to derive volume measure were seriously misleading when compared with those from using PIs.

We reiterate the caveat to these findings at the start of this paper. The evidence presented here is limited to two countries that compile both PIs and UVIIs, although other studies have similar conclusions. It is also limited by the fact that the deficiencies in UVIIs are not measured against a perfect benchmark, the PIs themselves having deficiencies. Yet, as outlined above, UVIIs suffer mainly from not comparing the prices of like with like, but establishment-based PIs do so. Furthermore, the coverage of PIs is by design representative, but the coverage of UVIIs results from a substantial discarding of outliers. This and other studies asked how well UVIIs stand up against PIs designed to overcome their major failings and the answer is that that they do not.

We then turned to the question of what can be done. The answer is to commence as soon as possible a program of establishment-based survey price collection. In Section III, we demonstrated that at the four-digit CPC level individual UVI series were still misleading. We would advocate a move from UVIIs to establishment survey PIs. We recognize that there are resource costs involved and such a move involve a transitional utilization of hybrid indices, using PIs for the “low-hanging fruit” of the relatively small number of establishments responsible for a relatively large proportion of trade. In Section III, we also argued that customs data were by nature limited to the extent that it could benefit from further stratification. On a positive note, we stated that other country indices or global product prices may play a useful role, but this was not a panacea. The fact that our comparisons between UVIIs and PIs were not pure was reiterated, and we then argued that customs and monetary unions and the increasing role of services in world trade give rise to the further cause of concern over a reliance on customs data. The main advantage of customs data had been argued to be their superior coverage of transactions and relatively low resource cost. We also argued that the extent of deletions gives rise to concern over the representativeness of UVIIs and potential bias in deletion of some of the signal. As regards the resource constraint, the development of establishment-based surveys was identified as a natural part of the development of a system.
of producer price indices (PPIs), with a smaller resource demand on countries with less-developed import and export markets. Indeed, it seems apparent that a disservice is being done to countries by advocating the cheaper alternative of UVIs.

REFERENCES


Solin, 1985, “Prices and Terms of Trade for Developed-Country Exports of Manu-
factured Goods,” NBER Working Papers: No. 0774 (Cambridge, Massachusetts, 


Derivation of Price and Volume Measures from Current Price Values,” Economic 
Trends, Vol. 521 (April). Reproduced in Office for National Statistics (ONS), 

Silver, Mick, 2007, “Do Unit Value Export, Import, and Terms of Trade Indices 
Represent or Misrepresent Price Indices?” IMF Working Paper 07/121 (Washington, 
International Monetary Fund).

———, 2008, “An Index Number Formula Problem: The Aggregation of Broadly 
Comparable Items,” paper presented at the 2008 World Congress on National 
Accounts and Economic Performance Measures for Nations, May 12–17, 
finalprogram.htm.

Effect and Real National Disposable Income within a National Accounting 
pp. 87–107.

the Basic Level,” Journal of Economic and Social Measurement, Vol. 28, No. 1–2, 
pp. 21–36.

United Nations, Department of International Economic and Social Affairs, 1981, 
Strategies for Price and Quantity Measurement in External Trade, Statistical Papers, 
Series M, No. 69 (New York, United Nations).

———, 1983, Price and Quantity Measurement in External Trade: Two Studies of National 
Practice, Statistical Papers, Series M, No. 76 (New York, United Nations).

Von der Lippe, Peter, 2007, “Price Indices and Unit Value Indices in German Foreign 
Trade Statistics” (unpublished: Germany, University of Duisburg-Essen).
Why Has the Grass Been Greener on One Side of Hispaniola? A Comparative Growth Analysis of the Dominican Republic and Haiti

LAURA JARAMILLO and CEMILE SANCAK

The Dominican Republic and Haiti share the island of Hispaniola and are broadly similar in terms of geography and historical institutions, yet their growth performance has diverged remarkably. The countries had the same per capita real GDP in 1960, but, by 2005, the Dominican Republic’s per capita real GDP had tripled, whereas that of Haiti had halved. Drawing on the growth literature, this paper explains this divergence through a combined approach that includes a panel regression to study growth determinants across a broad group of countries, and a case study framework to better understand the specific policy decisions and external conditions that have shaped economic outcomes in the Dominican Republic and Haiti. This paper finds that initial conditions cannot fully explain the growth divergence, but rather policy decisions have played a central role in the growth trends of the two countries. [JEL O11, O47, O57]


The Dominican Republic and Haiti present a quasi-natural experiment; the two countries share the island of Hispaniola and are broadly similar in

*Laura Jaramillo and Cemile Sancak are economists in the IMF’s Western Hemisphere and Fiscal Affairs Departments, respectively. The authors would like to thank Guy Meredith, Jeromin Zettelmeyer, and Andy Wolfe for their encouragement and support. We also thank Dan Holmes, Juan Climent, Chris Towe, Luis Cubeddu, and participants at the Western Hemisphere Department seminar and growth workshop for their useful comments. Volodymyr Tulin provided valuable research assistance.
terms of geography and historical institutions, yet their growth performance has diverged remarkably since 1960, when the two countries had the same per capita real GDP, just below $800. However, by 2005, the Dominican Republic’s per capita real GDP had tripled to about $2,500, whereas that of Haiti had halved to $430 (Figure 1). Accordingly, the Dominican Republic and Haiti have been at opposite ends of the spectrum within Latin America and the Caribbean in terms of growth rates over the past 45 years, with the Dominican Republic achieving one of the highest average real GDP growth rates at above 5 percent and Haiti, the lowest at about 1 percent (Figure 1).

What explains this divergence in per capita real GDP of the two countries? This paper seeks to answer this question by examining two main issues: (1) to what extent the divergence is the inevitable result of disparities in initial conditions, and (2) to what extent it is the result of differences in the policies pursued in each country since 1960. Drawing on the growth literature, the paper addresses these issues through a combined approach that includes a panel

Figure 1. GDP Per Capita, and Real GDP Growth Rates in Latin America, 1960–2005

![GDP Per Capita Chart]

Source: World Bank, World Development Indicators.
regression to study growth determinants across a broad group of countries, and a case study framework to better understand the specific policy decisions and external conditions that have shaped economic outcomes in the Dominican Republic and Haiti. To examine policy decisions, this paper uses growth determinants from the literature and introduces alternative variables of institutional quality and stabilization policies to help better explain the income divergence between the two countries. Furthermore, to facilitate comparisons, Latin America is used as a reference point throughout the paper.

When examining initial conditions, namely geography and historical institutions, we find great similarities between the Dominican Republic and Haiti, implying that initial conditions cannot explain their divergence in per capita real incomes. Moreover, based on the panel regression and case study, we find that policy decisions since 1960 have played a central role. In particular, the Dominican Republic has consistently outperformed Haiti and the rest of Latin America in terms of structural measures and stabilization policies, whereas Haiti has been subject to numerous political shocks that have severely affected its growth performance.

I. Literature Review

Only a few studies have compared the growth performance of the Dominican Republic and Haiti, and these studies have provided mostly qualitative discussions. Among the well-known ones is the chapter in Jared Diamond’s book *Collapse: How Societies Choose to Fail or Succeed* (2005). Although Diamond focuses on environmental policies, it can be inferred from his arguments that higher population density and lower rainfall have been the main factors behind the more rapid deforestation and loss of soil fertility on the Haitian side of Hispaniola, with adverse consequences for agricultural production and therefore growth performance. Similarly, Lundahl (2001) argues that Haiti is the poorest country in the western hemisphere because of the interplay between population growth and the destruction of arable land. He explains that the increase in the rural labor force has led to an expansion of subsistence food crops to the detriment of export crops, in the context of decreasing international food commodity prices.

Other studies have found that economic performance in the Dominican Republic has been favored by political and macroeconomic stability. Bulmer-Thomas (2001) finds that, for the Caribbean in general, improvements in per capita GDP are linked to higher exports per capita, the quality of institutions, and stability of the macroeconomic framework. The World Bank (2006) also argues that the Dominican Republic experienced a more enabling environment for private investment than Haiti due to political stability and stable macroeconomic conditions over prolonged periods that allowed it to follow a more diversified and outward-oriented growth strategy. In addition, IMF (2001) argues that growth in the Dominican Republic during the 1990s was anchored by capital formation and strong productivity growth, whereas trade liberalization encouraged private investment and output growth.
This paper contributes to the study of growth performance of the Dominican Republic and Haiti by providing a comparative analysis of the two countries. In contrast to previous work, this paper relies on a combination of approaches, specifically growth accounting, panel regressions, and case studies. These approaches are complementary because growth accounting provides a broad overview of economic performance and resource endowments in the Dominican Republic and Haiti, the panel regressions provide a benchmark to compare the performance of the two countries with an “average economy” facing similar shocks, and the case study allows us to capture the heterogeneity in the conditions and processes that have governed the growth experience in each country.

II. Initial Conditions

We begin by examining two initial conditions that growth literature highlights as the most likely to influence long-term growth performance: geography and historical institutions. Although the absence of national accounts prior to 1960 does not allow us to determine exactly at what point in time the Dominican Republic started growing faster than Haiti, this analysis helps us determine if the divergence started long before 1960.

Geography

Geography plays a direct role in shaping a country’s growth performance. It determines the quality of natural resources, the productivity of land, the public health environment, and the extent to which a country can become integrated with world markets. When we compare the geographic characteristics of Haiti and the Dominican Republic based on measures widely used in the literature, we find no substantial differences between the two countries on these grounds, from which we can infer that geography cannot explain the growth divergence between the two countries.

Gallup, Sachs, and Mellinger (1998) assess the impact of geography on economic development and find that growth is favored in temperate regions, in coastal regions, and also in regions with high population density and good access to trade. However, these factors do not explain the divergence between Haiti and the Dominican Republic as they have the same location, equal ocean access, and similar climate. In addition, Haiti has historically had twice the population density of the Dominican Republic.1

As explained in the literature review, Diamond (2005) also addresses the issue of geography and argues that rapid deforestation, caused by lower rainfall and higher population density, has led to lower growth in Haiti compared with the Dominican Republic. However, a 1941 study on rainfall in Hispaniola did not find evidence that Haiti had lower rainfall than the Dominican Republic. On the basis of data for an average of 11 years, the

1Haiti is about half the size of the Dominican Republic, but has roughly the same population.
study reveals that rainfall was comparable in the two countries (see Alpert, 1941). Likewise, had lower rainfall been an issue for Haiti, it would not have been one of the richest colonies in the French empire during the 18th century, when it produced about 40 percent of all the sugar and 60 percent of all the coffee consumed in Europe. In fact, deforestation on the Haitian side of Hispaniola can be considered a more recent phenomenon: even as late as 1960, the amount of arable land in both countries was comparable at about 20 hectares per person. Similarly, Diamond’s argument about the impact of high population density on land use cannot convincingly explain lower growth rates in Haiti compared with the Dominican Republic. Several studies have found evidence about the potential benefits of higher population density, including Gallup, Sachs, and Mellinger (1998) and Klasen and Nestmann (2004), who argue that population density generates the linkages, infrastructure, demand, and effective market size for technological innovations that fuel growth. Figure 2 illustrates the relationship between population density and growth. Between 1960 and 2005, many of the countries with the highest per capita real GDP growth had high population densities—in some cases even higher than that in Haiti—whereas countries with the lowest per capita real GDP growth had low population densities.  

### Historical Institutions

A growing body of literature argues that institutions are important for initiating and sustaining economic growth. Although institutions are clearly endogenous and evolve with economic performance, in this subsection we focus on the influence of historical institutions to understand if economic performance since the 1960s has been driven mainly by colonial legacies or rather by more recent policy developments. We find that the historical institutions of the Dominican Republic and Haiti were very similar leading into the 20th century, implying that this cannot fully explain the growth divergence.  

Acemoglu, Johnson, and Robinson (2001) argue in a seminal paper that colonial origin matters for growth. They find that Europeans were more likely to set up extractive institutions in places where they faced high mortality rates and could not settle, resulting in poor institutions that have persisted to the present. However, the Dominican Republic

---

2Looking at GDP growth by sector in Haiti and Dominican Republic over the period 1960–2000 reveals that performance of the primary sector did not drive overall growth performance in either country. In the Dominican Republic, the primary sector explains about 12.5 percent of the total average growth rate, whereas the secondary and tertiary sectors explain 32.5 and 55 percent, respectively. Similarly, in Haiti, the primary sector explains less than 10 percent of the total average growth rate, whereas the secondary and tertiary sectors explain about 45 percent each.

3Appendix I provides a chronology of political events for both the Dominican Republic and Haiti.
and Haiti had the same settler mortality rates as estimated by these authors. Therefore, it would be expected that both countries had equally extractive institutions (Figure 3). In terms of the impact of the colonial power, the literature does not provide evidence of significant differences between Spanish colonial rule in the Dominican Republic and French colonial rule in Haiti. Several studies have used dummy variables for French, British, and Spanish colonies to try to explain growth, corruption, and policy volatility, but have found only the British variable to be significant.4

Furthermore, Haiti and the Dominican Republic share common institutional features, such as those examined by La Porta and others (1998), who find that countries that are ethnolinguistically heterogeneous, use French or socialist laws, or have high proportions of Catholics or Muslims exhibit inferior government performance. The Dominican Republic and Haiti both have low ethnolinguistic fragmentation, both use French law, and both have mainly Catholic populations (Figure 3).

In fact, the quality of institutions was poor in both countries until early in the 20th century—at the time of the U.S. military occupation—with arguably greater political instability in the Dominican Republic. Between independence

---

in 1804 and the U.S. military occupation in 1915, Haiti had 33 heads of state, with an average time in power of 3.4 years. Meanwhile, between independence in 1844 and the U.S. military occupation in 1916, the Dominican Republic had 61 heads of state, with an average time in power of only 1.2 years. Moreover, although it served U.S. interests, the U.S. military occupation of the island was linked to internal struggles and violence in both countries.\(^5\) Prior to the U.S. occupation in 1916, the assassination in 1911 of President Cáceres in the Dominican Republic led to various revolutions, economic chaos, and a near-collapse of government institutions. Similarly, before the U.S. intervention in 1915, six different Haitian presidents had been killed or forced into exile since 1911, with revolutions leading to economic disorder and growing external indebtedness.

In summary, strong similarities in the initial conditions in the Dominican Republic and Haiti indicate that these cannot explain the divergence in real incomes of the two countries since 1960. However, this finding does not imply that all conditions were identical going into the 1960s. In fact, by 1960, Haiti was already trailing the Dominican Republic in some social indicators, such as life expectancy and illiteracy rates.\(^6\) Nonetheless, we find that these differences are likely to have emerged closer to 1960 and were not inherited from the 19th or early 20th centuries. As mentioned earlier, lack of national accounts prior to 1960 does not allow us to determine the exact point in time when the Dominican Republic started to outpace Haiti, but differences are likely to have started to emerge in part as a result of the policies implemented

---

\(^5\)U.S. expansion into the Caribbean Basin—at a time when the United States was pursuing the construction of the Panama canal—was supported by the Monroe Doctrine, originally intended to keep European nations out of Latin America, and Theodore Roosevelt’s corollary to this doctrine, which stated that the United States had a moral mandate to enforce “proper” behavior among Latin American countries.

\(^6\)In 1960, life expectancy at birth was 44 years in Haiti compared with 54 years in the Dominican Republic. The under-5 mortality rate per thousand children was 253 in Haiti compared with 149 in the Dominican Republic. The adult illiteracy rate above age 15 (data available for 1970) was 78 percent in Haiti and only 33 percent in the Dominican Republic.
following the U.S. military occupation. In general terms, the outcomes of the
U.S. intervention in both countries were akin: order was broadly restored;
the countries’ budgets were balanced and debts reduced; and infrastructure
was expanded, including new roads, telephone connections, port facilities,
and public health and education services. However, ensuing governments in
Haiti practiced only rent-seeking behavior without efforts to maintain public
infrastructure and social services, whereas the Trujillo regime in the
Dominican Republic promoted agriculture, industry, and public works.

III. Analysis of Policies Pursued

In light of the similarity of initial conditions in Haiti and the Dominican
Republic, we continue with an analysis of the policies pursued in each
country since 1960, when national accounts became available, to shed more
light on the factors contributing to the divergence in per capita real GDP.
The analysis is based on a combination of growth accounting, panel
regressions, and case studies.

Growth Accounting

A standard growth accounting exercise shows that total factor productivity
(TFP) has been an important factor for both the Dominican Republic
and Haiti (Figure 4).7 In broad terms, the Dominican Republic had
favorable growth trends between 1960 and 2000, largely fueled by
productivity gains and capital accumulation. In contrast, economic
performance in Haiti has been dismal, with negative TFP in all four
decades. Real growth in the 1970s, the only period in which Haiti had
positive per capita GDP growth performance, was achieved through strong
investment efforts. The empirical endogenous growth model explained below
will provide greater insight into the factors that underlie both TFP and
capital accumulation.

Empirical Endogenous Growth Model

The empirical endogenous growth model identifies partly endogenous
variables (structural policies, stabilization policies, and institutions) and
exogenous variables (external conditions) (Figure 5). Our choice of growth
determinants was guided by two criteria: that these variables are widely used
in the growth literature and that they capture the diverse aspects of policies
and shocks in Haiti and the Dominican Republic.

On the basis of this framework, a dynamic panel model of per capita real
GDP growth is estimated to assess the relative importance of these growth

---

7 The capital stock data were constructed using aggregate investment figures. We use a
perpetual inventory method to compute capital stocks, with a share of capital income in
national output of 0.4 (different values do not alter the conclusions). We do not control for
capacity utilization or quality of human capital, due to data limitations.
determinants. The reduced-form equation builds on the work by Loayza, Fajnzylber, and Calderón (2005), modifying their specification to better explain developments in the Dominican Republic and Haiti, as will be described in detail below.

The Loayza, Fajnzylber, and Calderón (2005) Model

Loayza, Fajnzylber, and Calderón (2005) (hereafter LFC) use the following variation of the standard growth regression:

\[ y_{i,t} - y_{i,t-1} = \alpha y_{i,t-1} + \alpha C (y_{i,t-1} - y_{i,t-1}^T) + \beta' X_{i,t} + \mu_i + \eta_i + \varepsilon_i, \]

where \( y \) is log of output per capita, \( y^T \) represents the trend component of output per capita, \( y_{i,t-1} - y_{i,t-1}^T \) is the output gap at the start of the period, \( X \) is...
a set of additional variables postulated as growth determinants, $\mu_t$ is a period-specific effect, $\eta_i$ represents unobserved country-specific factors, and $\epsilon$ is the regression residual. The inclusion of the initial output gap as an explanatory variable controls for cyclical output movements to differentiate between transitional convergence (initial GDP per capita, $y_{t-1}$) based on the conditional convergence hypothesis—and cyclical reversion to the long-run trend ($y_{t-1}^T$). Table 1 describes the growth determinants included in the LFC model, which can be grouped as in the proposed empirical endogenous growth model.8

The LFC model is estimated using a system generalized method of moments (GMM) estimator for a sample of 79 countries over the period 1961–99.9 The regression analysis is conducted using 5- and 10-year averages, but for conciseness, we will refer only to the 10-year results.

Figure 6 shows that, in broad terms, the LFC model does well in explaining the direction of the changes in growth rates in Latin America and the Caribbean. The results show that the Dominican Republic, Haiti, and Latin America and the Caribbean all experienced a decline in their growth rates in the 1980s, whereas economic recovery in the Dominican Republic

---

Table 1. Variables Used in Loayza, Fajnzylber, and Calderón (2005) Model

<table>
<thead>
<tr>
<th>Variables Used in Loayza, Fajnzylber, and Calderón (2005) Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transitional convergence (initial GDP per capita)</td>
</tr>
<tr>
<td>Cyclical reversion (initial output gap)</td>
</tr>
<tr>
<td><strong>Structural policies</strong></td>
</tr>
<tr>
<td>Education (secondary school enrollment)</td>
</tr>
<tr>
<td>Financial depth (private domestic credit/GDP)</td>
</tr>
<tr>
<td>Government burden (government consumption/GDP)</td>
</tr>
<tr>
<td>Public infrastructure (main phone lines per capita)</td>
</tr>
<tr>
<td>Trade openness (structure-adjusted trade/GDP)</td>
</tr>
<tr>
<td><strong>Stabilization policies</strong></td>
</tr>
<tr>
<td>Lack of price stability (inflation rate)</td>
</tr>
<tr>
<td>Cyclical volatility (standard deviation of output gap)</td>
</tr>
<tr>
<td>Real exchange rate overvaluation (index of real exchange rate overvaluation)</td>
</tr>
<tr>
<td>Systemic banking crises (frequency of years under crisis)</td>
</tr>
<tr>
<td><strong>Institutions</strong></td>
</tr>
<tr>
<td>Governance indicator (<em>International Country Risk Guide</em>)</td>
</tr>
<tr>
<td><strong>External conditions</strong></td>
</tr>
<tr>
<td>Terms of trade shocks (growth rate of terms of trade)</td>
</tr>
</tbody>
</table>

---

8See Appendix II for details on definitions and sources.

9See Appendix III for the list of countries included in the panel regression.
was stronger than the average economic recovery of Latin America and the Caribbean in the 1990s. However, the LFC model does not perform as well in explaining the magnitude of change, especially for Haiti. Therefore, to improve the fit of the model, we propose some modifications to the LFC specification.

**Improving the Fit of the LFC Model**

Looking more deeply into the behavior of the different growth determinants for the Dominican Republic, Haiti, and Latin America and the Caribbean, we identify variables in the LFC model that can be enhanced to improve the fit of the model. In particular, we propose alternative measures for institutional quality and stabilization policies.

**Institutional Quality**

LFC uses an *International Country Risk Guide* (ICRG) index as a measure of institutional quality that captures the prevalence of law and order, quality of bureaucracy, absence of corruption, and accountability of public officials. However, this variable is not found to have a statistically significant impact on economic growth. This may be the case because the time series is too short, as ICRG data are only available from 1984 onward, and because the ICRG is a subjective indicator that measures perceptions of change in institutional quality, not the actual change. Furthermore, for the particular case of Haiti, the ICRG indicator does not provide an adequate picture of important political and institutional developments because it shows improvement in institutional quality during the most politically unstable periods, that is, the mid-1980s and early 1990s.

Another factor—directly linked to institutional quality—that has been found to have a negative impact on growth is political instability (Barro, 1991; Corbo and Rojas, 1993). We propose using changes in political regime as a proxy for political instability, by constructing a variable that measures the absolute magnitude of regime changes in each period—regardless of the
type of regime (democratic or autocratic)—on the basis of information from the Polity IV database. In this way, the measure tests the relationship between political instability and growth without making a judgment on whether a democratic or authoritarian regime is better for fostering economic growth, given the mixed empirical evidence on the link between types of political regimes and economic performance.

Figure 7 shows the contrast between Haiti and the Dominican Republic in terms of political instability. Haiti has faced much more political instability than the rest of Latin America, with several democratically elected regimes quickly turned over by coups or elected leaders becoming more authoritarian. On the other end of the spectrum, the Dominican Republic has been among the most stable countries in the region, in particular since 1970, when the Dominican Republic’s growth rate began to outpace that of Latin America.

**Macroeconomic Stability**

We find that the stabilization measures used by LFC have several drawbacks related to measurement difficulties. In particular, a credible estimation of potential output is complex, especially in countries that face structural breaks (through conflict or structural reform), making the output gap difficult to measure. Determining the real exchange rate equilibrium to calculate overvaluation of the exchange rate is also tricky. These issues are evident in the case of Haiti during the 1980s, where continuous poor economic performance resulted in low output gap volatility, implying better stabilization policies according to LFC variables, but clearly contrary to overall developments in the economy (Figure 8).

Alternatively, to get an overall picture of the stance of stabilization policies, we propose a measure of macroeconomic instability that combines inflation, fiscal deficit, exchange rate volatility, and international reserves losses. The need to look at various factors simultaneously to determine the stance of macroeconomic policies has been underscored by Fischer (1993) and Sahay and Goyal (2006). A combined indicator is considered to be more

---

10 The Polity IV database provides a unified polity scale that ranges from +10 (strongly democratic regime) to –10 (strongly autocratic regime) on an annual basis for all countries between 1800 and 2004.

11 For completeness, we also estimate the model directly using the polity scale from the Polity IV database. The interpretation of this measure goes beyond political instability and focuses on the effect of democracy (or autocracy) on growth by taking into account the direction of regime change as well as its magnitude.

12 Since 1960, Haiti has experienced numerous regime changes, including following the fraudulent elections of Papa Doc (1961); the death of Papa Doc (1971); the freeing of political prisoners and loosening of control over the press by Baby Doc (1977); the departure of Baby Doc (1986); failed elections and coups d’etat (1988–91); return of Aristide (1994); the dissolving of Parliament (1999); and irregular elections (2000). Regime changes in the Dominican Republic have been few, especially since 1970, and include the death of Trujillo (1961); coup and civil war (1962–63); Balaguer’s defeat in the elections (1978); and Balaguer’s agreement to cut his term short following rigged elections (1994). See Appendix I.
appropriate because any variable taken in isolation provides only partial information. For example, inflation gives a good indicator of the stance of monetary and fiscal policies but may be biased by price controls. However,
price controls would show up as higher fiscal deficits when funds are transferred to price control agencies. Moreover, although price controls might keep inflation down, uncertainty and lack of confidence in financial policies would put pressure on the exchange rate. Exchange rate pressures may not be evident in the context of a fixed exchange rate regime, but the authorities’ efforts to maintain foreign exchange stability would show up as changes in international reserve holdings.

More specifically, a macroeconomic instability index ($mi$) is constructed as the weighted sum of inflation rates and exchange rate volatility minus reserve accumulation as a percent of base money at the beginning of the period and minus the fiscal balance as a percent of GDP. Therefore, a higher value for the index indicates more instability. Each variable is weighted by the inverse of its standard deviation. Standardizing the variables ensures that all the components of the index have equal sample volatilities so that movements in the index are not solely driven by the most volatile component. Although the methodology for constructing the $mi$ index draws from indicators of speculative pressure in the crisis literature, to our knowledge, this particular index has not been used elsewhere. The index is constructed as follows:

$$mi_{it} = \frac{\ln \left( \frac{cpi_{it}}{cpi_{i,t-1}} \right)}{\sigma \left( \frac{cpi_{i,t-1}}{cpi_{i,t-1}} \right)} + \frac{\ln \left( \frac{er_{it}}{er_{i,t-1}} \right)}{\sigma \left( \frac{er_{i,t-1}}{er_{i,t-1}} \right)} - \frac{\frac{res_{it} - res_{i,t-1}}{bm_{i,t-1}}}{\sigma \left( \frac{res_{i,t-1}}{bm_{i,t-1}} \right)} - \frac{\frac{fbal_{it}}{gdp_{it}}}{\sigma \left( \frac{fbal_{i}}{gdp_{i}} \right)},$$

where $mi$ is the macroeconomic instability index for country $i$ at time $t$, $cpi$ is the consumer price index, $er$ is the exchange rate of national currency to U.S. dollar, $res$ is the stock of international reserves, $bm$ is the base money, $fbal$ is the fiscal balance, $gdp$ is the nominal GDP, and $\sigma$ is the standard deviation of each variable in the numerator.

Figure 9 illustrates the behavior of the $mi$ index for the Dominican Republic and Haiti. Since the 1970s, the Dominican Republic has outperformed Haiti and Latin America on average in terms of stabilization policies. Meanwhile, Haiti’s performance in terms of stabilization policies was better than that of the region until the 1990s. This was largely the result of a conservative monetary policy, which consisted of a de facto currency board arrangement until 1979 and a tight policy stance during the 1980s with high reserve requirements and high real interest rates. Further details on stabilization policies in both countries are provided in the following subsection.

13See Eichengreen and others (1995), Kaminsky and Reinhart (1999), and Herrera and Garcia (1999). Sensitivity analysis indicated that the panel regression results are largely robust to the choice of weighting scheme.

14Until 1979, the central bank law stipulated that the amount of currency issued had to be fully covered by foreign reserves in order to preserve the exchange rate parity.
Panel Regression

We use dynamic panel analysis to test the significance of the two proposed variables discussed above. We follow the basic approach of LFC, modifying the explanatory variables by (1) replacing the ICRG index with the regime change variable based on the Polity IV database; and (2) replacing the four LFC stabilization policy variables (inflation rate, standard deviation of output gap, real exchange rate overvaluation, and systemic banking crises) with the composite macroeconomic instability index ($mi$). We use the same 79-country sample, with 5- and 10-year intervals between 1961 and 1999, but discuss only 10-year results for simplicity and conciseness. The model is estimated with a GMM-IV system estimator using lagged levels and first differences of the variables as instruments and imposing robust two-step standard errors (Table 2).

Growth Determinants

The analysis of changes in growth rates between decades reveals that the model improves the fit for both the Dominican Republic and Haiti, as well as for Latin America (Figure 10). In the case of the Dominican Republic, the model is able to better predict the changes in growth trends in the 1970s and 1980s, though some of the growth boom of 1990s remains unexplained. For Haiti, the model provides a better explanation of developments over the entire period.

Note: Macroeconomic instability indicator is calculated by using data from IMF, International Financial Statistics.

Figure 9. Indicator of Macroeconomic Instability

![Diagram showing macroeconomic instability index for different decades and regions.]

15 Both period intervals yield similar results; the coefficients have identical signs and are broadly of the same order of magnitude; however, the significance of these coefficients is lower for the 10-year estimation largely due to lower degrees of freedom.

16 The model is also estimated by replacing our measure of political instability with the polity scale from the Polity IV database, as discussed in footnote 11. This measure has the expected positive sign (not reported in Table 2); however, it is significant neither for 5- nor 10-year intervals.
Table 2. Results of Panel Regressions on Real Per Capita GDP

<table>
<thead>
<tr>
<th>Growth Determinants</th>
<th>GMM-IV System</th>
<th>GMM-IV System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Five-Year</td>
<td>10-Year</td>
</tr>
<tr>
<td></td>
<td>Periods</td>
<td>Periods</td>
</tr>
<tr>
<td>Transitional convergence (initial GDP per capita, in logs)</td>
<td>−0.0245</td>
<td>−0.0495</td>
</tr>
<tr>
<td></td>
<td>[0.023]</td>
<td>[0.089]</td>
</tr>
<tr>
<td>Cyclical reversion (initial output gap, in logs)</td>
<td>−0.2273</td>
<td>−0.0167</td>
</tr>
<tr>
<td></td>
<td>[0.027]</td>
<td>[0.818]</td>
</tr>
<tr>
<td><strong>Structural policies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross secondary school enrollment (in logs)</td>
<td>0.0186</td>
<td>0.0145</td>
</tr>
<tr>
<td></td>
<td>[0.093]</td>
<td>[0.483]</td>
</tr>
<tr>
<td>Private domestic credit/GDP (in logs)</td>
<td>0.0038</td>
<td>0.0092</td>
</tr>
<tr>
<td></td>
<td>[0.514]</td>
<td>[0.118]</td>
</tr>
<tr>
<td>Trade/GDP (in logs)</td>
<td>0.0139</td>
<td>0.0101</td>
</tr>
<tr>
<td></td>
<td>[0.139]</td>
<td>[0.269]</td>
</tr>
<tr>
<td>Government consumption/GDP (in logs)</td>
<td>−0.0208</td>
<td>−0.0031</td>
</tr>
<tr>
<td></td>
<td>[0.064]</td>
<td>[0.819]</td>
</tr>
<tr>
<td>Main phone lines per capita (in logs)</td>
<td>0.0112</td>
<td>0.0246</td>
</tr>
<tr>
<td></td>
<td>[0.174]</td>
<td>[0.002]</td>
</tr>
<tr>
<td><strong>Stabilization policies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macroeconomic instability index</td>
<td>−0.0024</td>
<td>−0.0021</td>
</tr>
<tr>
<td></td>
<td>[0.063]</td>
<td>[0.211]</td>
</tr>
<tr>
<td><strong>Institutions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polity IV index</td>
<td>−0.0016</td>
<td>−0.0003</td>
</tr>
<tr>
<td></td>
<td>[0.004]</td>
<td>[0.620]</td>
</tr>
<tr>
<td><strong>External conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth rate of terms of trade</td>
<td>0.0197</td>
<td>0.0592</td>
</tr>
<tr>
<td></td>
<td>[0.520]</td>
<td>[0.323]</td>
</tr>
<tr>
<td><strong>Period shifts</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1966–70</td>
<td>0.0058</td>
<td></td>
</tr>
<tr>
<td>1971–75</td>
<td>0.0038</td>
<td></td>
</tr>
<tr>
<td>1976–80</td>
<td>−0.0010</td>
<td></td>
</tr>
<tr>
<td>1981–85</td>
<td>−0.0227**</td>
<td></td>
</tr>
<tr>
<td>1986–90</td>
<td>−0.0161</td>
<td></td>
</tr>
<tr>
<td>1991–95</td>
<td>−0.0230*</td>
<td></td>
</tr>
<tr>
<td>1996–99</td>
<td>−0.0287**</td>
<td></td>
</tr>
<tr>
<td>1970s</td>
<td></td>
<td>−0.0081</td>
</tr>
<tr>
<td>1980s</td>
<td></td>
<td>−0.0288***</td>
</tr>
<tr>
<td>1990s</td>
<td></td>
<td>−0.0403***</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.0851</td>
<td>0.3010*</td>
</tr>
</tbody>
</table>
On the basis of these results, we use a case study approach that identifies the main determinants of growth for each period and for each country to provide a flavor of the specific policies being captured by the model. In general, structural policies have been the key determinant of growth in both the Dominican Republic and Haiti, followed by political stability and stabilization policies.

**Dominican Republic**

During the 1970s, average GDP per capita growth rates in the Dominican Republic increased to just above 5 percent from close to 3 percent in the
1960s. The improvement in growth rates is explained in most part by progress made on structural measures, in particular education and credit to the private sector, and by enhanced political stability (Figure 11). On the structural front, improvements in secondary school enrollment during the 1970s outpaced the average for Latin America and the Caribbean, which allowed the Dominican Republic to “catch up” with the average enrollment levels of the region. Specifically, the government introduced major curriculum reforms at the primary and secondary levels to make schooling more relevant to work life, resulting in improvements in access to education. Also during this period, credit to the private sector as a percent of GDP grew more rapidly in the Dominican Republic than that in the region, albeit still at lower levels than the Latin America and the Caribbean average. Commercial bank credit received a boost in the late 1960s when effective reserve requirements were lowered. The new system allowed banks to discharge part of their required reserve obligation by lending a certain minimum of their reserve liabilities to “productive” sectors. By end of 1973, all banks were under the new system. In terms of political stability, Joaquin Balaguer remained the president of the country for most of the 1970s, contrasting with the political unrest of the mid-1960s.

As with most of Latin America and the Caribbean, the 1980s were years of economic turmoil. Average growth of GDP per capita in the Dominican Republic was basically flat. The sharp contraction in growth rates during this decade can be explained by unfavorable external conditions and by the deterioration of stabilization policies. This took place despite considerable improvements in structural measures, particularly trade openness.\(^\text{17}\) During

\[^{17}\text{The increase in trade openness is explained by improvements in exports arising from greater trade benefits to the U.S. market, as the Caribbean Basin Initiative came into effect in 1983, and by the approval of the 1983 Free Trade Zone Law that provided incentives for export industries, including 20-year tax exemptions.}\]
this period, large fiscal deficits contributed to monetary expansion and inflation pressures, which in turn exacerbated the distortions created by extensive price controls. The inconsistency between exchange rate policy and other financial policies generated overvaluations of the peso that resulted in sizable depreciations, and the central bank steadily lost official reserves.

In the 1990s, the Dominican Republic recovered the GDP per capita growth rates of the 1970s, just under 5½ percent of GDP. The primary contributors to growth were structural measures, in particular important improvements in trade and infrastructure, supported by the implementation of corresponding stabilization policies. During this period, the Dominican Republic embarked on a comprehensive economic program that included liberalization of the exchange rate, prices, and interest rates, as well as fiscal consolidation. This led to a sharp reduction in inflation, foreign exchange rate stability, and declining public external debt. Meanwhile, trade openness jumped as a result of the elimination in 1993 of export restrictions (such as export licensing and minimum export prices for agricultural products) and all export taxes, as well as the reduction in tariffs. In addition, a new foreign direct investment (FDI) law was approved in 1996 that facilitated operations of foreign firms, reduced sectoral restrictions, and liberalized repatriation of capital and utilities. This led to a substantial increase in FDI, in particular in the tourism sector. Furthermore, infrastructure in the Dominican Republic grew at a faster rate than the average for the region, with the expansion of telephone lines and electricity generation, as well as construction in tourism resort areas (including an international airport and roads).

Haiti

The 1970s was the only decade when the change in GDP per capita growth rates in Haiti was positive (Figure 12). From negative growth rates in the 1960s, growth in the 1970s averaged just above 2.5 percent. The main contributors to growth were structural measures, in particular trade openness, education, and credit to the private sector. In 1971, Haiti freed exchange transactions for all current payments and capital investment while eliminating restrictive practices and controls (including the exchange surrender requirement for exports and delays in remittances for service payments). This favored the export environment, and the assembly sector in Haiti began to grow. In addition, the Haitian government began to reform its educational system by unifying educational administration, introducing the use of Haitian Creole as the language of instruction in the first four grades, as well as implementing school nutrition programs. Meanwhile, credit to the private sector was encouraged by a 1972 reform that gave banks permission to extend medium-term credit to industrial and export sectors.

The economic contraction in Haiti during the 1980s was stronger than that in Latin America and the Caribbean, at an average of −2.4 percent in Haiti compared with −0.9 percent for the region. Although external conditions were adverse, growth performance was affected by increasing
political instability and a weakening of stabilization policies. Political turmoil increased in the early 1980s due to growing discontent with the Duvalier regime. The departure of Duvalier in 1986 was followed by successive failed elections and coups d’État. Between 1986 and 1990, there were six different heads of state. Political instability affected macroeconomic performance, as fiscal revenues began to weaken while the government pursued heavy outlays on construction works, defense, and loss-making public enterprises. Extrabudgetary spending continued to expand in the face of civil disturbances, as external concessional assistance declined. The public sector increasingly relied on central bank financing that led to official reserve losses, and external payments arrears emerged, putting rising pressures on the exchange rate and domestic prices.

GDP per capita growth in the 1990s continued the same negative trend as in the 1980s, with an average growth rate of -2.4 percent. Growth performance over the period was dominated by a major shock to the economy: following the coup d’État against Jean Bertrand Aristide, the United States and the Organization of American States imposed a trade embargo in 1991, aggravated by a UN-sponsored oil embargo in 1993. Trade openness declined during the embargo years from about 40 percent of GDP to an average of 25 percent. Assembly sector exports were severely affected. At the end of the 1980s, Haiti assembled a wide variety of light manufactures, such as baseballs and electrical switches, together with apparel products. With the embargo, the assembly industry collapsed, and following the lifting of sanctions in 1994, only the garment sector reestablished itself. Employment in the assembly sector fell from 46,000 in the late 1980s to just 5,000 in 1995.

**IV. Conclusions**

This paper tries to explain why the Dominican Republic and Haiti have experienced a striking divergence in growth performance despite their broad
similarities in terms of geography and historical institutions. We examine both the initial conditions and the different policies pursued in each country since 1960 in order to identify the factors that may have contributed to this divergence.

When examining initial conditions, namely geography and historical institutions, we find strong similarities between the Dominican Republic and Haiti, implying that initial conditions cannot fully explain the divergence in real incomes of the two countries. Although, by 1960, Haiti was already trailing the Dominican Republic in some social indicators, differences were not inherited from the historical legacies of the 19th or early 20th centuries. Although lack of national accounts prior to 1960 does not allow us to determine the exact point in time when the Dominican Republic started to outpace Haiti, disparities are likely to have started to emerge in part as a result of the policies implemented in each country following the U.S. military occupation.

The panel regression and case study approach allow us to conclude that policy decisions since 1960 have played a central role in the growth divergence between Haiti and the Dominican Republic. In general, structural policies have been the key determinants of growth in both the Dominican Republic and Haiti, followed by political stability and stabilization policies. In particular, we find that the Dominican Republic has consistently outperformed Haiti and Latin America and the Caribbean in terms of implementation of structural measures, stabilization policies, and political stability. Meanwhile, Haiti has lagged the region in implementing structural policies while being subject to numerous political shocks that have severely affected its growth performance.

Although this paper identifies the kind of policies linked to growth performance in both countries of the Hispaniola, future work would be needed to understand why decision makers in the Dominican Republic chose and were able to implement superior policies to those in Haiti. Further research could also provide insight into the sources of the persistent political turmoil in Haiti, as well as the circumstances that allowed the Dominican Republic to surmount the political instability of the 19th and early 20th centuries.

APPENDIX I

<table>
<thead>
<tr>
<th>Dominican Republic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1821–43 In 1821, the Dominican Republic gains independence from Spain but is soon after invaded by Haitian leader Jean-Pierre Boyer, uniting the island for the next 22 years.</td>
</tr>
<tr>
<td>1844 On February 27, 1844 (Dominican Independence Day), Juan Pablo Duarte executes a bloodless coup in Santo Domingo. During the next 16 days, all of the eastern towns announce their decision to separate from Haiti.</td>
</tr>
</tbody>
</table>
1844–65 General Pedro Santana Familias and Buenaventura Baez Mendez dominate the political scene. In 1861 Santana agrees to the Dominican Republic’s annexation by Spain. However, on March 3, 1865 the annexation is annulled, and Spain withdraws its soldiers.

1865–78 Political turmoil and corrupt governments dominate this period.

1879–82 Two dominant parties—the Azules and the Rojos—emerge. For the next three years, the Azules control the government.

1882–99 General Ulises Heureaux comes to power. He retains power through fraudulent elections and army control. Heureaux borrows vast sums from U.S. investors at high interest rates. He also replaces the National Bank with the U.S.-owned and operated San Domingo Improvement Company. Heureaux is assassinated in July 1899.

1900–05 Soon after Heureaux’s death, the Dominican Republic could not repay its debts. The U.S. government intervenes by taking control of the customs houses in 1905, guaranteeing repayment of all loans.

1905–11 Ramon Cáceres is elected president. He constructs the railway and highways, rebuilds docks, improves the postal service, installs telegraph lines, and funds new schools. He increases export taxes on Dominican sugar to pay for public improvements, which angers plantation owners. Cáceres is shot dead in 1911.

1911–16 Various revolutions follow Cáceres’ death. U.S. President Woodrow Wilson, concerned about U.S. national security, threatens to send marines if elections are not held. Juan Isidro Jimenez is elected president but is soon impeached before Congress. The United States offers support, and though Jimenez only requests weapons, the marines are sent in.

1916–24 The Dominican Republic comes under U.S. control for eight years. In particular, the Americans control the budget. The American troops leave by 1924, as Woodrow Wilson is no longer in power, World War I is over, and the United States is considerably less concerned with the Dominican Republic’s strategic importance.

1924–30 President Horacio Vasquez has a progressive government, building roads creating access to the countryside, schools, and irrigation and sanitation services.

1930–61 Rafael Leonidas Trujillo, chief of the National Police (which later became the National Army), forces Vasquez to resign. Trujillo holds an election for which he is the sole candidate. Trujillo rules the Dominican Republic with an iron fist from 1930 to 1947 and indirectly thereafter until his assassination in 1961. Trujillo amasses a personal fortune by establishing monopolies that his family controls. He carries out programs of public works and construction. He also presses for industrial progress, and scores of factories are opened. Agricultural production improves and the economy flourishes.

1962–66 President Joaquin Balaguer is in office at the time of Trujillo’s assassination. Elections are organized. In 1962 Juan Bosch Gaviño is elected, but is toppled in a military coup in 1963. Bosch and a group of supporters who call themselves the Constitutionals take to the streets and seize the National Palace. To reinstate order, 24,000 U.S. soldiers are ordered to the Dominican Republic until new elections in 1966.

1966–78 Balaguer defeats Bosch in national elections. Balaguer purges the military and uses the National Police to curtail nonmilitary opposition. His reelections in 1970 and 1974 are mostly accomplished through intimidation. The economy expands rapidly, benefiting from favorable world prices for sugar. However, by the late 1970s, plunging sugar prices and rising oil costs bring the Dominican economy to a standstill.
1978–86 Silvestre Antonio Guzman defeats Balaguer in the elections. He leads a corrupt government. Public works programs are brought to a halt, and the administration borrows heavily from abroad. Guzman’s popularity diminishes rapidly. Salvador Jorge Blanco is elected in 1982.

1986–96 Balaguer is reelected for a fifth term. He runs his government like a dictatorship, intimidating political rivals. He reverses the adjustment program under Blanco, leading to a sharp depreciation of the peso and annual inflation of 60 percent. By 1990, 900,000 Dominicans move to New York, fleeing the economic situation. Balaguer rigs the 1990 and 1994 elections. However, in 1994 the military threatens to intervene. Balaguer agrees to cut his last term short and hold elections 18 months later.


2000–04 Hipolito Mejia becomes president. The events of September 11, 2001 and the ensuing slowdown in the world economy take a toll on economic growth. In 2003, failures of three large banks due to accounting malpractices and mismanagement lead to a banking crisis.

2004–06 Fernandez is reelected in 2004. The economy recovers at high growth rates.

**Haiti**

1804 The ex-slaves of the French colony of Saint-Domingue declare independence after defeating the French army at Vertière. They name their new nation Haiti, which means “mountainous” in the language of its original Arawak inhabitants.

1804–20 Jean Jacques Dessalines proclaims himself emperor, but is assassinated in 1806. His death leads to civil war between the south under General Pétion and the north under Henry Christophe.

1820–43 Faced with a rebellion by his own army, Christophe commits suicide, paving the way for Jean-Pierre Boyer to reunify the country and become president of the entire republic in 1820. President Boyer invades Santo Domingo following its declaration of independence from Spain, controlling the entire island until 1844. In 1938, France recognizes Haitian independence in exchange for an indemnity of 150 million francs to compensate for the losses of French planters during the 1803 revolution. In 1843, Boyer flees the country following a revolution to overthrow him from the presidency.

1844–1915 Haiti sees 22 heads of state, most of whom leave office by violent means. The United States and other slaveholding states do not recognize Haiti until 1862.

1915–34 Concerned about German economic influence in the country and continued political instability, the U.S. military occupies Haiti after the last in a series of short-lived presidents is torn to pieces by a mob. The U.S. marines establish control over customshouses and port authorities, and create the Haitian National Guard.

1934–56 Once the Americans leave, political instability resumes, with regime changes taking place through military coups. In 1937, thousands of Haitians living near the border of the Dominican Republic are massacred by Dominican soldiers under the orders of President Trujillo.

1957–71 Francois Duvalier (Papa Doc) is elected president in the country’s first universal suffrage election. Reelected in fraudulent elections in 1961, he declares himself president for life in 1964 and, until his death, holds on to power as a ruthless dictator with the help of a paramilitary force known as Tontons Macoutes.
1971–86 Jean-Claude Duvalier (Baby Doc) becomes the new president for life after his father’s death in 1971. After relatively favorable economic performance in the 1970s, the macroeconomic situation deteriorates sharply in the early 1980s, affected by the recession in the United States and economic mismanagement. Social discontent culminates in public protests and violence, and Duvalier flee to France in 1986.

1986–94 Starting in 1986 there are several brief attempts at civilian democracy, each terminated by a military coup. In September 1991, Jean-Bertrand Aristide, a popular priest elected in 1990, is forced to flee the country only nine months after taking office. The United States and the Organization of American States respond with a trade embargo, and in 1993 a UN-sponsored oil embargo is imposed. In September 1994, Aristide is reinstated in office with the help of a U.S.-led military intervention.

1995–96 Aristide disbands the army. Aristide supporters win parliamentary elections. As, according to the constitution, Aristide cannot serve a consecutive second term, he is succeeded by a close ally, René Préval.

1997–99 Following a period of political deadlock, Préval dissolve parliament and rules by decree.

2000–03 Aristide is reelected president, but the international community criticizes irregularities during the parliamentary elections. Political stalemate with the opposition leads to the freezing of foreign aid.

2004–05 Amid deteriorating economic conditions, growing dissatisfaction with the government culminates in an armed rebellion. President Aristide resigns in February 2004 and leaves the country. A transition government is formed to lead the country to elections and an interim multinational force arrives.

2006 Elections are held in February 2006, and René Préval is reelected president.

### Table A1. (concluded)

<table>
<thead>
<tr>
<th>Period</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971–86</td>
<td>Jean-Claude Duvalier (Baby Doc) becomes the new president for life after his father’s death in 1971. After relatively favorable economic performance in the 1970s, the macroeconomic situation deteriorates sharply in the early 1980s, affected by the recession in the United States and economic mismanagement. Social discontent culminates in public protests and violence, and Duvalier flee to France in 1986.</td>
</tr>
<tr>
<td>1986–94</td>
<td>Starting in 1986 there are several brief attempts at civilian democracy, each terminated by a military coup. In September 1991, Jean-Bertrand Aristide, a popular priest elected in 1990, is forced to flee the country only nine months after taking office. The United States and the Organization of American States respond with a trade embargo, and in 1993 a UN-sponsored oil embargo is imposed. In September 1994, Aristide is reinstated in office with the help of a U.S.-led military intervention.</td>
</tr>
<tr>
<td>1995–96</td>
<td>Aristide disbands the army. Aristide supporters win parliamentary elections. As, according to the constitution, Aristide cannot serve a consecutive second term, he is succeeded by a close ally, René Préval.</td>
</tr>
<tr>
<td>1997–99</td>
<td>Following a period of political deadlock, Préval dissolve parliament and rules by decree.</td>
</tr>
<tr>
<td>2000–03</td>
<td>Aristide is reelected president, but the international community criticizes irregularities during the parliamentary elections. Political stalemate with the opposition leads to the freezing of foreign aid.</td>
</tr>
<tr>
<td>2004–05</td>
<td>Amid deteriorating economic conditions, growing dissatisfaction with the government culminates in an armed rebellion. President Aristide resigns in February 2004 and leaves the country. A transition government is formed to lead the country to elections and an interim multinational force arrives.</td>
</tr>
<tr>
<td>2006</td>
<td>Elections are held in February 2006, and René Préval is reelected president.</td>
</tr>
</tbody>
</table>

### Table A2. Variable Definitions and Sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transitional convergence</td>
<td>Initial GDP per capita (in logs)</td>
<td></td>
</tr>
<tr>
<td>Cyclical reversion</td>
<td>Initial output gap</td>
<td>The difference between the log of actual GDP and the log of trend GDP at the beginning of the period. Trend growth is determined using a Baxter-King filter.</td>
</tr>
<tr>
<td>Education</td>
<td>Gross secondary school enrollment (in logs)</td>
<td>UNESCO and LFC</td>
</tr>
</tbody>
</table>

The gross enrollment ratio is defined as the total enrollment, regardless of age, expressed as a percentage of the official school-age population for a given level.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial depth</td>
<td>Private domestic credit/GDP (in logs)&lt;br&gt;Ratio to GDP of the stock of claims on the private sector by deposit money banks and other financial institutions.</td>
<td>IMF, International Financial Statistics (IFS)</td>
</tr>
<tr>
<td>Government burden</td>
<td>Government consumption/GDP (in logs).</td>
<td>IFS</td>
</tr>
<tr>
<td>Public infrastructure</td>
<td>Main phone lines per capita (in logs)&lt;br&gt;The number of telephone mainlines per 1,000 people.</td>
<td>World Bank, World Development Indicators (WDI)</td>
</tr>
<tr>
<td>Trade openness</td>
<td>The residual of a regression of the log of the ratio of exports and imports to GDP, on the logs of area and population, a dummy for oil-exporting countries, and a dummy for landlocked countries.</td>
<td>Authors’ estimates based on IFS and WDI data</td>
</tr>
<tr>
<td>Terms of trade</td>
<td>Change in terms of trade&lt;br&gt;Log difference of the terms of trade. Terms of trade is estimated as customary.</td>
<td>IMF, World Economic Outlook (WEO)</td>
</tr>
<tr>
<td><strong>Alternative Measures</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political instability</td>
<td>Change in political regime&lt;br&gt;The absolute magnitude of regime changes in each period, as determined by the Polity IV polity scale.</td>
<td>Authors’ estimates using Polity IV database.</td>
</tr>
<tr>
<td>MI</td>
<td>Macroeconomic instability index&lt;br&gt;Weighted sum of inflation rates and exchange rate volatility minus reserve accumulation as a percent of base money at the beginning of the period and minus the fiscal balance as a percent of GDP. Each variable is weighted by the inverse of its standard deviation.</td>
<td>Authors’ estimates based on IFS data</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>Annual percentage change in the consumer price index (in logs).</td>
<td>Authors’ estimates based on IFS data</td>
</tr>
<tr>
<td>Exchange rate volatility</td>
<td>Annual percentage change of the foreign exchange rate (in logs).</td>
<td>Authors’ estimates based on IFS data</td>
</tr>
<tr>
<td>International reserve accumulation</td>
<td>Annual change in net international reserves as a percent of base money at the beginning of the period (in logs).</td>
<td>Authors’ estimates based on IFS data</td>
</tr>
<tr>
<td>Fiscal balance</td>
<td>Government fiscal balance/GDP (in logs).</td>
<td>Authors’ estimates based on IFS data</td>
</tr>
</tbody>
</table>

Note: Variables Used in Loayza, Fajnzylber, and Calderón (LFC) (2005)
Table A3. List of Countries Included in the Panel Regression

<table>
<thead>
<tr>
<th>Algeria</th>
<th>Kenya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Korea, Republic of</td>
</tr>
<tr>
<td>Australia</td>
<td>Madagascar</td>
</tr>
<tr>
<td>Austria</td>
<td>Malawi</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Belgium</td>
<td>Mexico</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Morocco</td>
</tr>
<tr>
<td>Botswana</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Brazil</td>
<td>Nicaragua</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>Niger</td>
</tr>
<tr>
<td>Canada</td>
<td>Nigeria</td>
</tr>
<tr>
<td>Chile</td>
<td>Norway</td>
</tr>
<tr>
<td>Colombia</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Congo, Democratic Republic</td>
<td>Panama</td>
</tr>
<tr>
<td>Congo, Republic</td>
<td>Papua New Guinea</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>Paraguay</td>
</tr>
<tr>
<td>Côte d’Ivoire</td>
<td>Peru</td>
</tr>
<tr>
<td>Denmark</td>
<td>Philippines</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>Portugal</td>
</tr>
<tr>
<td>Ecuador</td>
<td>Senegal</td>
</tr>
<tr>
<td>Egypt, Arab Republic</td>
<td>Sierra Leone</td>
</tr>
<tr>
<td>El Salvador</td>
<td>South Africa</td>
</tr>
<tr>
<td>Finland</td>
<td>Spain</td>
</tr>
<tr>
<td>France</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>Gambia</td>
<td>Sweden</td>
</tr>
<tr>
<td>Ghana</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Greece</td>
<td>Syria, Arab Republic</td>
</tr>
<tr>
<td>Guatemala</td>
<td>Thailand</td>
</tr>
<tr>
<td>Haiti</td>
<td>Togo</td>
</tr>
<tr>
<td>Honduras</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>Iceland</td>
<td>Tunisia</td>
</tr>
<tr>
<td>India</td>
<td>Turkey</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Uganda</td>
</tr>
<tr>
<td>Iran, Islamic Republic</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Ireland</td>
<td>United States</td>
</tr>
<tr>
<td>Israel</td>
<td>Uruguay</td>
</tr>
<tr>
<td>Italy</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Jamaica</td>
<td>Zambia</td>
</tr>
<tr>
<td>Japan</td>
<td>Zimbabwe</td>
</tr>
</tbody>
</table>

REFERENCES


Heston, Alan, Robert Summers, and Bettina Aten, 2002, *Penn World Table Version 6.1* (Center for International Comparisons at the University of Pennsylvania (CICUP), October).


Sirimaneetham, Vatcharin, 2006, “Explaining Policy Volatility in Developing Countries,” Bristol Economics Discussion Papers No. 06/583 (Bristol, University of Bristol).


With its near universal membership, the International Monetary Fund is in a unique position to examine global interrelationships. Indeed, cross-country linkages lie at the heart of the Fund’s role in the world economy. In particular, the central objective of the Fund’s surveillance of exchange rate and domestic policies is to avoid negative spillovers from the policies of one country to its international partners.

This special section of *IMF Staff Papers* “Global Reach? Perspectives on U.S. International Spillovers” includes three papers, each tackling different aspects of the links between the United States and the rest of the world. Reflecting both recent events and the new focus of the Fund, an important theme in all three papers is the role of financial markets in propagating spillovers. While U.S. trade links have been analyzed in great detail, there has been significantly less work in the past on the overall size and impact of financial spillovers.

As the recent turbulence has shown, however, financial links can have powerful effects on the global economy. This special section is particularly timely, providing insights into how these links work.

---

*John Lipsky is First Deputy Managing Director of the IMF.*
The first paper, “Foreign Entanglements: Estimating the Source and Size of Spillovers Across Industrial Countries” by Tamim Bayoumi and Andrew Swiston, examines the general issue of the sources of output spillovers across countries. Recent work on the international business cycle has tended to focus more on the size of the links across countries than on the sources of the underlying shocks. As a result, there remains considerable uncertainty as to whether the international cycle is driven largely by common shocks (all countries facing—say—a similar rise in costs of energy) or by spillovers from some countries to others. The paper aims to untangle the sources of shocks by including both changes in output in the major global currency areas—the United States, euro area, and Japan—and an aggregate of geographically and economically diverse smaller countries. The logic of adding the latter group is that a truly global shock would likely affect these countries at the same time as the large currency areas, and hence by including them in the analysis the impact of global shocks can be differentiated from those emanating from the major currency unions.

The results suggest that the United States has large effects on the rest of the world, but that the euro area and Japan do not, while the impact of global shocks is less well defined. In addition, the paper finds that the main source of U.S. spillovers to the rest of the world comes through financial markets rather than trade or commodity price effects. This helps to explain the disproportionate effect of U.S. growth on the rest of the world compared with the euro area and Japan, which have strong trade links but are less dominant in financial markets.

The next paper, “Yen Carry Trade and the Subprime Crisis” by Masazumi Hattori and Hyun Song Shin, links carry trades to the expansion of liquidity in the United States and elsewhere in recent years. Traditionally, carry trades—the practice of borrowing in a country with low interest rates to invest in countries with higher rates—have been seen as a separate investment strategy driven primarily by interest rate differentials. By contrast, Hattori and Shin suggest that it is often linked to an overall expansion in the balance sheet of international banks. If such a bank wants to expand (say) its U.S. balance sheet, at least some of its funding will come from abroad through borrowing by overseas offices. In essence, some of the most recent expansion of U.S. leverage has been financed from “cheap” foreign sources.

The paper traces this effect by looking at the net interoffice accounts (that is, net borrowing in short-term markets) of foreign banks in Japan. They find that this net borrowing rose rapidly from 2002 to mid-2007 and then fell rapidly in parallel with the behavior of U.S. financial market liquidity. Net interoffice accounts are then found to be closely linked to the net international asset position of foreign banks in Japan, and with measures of market risk aversion and with interest rate differentials. In short, the paper links carry trade financial outflows from Japan to overall U.S. financial market conditions.

The final paper, “Rhyme or Reason: What Explains the Easy Financing of the U.S. Current Account Deficit?” by Ravi Balakrishnan, Tamim
Bayoumi, and Volodymyr Tulin, explores alternative explanations for the factors that have attracted the funds needed to finance massive recent U.S. current account deficits. The paper initially notes that most of the funding has occurred in the bond market, which casts doubt on the importance of rapid U.S. growth as an attraction, because equity investments have larger upside potential. Instead, the paper suggests that financing reflected both the dominant position of U.S. financial markets at a time of rapid financial deepening and globalization as well as innovation in U.S. financial markets that were perceived at the time to make the underlying securitized bonds more attractive.

The consequences of U.S. financial links for the rest of the world will continue to be an important issue for many years to come. In this special section, IMF Staff Papers helps to provide some food for thought as to how these links are currently working, and may work in the future.
Foreign Entanglements: Estimating the Source and Size of Spillovers Across Industrial Countries

TAMIM BAYOUMI and ANDREW SWISTON*

Vector autoregressions of real growth since 1970 are used to estimate spillovers between the United States, the euro area, Japan, and an aggregate of smaller countries proxying for global shocks. U.S. and global shocks generate significant spillovers, but those from the euro area and Japan are small. This paper calculates the standard errors of impulse-response functions, including uncertainty over the proper Cholesky ordering. Extensions adding exports, commodity prices, and financial variables indicate that financial effects are the largest source of spillovers. The results by subperiod underline the importance of the great moderation in U.S. output fluctuations and associated financial stability in lowering output volatility elsewhere. [JEL C32, E32, F20, F43] IMF Staff Papers (2009) 56, 353–383. doi:10.1057/imfsp.2008.23; published online 9 September 2008

The extent of spillovers across industrial regions remains an area of considerable interest and uncertainty. The importance of common or global factors in national output fluctuations is widely recognized, given the long history of substantial international business cycle fluctuations (see Bordo and Helbling, 2004). Consequently, a large body of literature has

*Tamim Bayoumi is an assistant director with the IMF’s Western Hemisphere Department, and Andrew Swiston is a research assistant with that department. The authors gratefully acknowledge invaluable contributions from Sam Ouliaris and Thomas Helbling. Useful comments were also received from Petya Brooks, Trish Pollard, Nathan Sheets, Jeromin Zettelmeyer, participants in a seminar with U.S. government officials, participants in a Western Hemisphere Department seminar, and participants in an IMF seminar on the Macroeconomic and International Implications of Financial Market Innovation.

©International Monetary Fund. Not for Redistribution
sought to measure the contribution of common factors to national business cycle fluctuations. In recent studies, dynamic factor models have been the main preferred approach because these models reduce common variations across individual countries to a small number of significant but unrelated factors (Gerlach, 1988; Gregory, Head, and Raynauld, 1997; Kose, Otrok, and Whiteman, 2003; and Stock and Watson, 2005).

The common factors in such studies, however, are typically difficult to interpret, because basic factor model decompositions are atheoretical and lack a structural identification scheme. The common factor could reflect global shocks, spillovers from one country to others, or idiosyncratic shocks that happen to be correlated across countries.\(^1\) So far, plausible schemes to distinguish between common shocks and spillovers have not been developed, so questions such as whether or not U.S. shocks account for a significant share of common output fluctuations remain unanswered.\(^2\) A related literature uses generalized vector autoregressions (VARs) to model links across large numbers of countries, but again common shocks and spillovers remain essentially undifferentiated (Pesaran, Schuermann, and Weiner, 2004; and Dees and others, 2007).

This paper uses a new approach for solving this identification issue. We construct an aggregate of smaller countries as a proxy for global shocks. This aggregate includes Australia, Canada, Denmark, Korea, Mexico, Norway, New Zealand, South Africa, Sweden, Switzerland, Taiwan, and the United Kingdom. For convenience, we will henceforth call this group the rest of the world. The rest of the world contains a set of countries that is diverse in terms of both geography and industrial structure. Given the wide differences of the constituent countries, any shock to this aggregate is a strong candidate for a global disturbance. Because the individual economies involved are both varied and small relative to the United States, the euro area, and Japan, they are unlikely to have significant direct effects on them. Spillovers from the rest of the world to these major regions can thus be regarded as a reasonable measure of the impact of global shocks.

We also introduce a procedure to calculate uncertainty across VAR identification schemes, which allows us to examine the robustness of our results to differing assumptions about the direction of causation between contemporaneous shocks. We find that, with the important exception of the global disturbance, specification uncertainty rarely influences the statistical significance of the results.

---

\(^1\)See, for example, Canova and Dellas (1993). There are other problems as well. For example, if countries respond differently to some common shock, say, for example, because of differences in economic structure, the estimated common factors may or may not capture the effects of these common shocks, depending on the stringency of the restrictions on the dynamic structure of the underlying model.

\(^2\)Stock and Watson (2005) allow for lagged spillovers of country-specific shocks, but this still leaves contemporaneous shocks unidentified.
Using VARs of growth across the four regions, we can therefore differentiate between the effects of global, U.S., euro area, and Japanese shocks. U.S. shocks generate significant spillovers to other regions of one-quarter to one-half the size of the U.S. shock after two years, but those from the euro area and Japan are smaller and insignificant in almost all cases. Spillovers from the rest of the world, on the other hand, are sensitive to the identification of the correlated component of shocks across regions as either emanating from the United States or representing a global shock; correlations with euro area and Japanese shocks matter less. In our baseline specification, the response of the euro area and Japan is two-thirds the size of the shock to the rest of the world and the impact on the United States is one-third the size of the shock.

Having estimated overall spillovers across countries, we go on to quantify the contributions to spillovers of each of the major channels through which shocks are propagated—trade, commodity prices, and financial markets. By contrast, the international business cycle literature has focused on the factors associated with higher correlations across countries more than on quantifying the contribution of each of these factors to spillovers (Kose, Prasad, and Terrones, 2004; Baxter and Kouparitsas, 2005; Kose, Otrok, and Whiteman, 2005; and Imbs, 2006). Meanwhile, large-scale models that capture trade linkages more completely than financial ones have difficulty in explaining the degree of co-movement across countries present in the data (Kose and Yi, 2006).

Spillovers from trade, commodity prices, and financial markets are identified by extending the VAR to include the contribution of real exports to growth, the change in real commodity prices, the levels of short-term interest rates and bond yields, and the change in real equity prices for the regions under analysis. This method can be used as a cross-check on the plausibility of the main results. Encouragingly, the aggregate impact of these separate channels corresponds reasonably closely to the direct estimation of impulses. We find that financial variables play the largest role in the transmission of global and U.S. shocks, and, consistent with other literature on the dominance of U.S. markets in generating financial spillovers, there is little feedback from other regions to the United States.

I. A New Approach to Identifying VARs

In order to identify independent impulse response functions (IRFs) from a VAR, procedures generally transform the errors across the individual regressions so that they are orthogonal (an exception, called generalized impulse responses, is discussed further below). Traditionally, this is done using a Cholesky decomposition, which assumes that all of the correlations between errors are assigned to the equation that is earliest in the ordering. For example, in a three-variable VAR, all of the correlation between the errors in the first equation and the second and third ones is assigned to the first, but any remaining correlation between the errors in the second and third equations is assigned to the second.
Such an approach works well if there is a relatively clear ordering for the Cholesky decomposition. For example, in small monetary VARs containing inflation, output, and interest rates, it appears intuitive to assume that easily adjustable interest rates respond to shocks in more slow-moving inflation and output, and not the other way around. However, it is much less clear that such a stark assumption about causation is appropriate in a VAR containing growth across countries. Accordingly, although results for some individual Cholesky orderings are reported, the empirical results below focus on an average of impulse responses across a range of “plausible” Cholesky orderings.

This procedure has a strong Bayesian flavor. The weights assigned to the various orderings can be seen as placing priors on the relative importance of spillovers going from variable $A$ to $B$ as opposed to those from $B$ to $A$. These priors are then updated using the estimated variance-covariance matrix of equation errors. Note, however, that this updating depends only on the parameters of the variance-covariance matrix, not on the full probability distribution, which is used in traditional Bayesian methods.3

The underlying approach is easily illustrated using a two-variable VAR. Consider the matrix $A$ that transforms the estimated errors $e$ from such a VAR into orthogonalized errors $\tilde{e}$. Mathematically, $\tilde{e} = Ae$. For the two possible Cholesky decompositions, the matrix $A$ is

$$A = \begin{pmatrix} 1 & -\frac{\sigma_{12}}{\sigma_{11}} \\ 0 & 1 \end{pmatrix} \text{ or } \begin{pmatrix} 1 & 0 \\ -\frac{\sigma_{12}}{\sigma_{22}} & 1 \end{pmatrix},$$

where $\sigma_{ij}$ is the relevant entry in the estimated variance-covariance matrix of the equation errors (for example, $\sigma_{11}$ is the variance of the error on the first variable in the first equation). The zeros in the lower left cell of the first matrix and the upper right cell of the second indicate that in each of these decompositions, contemporaneous feedback between the two variables flows in only one direction.

By putting weight on both decompositions, however, our procedure allows such feedback to go in both directions. More specifically, the procedure assigns a (user-defined) weight of $\alpha$ to the first Cholesky decomposition and $(1-\alpha)$ to the second. The matrix that decomposes the equation errors into their orthogonalized versions is now:

$$A = \begin{pmatrix} 1 & -\frac{\sigma_{12}}{\sigma_{11}} \\ -(1-\alpha)\frac{\sigma_{12}}{\sigma_{22}} & 1 \end{pmatrix}. $$

3For approaches that use Bayesian techniques to update forecasts across models, see Sala-i-Martin, Doppelhofer, and Miller (2004) and Leamer (1978). See Wright (2003) for a discussion and application of Leamer’s Bayesian model averaging technique.
One way of interpreting the weight $\alpha$ is that it defines the prior probability on the source of contemporaneous correlation between the two error terms. Note, however, that this prior is modified by the estimated parameters of the variance-covariance matrix of errors ($\sigma_{11}$, $\sigma_{12}$, and $\sigma_{22}$). Mathematically,

$$\frac{a_{12}}{a_{21}} = \frac{\alpha}{(1 - \alpha)} \frac{\sigma_{22}}{\sigma_{11}},$$

where $a_{ij}$ is the relevant entry of the matrix $A$. The relative importance assigned to each possible direction of causation depends on both the prior ($\alpha$) and on the ratio of the variance of the errors in the first equation ($\sigma_{11}$) and the second one ($\sigma_{22}$). Therefore, the estimated magnitude of spillovers depends on both the prior and on the estimated variances and covariances of the errors in the VAR (which are not affected by the ordering of the variables). This updating of the priors by the distribution of the error terms turns out to be important in interpreting the results, as discussed further below.

The intuition of this example can be generalized to the $n$-variable case, with the complication that adding variables to the VAR makes it more difficult to define the errors in each equation (the $e$'s), as account has to be taken of correlations with errors from a greater number of equations. But, once this has been done, the rest of the logic of this two-variable case holds.

In addition, it is possible to calculate how uncertainty over the correct Cholesky ordering adds to the variance around the IRFs, over and above the usual variance associated with uncertainty about the underlying parameters of the VAR. Sticking with the two-variable example, let $\bar{x}_t$ represent the average impulse response for period $t$ across the two decompositions (so that $\bar{x}_t = \alpha \bar{x}_{1t} + (1-\alpha)\bar{x}_{2t}$). The variance of the IRF can be written as

$$E(x_{ijt} - \bar{x}_t)^2 = \alpha^2 E(x_{1jt} - \bar{x}_{1t})^2$$

$$+ 2\alpha(1 - \alpha)E(x_{1jt} - \bar{x}_{1t})(x_{2jt} - \bar{x}_{2t})$$

$$+ (1 - \alpha)^2 E(x_{2jt} - \bar{x}_{2t})^2$$

$$+ \alpha^2 E(\bar{x}_{1t} - \bar{x}_t)^2 + (1 - \alpha)^2 E(\bar{x}_{2t} - \bar{x}_t)^2,$$

where subscript $i$ on the left-hand side indicates the different orderings (1 and 2). Variation across orderings produces the fourth and fifth terms in Equation (4), which we call specification uncertainty. Subscript $j$ indexes the individual observations represented in the sample from which the standard errors are calculated. This generates the first three terms in Equation (4), reflecting the familiar uncertainty associated with each individual identification scheme, coming from the imprecision with which the coefficients of the VAR are estimated (recall that the coefficient estimates are independent of the choice of ordering).
Given that the individual identification schemes differ only in their assumptions about the ordering of the variables, the errors across individual orderings are likely to be highly correlated. Accordingly, we assume that the correlation across different orderings is unity. Given this assumption, the first three terms of Equation (4) can be approximated by taking the weighted average of the variances of each of the decompositions. The final line of Equation (4) reflects the uncertainty due to variation in the response across orderings and is simply the variance of the response across these decompositions.

Hence, the uncertainty associated with identification can be approximated by simply adding the average variance of the impulse responses across identification schemes to the variance associated with parameter uncertainty. Given our assumption of a perfect correlation of errors associated with parameter uncertainty across orderings, this is an upper limit for the true value of this variance. This procedure can again be generalized to the \( n \)-variable case.

Our approach has some similarities, but also important differences, from generalized IRFs (Pesaran and Shin, 1998). First, although our procedure puts explicit weights on various Cholesky orderings, generalized response functions implicitly put an equal weight on all possible orderings. In our context, this implies assuming that shocks coming from the euro area, Japan, and the United States are equally likely to create spillovers to the other regions, whereas the approach adopted in this paper puts a stronger prior on U.S. shocks being the source of such spillovers. Second, although our responses are to shocks that have been orthogonalized and hence can be used to decompose the impact of each shock on the system, the generalized responses involve underlying shocks that are correlated and hence “overfit” the system. Finally, our distinction between parameter and ordering uncertainty has not been applied to generalized responses, although it appears it could be.

II. How Large Are Spillovers?

Data on quarterly growth (measured as the difference in the logarithm of real GDP) for the four regions were collected from 1970 through the fourth quarter of 2007. The official euro area data extend back to 1991, and earlier data were spliced back to 1970 using the estimates in Fagan, Henry, and Mestre (2005). For the rest-of-world aggregate, each country’s growth rate is weighted by the size of its GDP in purchasing-power-parity (PPP) terms. The weighted-average growth rate is then used to construct an index of real GDP, which implies approximately equal effects from North America, Europe, and Asia (at least toward the end of the sample).\(^4\)

Regressions were run on the full sample and its first and second halves, with the split between the two subsamples being set at the first quarter of 1988.

---

\(^4\)Results using alternative groups of countries and weighting schemes produced similar results. The countries included are based on availability of quarterly GDP data since 1970.
This break was chosen to differentiate the relatively turbulent 1970s and 1980s, with large oil shocks and rampant inflation, from the period after inflation had been controlled, which also includes the great moderation in real output variability that became apparent in the late 1990s. The basic VARs contain GDP growth for each of the four regions. Four lags were used in the VAR, following Perez, Osborn, and Artis (2006) and Stock and Watson (2005).5

A major focus of the empirical analysis is examining the robustness of the results to alternative orderings of the contemporaneous correlations across shocks in the VAR. Table 1 reports the correlation of these shocks for the full sample period and the two subperiods (in the bottom left triangle of each block). For the full sample, there are two correlations of 0.4 or more in the VAR residuals—those between shocks to growth in the United States and the rest of the world, and between the euro area and the rest of the world. Hence, using the rest of the world as a proxy for global shocks has reduced, but not eliminated, the correlation of these shocks with those from the United States and euro area.

Table 1 also reports the variances and covariances of shocks over the three samples, to give a sense of the relative size of disturbances across regions. Shocks to the United States and Japan are significantly larger than those to the euro area and the rest of the world. As a result, the covariance between shocks to growth in the United States and the rest of the world is significantly larger than that between the euro area and the rest of the world, even though the correlations between the VAR residuals are similar. This means that, when the prior weights are updated with the United States–rest of the world covariance, the U.S. weight will be reduced and that on the rest of the world will be increased. In addition, consistent with the onset of the great moderation, the variance of all of the shocks declines in the second period. The moderation has been largest in the United States (whose variance is lower by a factor of five) and smallest in Japan (whose variance falls by only one-third).6

This paper does not take a strong view on the appropriate ordering in the VAR. Rather, results are averaged across several plausible orderings, in order to allow for the possibility of spillovers in either direction between countries.7 This allows for two-way causation between the United States and the other two major industrial regions. Using U.S., EA, JP, and ROW to

---

5 Both the final prediction error and the Schwarz information criterion suggest three lags, but the Aikaike information criterion finds one lag to be sufficient.

6 The disproportionate fall in U.S. volatility is robust to modest changes in the sample period, and is consistent with the results in Stock and Watson (2005) and International Monetary Fund (2007). The source of the great moderation—smaller underlying shocks or better policies—remains a subject of much debate. See Stock and Watson (2003); Juillard and others (2006); and International Monetary Fund (2007).

7 This is also consistent with the evidence that averaging across a range of models tends to produce better forecasts than a single model. See, for example, Stock and Watson (2004).
The four orderings on the left place U.S. shocks ahead of those of other countries, implying that the U.S. economy is the most important driver of global fluctuations. In two decompositions, the rest of the world is ordered first as it is assumed to be a proxy for global shocks, but the euro area and Japan are each placed first in one ordering.

As discussed above, the choice of orderings can be seen as defining “priors” on the relative importance of contemporaneous spillovers from one area to another. The above orderings give, for example, a 50 percent probability that the correlation between U.S. and rest-of-world shocks is driven by the United States, and another 50 percent probability that it is driven by the rest of the world. The other probabilities are 75:25 United States, euro area, Japan, and the rest of the world, respectively, the simple average across the following eight Cholesky decompositions is reported (in order of independence from other regions):

1. U.S., EA, JP, ROW;
2. U.S., JP, EA, ROW;
5. ROW, U.S., EA, JP;
6. ROW, U.S., JP, EA;
7. EA, ROW, JP, U.S.:
8. JP, ROW, EA, U.S.

Table 1. Correlations, Variances, and Covariances of VAR Residuals

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Euro area</th>
<th>Japan</th>
<th>Rest of world</th>
<th>Variance of Domestic Shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Sample: 1970:Q1 to 2007:Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correlation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>0.08</td>
<td>0.11</td>
<td>0.15</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>Euro area</td>
<td>0.23</td>
<td>0.07</td>
<td>0.09</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>0.17</td>
<td>0.17</td>
<td>0.11</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Rest of world</td>
<td>0.41</td>
<td>0.38</td>
<td>0.25</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td><strong>First Half of Sample: 1970:Q1 to 1987:Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correlation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>0.16</td>
<td>0.35</td>
<td>0.36</td>
<td>1.14</td>
<td></td>
</tr>
<tr>
<td>Euro area</td>
<td>0.26</td>
<td>0.08</td>
<td>0.13</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>0.35</td>
<td>0.15</td>
<td>0.13</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Rest of world</td>
<td>0.54</td>
<td>0.37</td>
<td>0.22</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td><strong>Second Half of Sample: 1988:Q1 to 2007:Q4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correlation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>0.02</td>
<td>−0.06</td>
<td>0.03</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Euro area</td>
<td>0.16</td>
<td>0.06</td>
<td>0.04</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>−0.17</td>
<td>0.21</td>
<td>0.04</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Rest of world</td>
<td>0.21</td>
<td>0.35</td>
<td>0.17</td>
<td>0.11</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors’ calculations.
States–euro area and United States–Japan, and 50:50 euro area-Japan, rest of world-euro area, and rest of the world-Japan.

The average results are augmented by presenting three “extreme” orderings that illustrate the range of potential outcomes—namely orderings one, five, and seven. The first assumes that the contemporaneous correlation between U.S. shocks and those of other regions is driven by the United States, in effect saying that the rest of the world represents small countries that create no contemporaneous spillovers to other regions. The second assumes that all contemporaneous correlation between shocks to the rest of the world and those of other regions are global shocks that spill over onto the main industrial regions (as discussed above, the prior in our averaging procedure puts an even chance on these two interpretations). Finally, we also examine ordering seven to show the sensitivity of the results to the assumption that correlation among global shocks is driven by the euro area.

**Full Sample Results**

Figure 1 contains IRFs showing the impact on the level of real GDP over eight quarters averaged across eight Cholesky decompositions. The first column reports the impact of a shock to U.S. real GDP first on itself, then on the euro area, on Japan, and, finally, on the rest of the world. The second, third, and fourth columns report IRFs for shocks to the euro area, Japan, and rest of the world in the same order. Each graph reports the response plus two standard error bands that only account for coefficient uncertainty, and an additional set of bands incorporating the specification uncertainty discussed above.

Spillovers from the United States to other regions are of economic and statistical significance. A typical shock to the level of U.S. GDP is 3/4 percent initially and rises to over 1 percent after two years. The initial impact elsewhere is small, but gradually builds to 1/2 percent or more in the euro area and rest of the world, and slightly over 1/4 percent in Japan. Hence, after two years, the spillover of U.S. shocks to other regions is somewhere between one-quarter and one-half the size of the initial shock. These responses are significant except that of Japan.

By contrast, a shock to euro area real GDP has a negligible impact on other regions. Domestic shocks of the order of 1/2 percent of GDP have insignificant positive effects on the other regions in the short run that die out over two years. Spillovers from Japan are only significant to the euro area, where their size is similar to those from the United States. However, as discussed below, this result is not robust across subperiods.

Spillovers from the rest of the world are the most sensitive to the Cholesky ordering. The last column of Figure 1 shows that the average shock to the rest of the world is some 1/2 percent of real GDP, with spillovers to other regions statistically insignificant in all cases. However, it is the sizable

---

8 These magnitudes are similar to those found by Perez, Osborn, and Artis (2006).
Figure 1. Responses to Shocks to GDP Across Eight VARs (In percent)

- Response
- +/- 2 standard errors parameter uncertainty only
- +/- 2 standard errors with specification uncertainty
Figure 1 (concluded)

Response of U.S. GDP to Japan GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of U.S. GDP to rest of world GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of euro area GDP to Japan GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of euro area GDP to rest of world GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of Japan GDP to Japan GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of Japan GDP to rest of world GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of rest of world GDP to Japan GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Response of rest of world GDP to rest of world GDP
-0.5 0.0 0.5 1.0 1.5 2.0 2.5
1Q 2Q 3Q 4Q 5Q 6Q 7Q 8Q

Source: Authors’ calculations.
uncertainty engendered by differences across specifications that keeps the rest of world from having a significant impact on euro area, and, in the early quarters, the United States. This uncertainty is mainly reflected in spillovers from the rest of the world, rather than vice versa, because of the larger variance of U.S. shocks compared with shocks to the rest of the world, as discussed in the theory section above.

Sensitivity to Cholesky Ordering

The average results across eight orderings allow the magnitude of spillovers to be calculated given prior convictions on the source of contemporaneous correlation between shocks, but analysis of the individual orderings illustrates the range of possible estimates. As can be seen in Figure 2, the main uncertainty across specifications is in the estimated spillovers from the rest of the world. If the rest of the world is placed first—and hence the correlation between its shock and fluctuations in other regions reflects global disturbances—the estimated spillovers approximately double, and are statistically significant for all regions. By contrast, when the rest of the world is last in the VAR all spillovers are negligible. This is consistent with the interpretation of the shock implicit in each ordering—when it is a global shock, it matters for other regions, but it is unimportant when interpreted as an impulse emanating from small countries.

Spillovers from the rest of the world thus depend crucially on whether their output fluctuations can be assumed to accurately reflect global shocks. When the rest of the world is placed first in the ordering, and hence all disturbances to this aggregate are assumed to be global shocks, they average about 0.6 percent of GDP. The impact on the euro area and Japan rises to a similar value after two years, but the U.S. response remains relatively constant at about two-thirds of the global shock. This suggests that global disturbances have a significant impact on other regions, with the estimated size depending crucially on the chosen prior—particularly as regards the direction of causation between shocks to the United States and the rest of the world.

The extreme ordering with the rest of the world first also results in about a 25 percent reduction in the size of contemporaneous spillovers from the United States to other regions, relative to the average. However, U.S. spillovers to the euro area and rest of world remain statistically significant in both of the extreme orderings where those regions are placed first. When the euro area is placed first, its shocks impact growth in the United States and the rest of the world, but the effects still die out after a year, but the estimated responses to Japanese shocks show almost no variation across these orderings.

9Full results for these orderings, including standard errors, are available from the authors upon request.
Figure 2. Sensitivity to Cholesky Ordering
(In percent)

Response of U.S. GDP to U.S. GDP

Response of U.S. GDP to euro area GDP

Response of euro area GDP to U.S. GDP

Response of euro area GDP to euro area GDP

Response of Japan GDP to U.S. GDP

Response of Japan GDP to euro area GDP

Response of rest of world GDP to U.S. GDP

Response of rest of world GDP to euro area GDP

ESTIMATING THE SOURCE AND SIZE OF SPILLOVERS ACROSS INDUSTRIAL COUNTRIES
Figure 2 (concluded)

- Response of U.S. GDP to Japan GDP
- Response of euro area GDP to Japan GDP
- Response of Japan GDP to Japan GDP
- Response of rest of world GDP to Japan GDP
- Response of U.S. GDP to rest of world GDP
- Response of euro area GDP to rest of world GDP
- Response of Japan GDP to rest of world GDP
- Response of rest of world GDP to rest of world GDP

Source: Authors’ calculations.
Results by Subsample

The results from estimating the baseline “average” VAR over the periods 1970–87 and 1988–2007 are reported in Figure 3. In addition, the dotted line shows the responses from a VAR using the coefficients for 1988–2007 but the distribution and magnitude of shocks from 1970 to 1987. This allows us to attribute variation in spillovers over time into portions that are related to the changing nature of business cycle comovement across regions (the gap between the dashed and dotted lines) and those that merely reflect differences in the size of shocks (the gap between the dotted and solid line). Three shifts over time are apparent—namely, the relative decline in the average size (and hence variability) of U.S. shocks at home and associated spillovers, the fall in the importance of spillovers from Japan to other regions, and the larger role played by spillovers from the rest of the world.

Focusing initially on results for the United States, the first column of Figure 3 shows that all of the responses to U.S. shocks decrease significantly between the first and second samples. However, for the euro area and the rest of the world, most of the decline is due to the reduction in shocks emanating from the United States. As shown by the close correspondence between the dotted and dashed lines, there is little difference in the transmission of U.S. shocks to other regions when the magnitude of shocks is held constant. The “great moderation” in U.S. macroeconomic volatility cuts U.S. spillovers to other regions by a half, but the response of the other economies to a U.S. shock of a given size has remained relatively constant, consistent with the findings of Stock and Watson (2005) and Perez, Osborn, and Artis (2006).

In the other three regions, by contrast, changes in cross-country linkages have contributed more to differences in spillovers over time, but there is less evidence of moderation in domestic shocks. The responses to euro area shocks show the least variation, with the Japanese cycle becoming slightly more sensitive to them. The decline in spillovers from Japan has been driven entirely by a change in the comovement of other countries’ business cycles—consistent with the observation that the intense economic difficulties experienced by Japan after the bursting of the real estate bubble in the late 1980s had relatively limited impact elsewhere. Similarly, spillovers from the rest of the world to the euro area and Japan have risen, despite a slight fall in the initial magnitude of the typical shock, as the propagation of these shocks has become much more powerful. This is consistent with the view that rising globalization has made the world more sensitive to global events, although this pattern is not seen in the U.S. response to global shocks.

10Results with standard errors for each period are available from the authors upon request.
11See Stock and Watson (2005) and Perez, Osborn, and Artis (2006) for other examples of this approach.
12Perez, Osborn, and Artis (2006) found a similar result.
Figure 3. Responses to Shocks to GDP Across Eight VARs by Subsample (In percent)

- Response of U.S. GDP to U.S. GDP
- Response of euro area GDP to U.S. GDP
- Response of Japan GDP to U.S. GDP
- Response of rest of world GDP to U.S. GDP

- 1970–87
- 1988–2007
Figure 3 (concluded)

Response of U.S. GDP to Japan GDP

Response of euro area GDP to Japan GDP

Response of Japan GDP to Japan GDP

Response of rest of world GDP to Japan GDP

Response of U.S. GDP to rest of world GDP

Response of euro area GDP to rest of world GDP

Response of Japan GDP to rest of world GDP

Response of rest of world GDP to rest of world GDP

Source: Authors’ calculations.
The main implication of these results is that the great moderation in U.S. output volatility is an important factor behind the decline in fluctuations elsewhere. As domestic shocks in the other three regions have not varied as much over time, and tighter linkages with the rest of the world have offset Japan’s loss of influence, it follows that lower global volatility is related to the increased stability of U.S. activity and corresponding reduction in spillovers to the rest of the world.\textsuperscript{13} Table 2 presents variance decompositions, which relate the share of variability in each region’s output accounted for by fluctuations in the other regions, and shows that U.S. shocks fall in relative importance in all cases. Meanwhile, Japanese shocks have declined in importance and fluctuations in the rest of the world and euro area explain an increasing share of the cyclical movements of other regions.

III. What Are the Sources of Spillovers?

This section builds on the analysis of the geographic provenance of spillovers by estimating the linkages by which these spillovers are transmitted across borders. Three potential channels are considered—trade, commodity prices, and financial conditions. It should be recognized from the outset that this procedure is more applicable to identifying spillovers across regions than the sources of fluctuations in a domestic economy, which can be driven by additional factors such as consumer and business confidence.

The four-variable VAR in the previous section is augmented by adding each factor as an exogenous variable in a separate VAR run. This procedure amounts to assuming that each channel is independent of the others, and hence its impact can be estimated separately.\textsuperscript{14} The response of GDP to foreign activity in the augmented VAR can be thought of as the size of the spillover excluding the channel present as an exogenous variable. The individual channel’s contribution to spillovers, then, equals the difference between this response and the one from the original VAR, as in Equation (5):

\[ c_{i,j} = r_i - r_{i,j} \]

where \( c_{i,j} \) is the contribution of channel \( j \) in period \( i \), and \( r_i \) and \( r_{i,j} \) are the overall response and the response from the VAR with channel \( j \) included, respectively. The sum of the spillovers coming from the individual sources is not constrained to equal the overall spillover estimated in the base VAR, so it provides an alternative estimate of the size of spillovers that can be used to verify the main results. We also report results from a VAR in which all the exogenous variables are included, which indicates the extent of multicollinearity between the three channels.

\textsuperscript{13}This result is robust to modest changes in the sample, although if the break point is moved after 1993—leaving only one recession in the second period which is probably inadequate for accurately identifying spillovers—there is a stronger role played by moderation of shocks in other regions.

\textsuperscript{14}This also keeps the VARs smaller, which conserves degrees of freedom.
To identify trade spillovers, we use the contribution of exports to GDP growth. As imports are a function of domestic activity, contemporaneous movements in a country’s imports and its output are likely to capture domestic factors in addition to the effects of foreign activity on income. Fluctuations in exports, however, are mainly a function of foreign income and their contemporaneous correlation with domestic demand can be considered exogenous to domestic factors. If the effects of shocks to foreign growth on domestic activity are accounted for by movements in domestic exports, then there is evidence of spillovers through trade. Similarly, if a shock to a major economy’s exports affects its GDP, and in turn this feeds through into growth in another country, this is a trade spillover. The contribution for the rest-of-world aggregate is excluded, however, because these countries are proxying for global shocks, and it is not clear that global exports can be considered to be exogenous to the global economy.¹⁵

¹⁵Results including the export contribution for the rest-of-world aggregate are similar to those reported here and are available upon request.
structure should be short to prevent reverse causality from GDP shocks to exports in future periods from contaminating the estimates. Therefore, the contemporaneous and only one lagged value are included, given the evidence of some autocorrelation in the variable.16

Spillovers from financial channels are captured by including short-term interest rates (the yield on three-month government securities), long-term interest rates (the yield on 10-year government securities), and equity prices for the United States, euro area, and Japan.17 The interest rates are expressed in levels, as yields approximate a random walk. Equity prices were deflated by the country’s GDP deflator, then expressed in quarterly percent changes. Because of the possibility of collinearity among the three variables, they enter as a group in a single VAR rather than individually. The contemporaneous value and first lag of each variable is included, in order to allow for transmission lags. One concern is whether these variables fully capture all financial factors, such as the state of the banking system. To investigate this issue, we also added series on equity prices of the financial sector for the United States, euro area, and Japan. However, the results were similar to the baseline and are not reported for brevity (they are available from the authors on request).

The commodity prices used are the oil price and the nonenergy component of the Goldman Sachs Commodity Index, a broad measure with weights based on global production. Because both track prices in dollars, they are converted into real terms using the U.S. GDP deflator. The real prices then enter the VAR in quarterly percent changes. The contemporaneous value and four lags are used in order to allow for transmission lags.

Full Sample Results

Figure 4 presents the contributions of each of these three channels averaged over eight orderings.18 The line in each graph represents the direct estimate of the average response, as in Figure 1. Although, as expected, the specification does not do a particularly good job at identifying the sources of fluctuations within each region, the fit is better for spillovers across regions, especially in cases where the response itself is statistically significant.

16 Estimation using zero lags showed only minor differences, while trade spillovers were smaller, on average, with four lags. Results for both specifications are available upon request.
17 Rest-of-world financial conditions are not included. Given that the data already include the largest financial markets and those in other major economies are highly correlated with the regions included here, the rest-of-world financial conditions variable would be unlikely to add a significant amount of information. One indication of the success of this method is that we find sizable financial spillovers from rest-of-world growth shocks even in the absence of a specific measure of the region’s financial conditions.
18 Decompositions based on the individual orderings discussed in the previous section are available from the authors upon request.
Figure 4. Decomposition of Responses to GDP Shocks with Financial Variables Included Jointly (in percent)

- **Response of U.S. GDP to U.S. GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of euro area GDP to U.S. GDP**
  - Trade: -0.8, -0.4, 0.0, 0.4, 0.8
  - Commodity prices: -0.8, -0.4, 0.0, 0.4, 0.8
  - All financial variables: -0.8, -0.4, 0.0, 0.4, 0.8

- **Response of Japan GDP to U.S. GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of rest of world GDP to U.S. GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of U.S. GDP to euro area GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of euro area GDP to euro area GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of Japan GDP to euro area GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5

- **Response of rest of world GDP to euro area GDP**
  - Trade: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - Commodity prices: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
  - All financial variables: -0.3, 0.0, 0.3, 0.6, 0.9, 1.2, 1.5
Figure 4 (concluded)

Source: Authors’ calculations.
The results for each type of variable can be summarized as follows:

- **Trade.** The impact of direct trade links is generally small. Even the largest trade spillover, from the United States to the euro area, explains less than half of the transmission of U.S. shocks. Trade channels account for about 20 percent of U.S. spillovers to the rest of the world and the rest of the world’s spillovers to the euro area, and estimates for the other bilateral pairs are even smaller. The magnitudes we find here plausibly reflect the fact that international trade accounts for only a fraction of activity among the main economic regions in the world, and hence that the impact of trade shocks is inevitably relatively minor.  

- **Commodity prices.** The impact of commodity prices on real GDP spillovers is also limited. Because the rest of the world aggregate has several sizable commodity exporters, a rise in activity elsewhere, which will tend to raise global commodity prices, has a mild positive impact on real GDP. Responses for the other three regions, which are net commodity importers, are mixed, but tend more toward the negative side in their response to the rest of the world, which may reflect the influence of global supply shocks.

- **Financial variables.** The largest estimated contributions to spillovers almost universally come from financial variables. These effects are positive for the United States, Japan, and the rest of the world, but, perhaps somewhat surprisingly, always negative for the euro area. About half of spillovers from the United States and the rest of the world are explained by the financial channel. The United States is the least sensitive to shocks to global financial conditions. Overall, our findings imply that financial markets are the main conduit for both U.S. and global shocks but financial shocks from other regions are not as important. This is consistent with the large body of work finding that U.S. financial disturbances affect other regions with little feedback in the other direction (Ehrmann and Fratzscher, 2005; Bayoumi and Swiston, 2007; and Faust and others, 2007).

---

19 Experimentation with other methods of quantifying the trade channel, including making trade an endogenous variable in the VAR, or using net exports’ contribution to growth, yielded similar results. A related paper (Swiston and Bayoumi, 2008) examines spillovers to Canada and Mexico and finds that trade spillovers are stronger where there is a large amount of bilateral trade—in that case, from the United States.

20 Dees and others (2007) come to the same conclusion using a different methodology.

21 In estimates including each variable separately, they all make sizable contributions to spillovers. Therefore, while monetary policy is an important driver of spillovers, so are financial conditions more generally. Furthermore, the estimate of their joint impact is not much smaller than the sum of their individual contributions, suggesting that the effects of the three financial variables are relatively orthogonal to each other.
Figure 5. Responses to Shocks by Identification Method
(In percent)

- Average across eight VARs
- ±2 standard errors across eight VARs with specification uncertainty
- Sum of individual spillover channels
- Response from comprehensive VAR

Response of U.S. GDP to U.S. GDP
Response of euro area GDP to U.S. GDP
Response of Japan GDP to U.S. GDP
Response of rest of world GDP to U.S. GDP

Response of euro area GDP to euro area GDP
Response of Japan GDP to euro area GDP
Response of rest of world GDP to euro area GDP

©International Monetary Fund. Not for Redistribution
Figure 5 (concluded)

Response of U.S. GDP to Japan GDP

Response of U.S. GDP to rest of world GDP

Response of euro area GDP to Japan GDP

Response of euro area GDP to rest of world GDP

Response of Japan GDP to Japan GDP

Response of Japan GDP to rest of world GDP

Response of rest of world GDP to Japan GDP

Response of rest of world GDP to rest of world GDP

Source: Authors’ calculations.
As a robustness check, Figure 5 compares the IRFs estimated for the average specification with the responses implied by summing the impact of the individual potential sources of spillovers. The results confirm that summing the individual sources of shocks provides only a partial explanation for domestic shocks. Turning to spillovers, however, the correspondence between the average IRF and the sum across channels is generally close. In addition, results are reported from a VAR where all the exogenous variables are added simultaneously. If the impact across individual spillover channels were highly correlated, this VAR would show smaller spillovers than the results from summing the three channels. The fact that there are no large divergences suggests that the various channels of spillovers can be regarded as relatively independent of each other.

Results by Subsample

In order to examine changes in the transmission of spillovers over time, Figures 6 and 7 present the decompositions by subsample for U.S. and rest-of-world shocks (euro area and Japanese spillovers are not reported as they are generally insignificant). For the United States, the magnitude of spillovers through all three channels declined in the second half of the sample, but the relative importance of financial linkages with the euro area and the rest of the world has increased at the expense of trade and commodity prices. For rest-of-world spillovers, financial shocks have become more important in terms of both magnitude and relative importance. They now have a stronger influence on activity in the euro area and Japan than do U.S. financial conditions. In line with previous sections, these results point to the increased stability of the U.S. economy as a major factor in the reduction in global economic volatility.

IV. Conclusions

This paper has examined both the sources and size of spillovers across major industrial country regions. Particular attention has been given to identifying the uncertainties involved in distinguishing between spillovers emanating from the United States and from global sources, by using disturbances to an aggregate of 12 smaller countries as a proxy for global shocks. The results suggest the following:

- The United States creates large spillovers to other regions. Regardless of the identifying assumptions used, the United States generates statistically significant spillovers to the euro area and the rest of the world. The effect on foreign output is about one-quarter to one-half the size of the shock to U.S. GDP.
- There also appear to be sizable spillovers from global shocks (identified as those coming from the rest-of-world aggregate). However, their magnitude and significance depend on priors, particularly on the assumed
Figure 6. Decomposition of Responses to U.S. GDP Shocks by Subsample (in percent)

- **Net exports**
  - 1970–87
  - 1988–2007

- **Commodity prices**

- **All financial variables**
  - 1970–87
  - 1988–2007

Source: Authors’ calculations.
Figure 7. Decomposition of Responses to Rest of World GDP Shocks by Subsample (in percent)

Source: Authors’ calculations.
direction of causation of contemporaneous shocks between the rest of the world and the United States. Shocks to activity in the euro area and Japan generally have limited effects on other parts of the world.

- **Smaller U.S. domestic shocks appear to be central to the global moderation in output fluctuations between the 1970s/1980s and the 1990s/2000s.** Although U.S. domestic shocks fell notably, the magnitude of domestic shocks elsewhere has remained stable. U.S. spillovers to other regions have fallen because of this moderation in domestic fluctuations, not because of a reduction in cross-country linkages.

- **The main source of spillovers is financial conditions.** Short-term interest rates and financial conditions more generally (bond yields and equity prices) matter for transferring activity across regions, and financial linkages appear to have become more important than other channels over time. By contrast, trade and commodity prices are less potent factors in this process. These channels also seem relatively independent of each other.

Taken together, these results imply that a major factor in the reduction in output fluctuations around the world was the declining volatility of the U.S. macroeconomy and the associated stability in financial conditions. Given the importance of financial linkages, at least some of the global moderation can be attributed to steadier U.S. monetary policy. This more benign environment may well have been conducive to better domestic policies elsewhere, but the size of domestic shocks does not appear to have fallen over time in other regions to the extent that it has in the United States.

Our methodology allows us to identify global shocks and to estimate spillovers from contemporaneous shocks across countries. Previous work has concluded that global economic fluctuations reflect, to a large extent, common shocks rather than spillovers between countries, but this paper casts considerable doubt on that explanation. Even if there are large global shocks (an issue that remains uncertain), there are also significant spillovers from U.S. shocks.

These are transmitted through financial markets, suggesting that documenting the macroeconomic effects of these linkages is necessary in order to successfully explain spillovers across major regions. Consistent with our results, models that capture trade linkages better than financial ones have failed to find large spillovers across major global regions. Finally, a possible extension of the approach in this paper is to examine spillovers from the major industrial countries or regions onto other economies. This can be done by adding growth of other regions last in the VAR, as in Perez, Osborn, and Artis (2006) and Swiston and Bayoumi (2008).

**REFERENCES**


International Monetary Fund, 2007, World Economic Outlook, October 2007: Globalization and Inequality (Washington, International Monetary Fund).


Yen Carry Trade and the Subprime Crisis

MASAZUMI HATTORI and HYUN SONG SHIN

Yen carry trades have traditionally been viewed in narrow terms purely as a foreign exchange transaction. This paper argues that the carry trade should instead be viewed in the broader context of global credit conditions. We show that the volume of yen funding that is channeled for use outside Japan is mirrored by fluctuations in the size of U.S. broker-dealer balance sheets. Differences in short-term interest rates across currencies help to explain the incidence of the carry trade, as does the measure of implied equity risk given by the VIX index. The conjunction of deteriorating credit conditions in the United States and the weakness of the dollar against the yen in the early stages of the credit crisis of 2007–08 can thus be seen as two sides of the same coin. Both can be seen as consequences of financial sector deleveraging in the United States. 

JEL F31, F32, F33


The tightening of credit conditions that started in the subprime sector of the U.S. mortgage credit market in the summer of 2007 has implications for external adjustment for the United States. As the credit crisis unfolded over the ensuing months, weakness in credit markets was accompanied by the conspicuous weakness of the U.S. dollar, with short-term exchange rate fluctuations mirroring closely overall conditions in the credit market.

*Masazumi Hattori is director and senior economist, deputy head of economics section, Institute for Monetary and Economic Studies, Bank of Japan. Hyun Song Shin is professor of economics at Princeton University. The authors are grateful to Tam Bayoumi, Bob Flood, Kazuo Fukuda, Dick Herring, Isao Hishikawa, Wataru Takahashi and a referee for their suggestions, and to Tobias Adrian for encouragement and support.
The financial press at the time referred to a collective “margin call” on the United States in which foreign creditors sought to reduce their exposure to the deteriorating creditworthiness of U.S. borrowers (including financial intermediaries) by cutting back lending or demanding higher premiums to cover potential losses.

The purpose of our paper is to examine one component of the external adjustment—namely, the unwinding of the so-called yen carry trade. A carry trade refers to the borrowing of a low interest rate currency to fund the purchase of a high interest rate currency—that is, in selling currencies forward that are at a significant forward premium. The “yen carry trade” in particular has been a topical subject of debate over the last decade or more given the extended period of low interest rates in Japan.

Although the carry trade is often portrayed purely as a bet on exchange rate movements, the significance of the carry trade extends far beyond the confines of the foreign exchange market. The key to understanding the wider significance of the carry trade is to follow the trail of leveraged bets through the financial system through interlocking balance sheets of the financial intermediaries involved. Take an example, illustrated in Figure 1. A hedge fund that wishes to take on a speculative leveraged position in subprime mortgage securities must obtain funding from its prime broker. In Figure 1, the prime broker is depicted as a Wall Street investment bank, but the scenario would be equally applicable to a hedge fund operating from London, who obtains funding from banks headquartered in Zurich, Frankfurt, London, or Paris. The prime broker, for its part, is also a leveraged institution. An investment bank is typically leveraged 25 to 30 times. It must fund the loan to the hedge fund by borrowing from another party. But who lends to the prime broker and at what rate?

If the Wall Street bank borrows dollars in New York, it will pay a rate closely tied to the short-term U.S. dollar interbank rate. However, if it were to borrow in Tokyo, and in Japanese yen, it can borrow at the much lower yen overnight rate. A bank with global reach can borrow yen through its Tokyo office. Having borrowed yen in Japan, the investment bank can recycle the yen funding to other users such as their hedge fund clients, or be kept on the bank’s books for its own use (such as funding its own holding of mortgage assets).

In Figure 1, the Tokyo office of the Wall Street bank has yen liabilities to Japanese banks, but has yen assets against its New York head office. The lending by the Japan office of the Wall Street bank to its head office is captured in its “interoffice” accounts. Although the interbank liabilities (the final link) will give some idea of the aggregate yen liabilities, the interoffice account (penultimate link) gives an insight into how much of the


2See Brunnermeier (2008); BIS (2008); IMF (2008); and Greenlaw and others (2008) for a chronology of the credit crisis of 2007–08.
yen liabilities are used to fund activities outside Japan. The tell-tale signs of the channeling of yen funding for use outside Japan would be the conjunction of large yen liabilities of foreign banks in the yen interbank market and large net assets of foreign banks on the interoffice account.

This is because when yen funds are channeled for use outside Japan, there is the conjunction of large yen borrowing and then the on-lending of these yen funds to entities outside Japan.

Figure 2 illustrates the trail through the balance sheet of the Japan office of the global bank. The left-hand panel shows the initial stylized balance sheet of the Japan office. The Japan office holds various assets—such as
Japanese securities and loans to Japanese entities ("call loans")—and funds the asset holding partly by borrowing locally in the yen interbank market ("call money"), and partly by funding from its headquarters through the interoffice liabilities. In the left-hand panel, the net interoffice account (interoffice assets minus interoffice liabilities) is negative, meaning that the global bank holds a net long position in Japanese assets.

The right-hand panel of Figure 2 shows the increased channeling of yen funds to the head office of the global bank via the interoffice account. The Japan office borrows more yen (increases call money), and then lends on the proceeds to its headquarters through increased interoffice assets.

The fluctuations in the interoffice accounts of foreign banks in Tokyo therefore provide a window on the credit market events of 2007 and 2008. Interoffice accounts of foreign banks in Japan are published by the Bank of Japan. A study of the interoffice accounts yields several insights.

First, as we will show below, foreign banks have generally maintained negative interoffice net assets, consistent with the foreign banks maintaining a net long position in Japanese assets. However, in the period leading up to the beginning of the credit crisis of 2007, yen liabilities of foreign banks surged, leading to an unprecedented net positive interoffice accounts of foreign banks. Such positions are tantamount to the foreign banks maintaining a net short position in Japanese assets. These net short positions were unwound sharply in August 2007, coinciding with the initial stages of the credit crisis, and were reduced further as the credit crisis developed into the latter half of 2007 and into 2008.

We show below that the period when yen funding was being channeled out of Japan also coincides with the rapid growth of financial intermediary balance sheets. Using data for the United States, we show that the growth of total assets of the U.S. security broker dealer sector (which includes the major investments banks) is closely related to the evolution of the size of net interoffice accounts.

By tracking proxies for the prices of subprime mortgages, such as the ABX index supplied by the London firm Markit,\(^3\) it is possible to put the reversal of the interoffice accounts into the context of the wider sub-prime crisis. We show below that the sharp price declines in mortgage securities secured on subprime mortgages are mirrored by the fluctuations in the net interoffice accounts. In this respect, the credit crisis and the external adjustment of financial intermediary balance sheets can be seen as two sides of the same coin. They are both manifestations of the deleveraging of financial intermediaries and their hedge fund clients.

We also examine a number of related questions. As found in Adrian and Shin (2007) for the fluctuations in U.S. primary dealer balance sheets, we find that the fluctuations in the size of the net interoffice accounts is related to the state of overall risk appetite, as measured by the VIX index of implied

\(^3\)The index is available at www.markit.com.
volatility on the broader U.S. stock market. The periods when foreign banks have large yen liabilities are also those periods with low readings of the VIX index. This fact gives a clue as to why major global stock indices have been so closely aligned with the exchange rates of high yielding currencies vis-à-vis the yen in recent years.

In addition, we find that the difference between the yen overnight rate and a summary measure of overnight rates in developed countries mirrors closely the overall size of the net interoffice accounts. Yen liabilities are high when foreign overnight rates are high relative to overnight rates in Japan. Conversely, when foreign overnight rates are close to Japanese rates, foreign banks have low yen liabilities. During the period of historically low U.S. interest rates in 2002 to 2005, foreign banks maintained low yen liabilities, suggesting that they could satisfy their funding needs by borrowing in U.S. dollars without tapping the yen market. Indeed, in a regression where both VIX and the interest rate differential appear together as regressors, both are highly significant, suggesting that they are two windows on the same underlying phenomenon.

Our findings hold potentially important lessons for monetary policy. Although monetary policy is conducted primarily with domestic macroeconomic conditions in mind, there are inevitable global spillovers of monetary policy. In recent years, with the advent of formal inflation-targeting and moves toward greater focus on managing market expectations of future central bank actions, attention has shifted away from short-term rates as an important price variable in its own right. Our findings suggest that short-term rates and balance sheet size may be important in their own right for the conduct of monetary policy.

This paper begins with a sketch of an analytical framework that links external balance with the balance sheet adjustments of financial intermediaries. We then chart the fluctuations in the interoffice account, and highlight the relationship between the interoffice accounts and the subprime mortgage assets. We go on to investigate how the fluctuations in the net interoffice accounts relate to risk appetite, as measured by the VIX index, and how they relate to the difference between foreign overnight rates and the yen interest rate. We conclude by showing how the unwinding of the carry trade has been mirrored by the fall in subprime mortgage prices, adding weight to the main hypothesis that the dollar and subprime are two sides of the same coin—both being the manifestations of the deleveraging of financial intermediaries.

I. Balance Sheet Perspective

There have been many proposed explanations of how the United States has managed to fund its current account deficit with such ease in recent years. One explanation has been the higher return from U.S. assets due to the higher productivity growth and stronger fundamentals in the United States. However, as noted in the paper by Balakrishnan, Bayoumi, and Tulin in this
special section, explanations that rely on prospective higher returns fall foul of one key fact—namely that the bulk of the funding of the current account deficit has been in the form of debt claims, especially the mortgage-backed securities issued by the U.S. government-sponsored enterprises (GSEs), such as Fannie Mae and Freddie Mac.

Figure 3 plots the proportion of U.S. agency and GSE-backed securities holdings by various classes of holders from end-2001 to end-2007. The data are drawn from the U.S. flow of funds accounts (Table L.210). The striking feature is the increased holdings of the “rest of the world” category, which itself is mostly accounted for by foreign central banks or other official holders. The “rest of the world” holding has more than tripled from $504 billion at the end of 2001 to $1,540 billion at the end of 2007. Because debt claims have little exposure to the upside of any potentially higher returns, explanations that rely on future higher returns do not sit comfortably with the facts.

An alternative perspective is to focus on the actions of the financial intermediaries themselves, and to chart how the waxing and waning of the risk appetite of such intermediaries to shifts in measured risks can explain external adjustments. Adrian and Shin (2007) have emphasized the procyclical nature of financial intermediary balance sheets and its role in amplifying financial cycles. We can illustrate the effects of fluctuating risk
appetite by means of a simple example, modifying the framework in Shin (2008). The framework rests on a stylized financial system depicted in Figure 4.

The financial system consists of four sectors. The end-user borrowers are U.S. households who rely on financial intermediaries to supply mortgage funding. The funding comes ultimately from two sources—domestic households who hold equity and debt claims on the financial intermediaries, and foreign creditors who hold debt claims against financial intermediaries.

There are $n$ leveraged financial intermediaries that we call “banks” for convenience but in principle, they encompass intermediaries such as broker dealers and other entities involved in the securitization process. The banks are indexed by $i \in \{1, \ldots, n\}$. The domestic claim holders and the foreign creditors are gathered together, and labeled as sector $n+1$.

Denote by $y_i$ the market value of loans made by bank $i$ to end-users. The financial intermediaries also hold claims against each other. Suppose that proportion $\pi_{ij}$ of bank $i$’s debt is held by bank $j$. The proportion $\pi_{i,n+1}$ is held by sector $n+1$, consisting of domestic nonbank claim holders and foreign claim holders. Denoting by $x_i$ the market value of bank $i$’s debt, we can write the market value of bank $i$’s assets as:

$$a_i = y_i + \sum_j x_j \pi_{ji}.$$  

Total liabilities of bank $i$ are then given by the sum of equity and debt.

$$e_i + x_i.$$  

Denote the leverage of bank $i$ as $\lambda_i$, where leverage is defined as the ratio of total assets to equity. That is

$$\frac{a_i}{a_i - x_i} = \lambda_i. \quad (1)$$

Note: The figure depicts a stylized financial system where the financial intermediaries lend to the end-user borrowers by obtaining funding either from domestic claimants or from foreign creditors.
Then, for \( \delta_i = 1 - (1/\lambda_i) \), we have

\[
x_i = \delta_i \left( y_i + \sum_j x_j \pi_{ji} \right)
= \delta_i y_i + \begin{bmatrix} \vdots \\ \delta_i \pi_{1i} \\ \vdots \\ \delta_i \pi_{ni} \end{bmatrix},
\]

(2)

Let \( x = [x_1 \ldots x_n] \), \( y = [y_1 \ldots y_n] \), and

\[
\Delta = \begin{bmatrix} \delta_1 \\ \vdots \\ \delta_n \end{bmatrix}.
\]

(3)

Then we can write equation (2) in vector form as:

\[
x = y \Delta + x \Pi \Delta.
\]

Solving for \( x \),

\[
x = y \Delta (I - \Pi \Delta)^{-1}
= y \Delta (I + \Pi \Delta + (\Pi \Delta)^2 + (\Pi \Delta)^3 + \cdots).
\]

(4)

The matrix \( \Pi \Delta \) is given by

\[
\Pi \Delta = \begin{bmatrix} 0 & \delta_2 \pi_{12} & \cdots & \delta_n \pi_{1n} \\ \delta_1 \pi_{21} & 0 & \cdots & \delta_n \pi_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \delta_1 \pi_{n1} & \delta_2 \pi_{n2} & \cdots & 0 \end{bmatrix}.
\]

(5)

The infinite series in equation (4) converges as the rows of \( \Pi \Delta \) sum to a number strictly less than 1. Hence, the inverse \( (I - \Pi \Delta)^{-1} \) is well defined.

Equation (4) is just a rewriting of the balance sheet identity of all financial intermediaries in the system. However, equation (4) can be given empirical content once we model the banks’ choice of leverage, as given by the diagonal matrix \( \Delta \). Leverage will be determined by banks’ measured risks on their asset portfolio.

**Value-at-Risk**

For bank \( i \) its value-at-risk at confidence level \( c \) relative to the face value of its assets \( a_i \), is defined as the smallest nonnegative number \( V \) such that

\[
Pr(\hat{a}_i < \bar{a}_i - V) \leq 1 - c,
\]

(6)

where \( \hat{a}_i \) is the realized value of assets of bank \( i \) at some future terminal date. In other words, the value-at-risk \( V \) can be seen as the “approximately worst case” loss that the bank may suffer, where “approximately worst case” is
defined so that anything worse than this approximately worst case happens with probability less than some benchmark $1 - c$.

The concept of value-at-risk has been adopted widely among financial institutions in their risk management practices. The annual reports and regulatory filings of major banks devote a substantial part to a discussion of their value-at-risk estimates. Moreover, value-at-risk has been adopted in the regulatory framework for capital since the 1996 Market Risk Amendment of the Basel Accord, and in the Basel II regulations. See Adrian and Shin (2008b) for a microeconomic model where value-at-risk emerges as the outcome of a contracting problem between banks and their creditors.

### Determination of Leverage

Risk management is intimately tied to the leverage of the bank. Suppose that a bank aims to adjust its balance sheet so that its market equity $e_i$ is set equal to its value-at-risk. The term “economic capital” is sometimes used interchangeably with the bank’s value-at-risk.

Of particular interest is the comparative statics effect on leverage and debt of improvements in the credit quality of the underlying end-user loans. In particular, consider a first-degree stochastic dominance shift in the repayments associated with an improvement in the credit quality of the loans to end-users. The direct effect on the market values $\{y_i\}$ of the loans to end-users is immediate, but there is also an indirect effect on the market values $\{x_i\}$ of the debt issues by the $n$ banks. This follows from the fact that the market value of bank $i$’s debt is increasing in the value of its assets, because the bank’s debt is a promise backed by its assets (Shin, 2008).

The overall effect of a first-degree stochastic dominance shift in the repayment density associated with loans to end-users is that the possible asset value realizations of the banks also shifts in a first-degree stochastic dominance sense. Figure 5 illustrates the comparative statics effect. As before, $\bar{a}_i$ is the face value of bank $i$’s assets. Initially, the probability density over realized assets is such that the market value of assets is $a_i$, and the value-at-risk is given by initial market equity $e_i$. After the first degree stochastic dominance shift in the repayment density, there is an associated first degree stochastic dominance shift in the density over possible asset value realizations, both directly through the end-user loans, and indirectly through the strengthening of other banks’ balance sheets. Figure 5 illustrates the shift.

The new market value of assets is given by $a'_i$, and economic capital falls to the bank’s value-at-risk $V'$, but the market value of equity rises to $e'$. We have $V' < e'$, as the area under the density to the left of $\bar{a}_i - e_i$ under the old density must be equal to the area to the left of $\bar{a}_i - V'$ under the new density. Thus, market equity $e'$ after the shift exceeds economic capital, given by value-at-risk $V'$. Hence, banks seek to adjust their leverage upward, so that equity is once again in line with the new (lower) value-at-risk. The banks

---

4See Shin (2008) for the details of the analysis.
expand their balance sheets by increasing the face value of debt. The mechanism works exactly in reverse “on the way down.”

The actions of individual banks in reaction to balance sheet changes have an aggregate effect on the sector as a whole. As a sector as a whole, the increased balance sheets of the financial intermediaries are achieved through greater borrowing from either the domestic claimholders or the foreign creditors. Thus, part of the increased financial intermediary balance sheets will be financed through greater borrowing from foreign creditors. Hence, external adjustment through greater borrowing from foreign creditors will be an important component of the funding necessary to accomplish such an expansion.

In particular, if the domestic claim holders in Figure 4 are already heavily committed to the financial intermediary sector through deposits and holdings of mortgage-backed securities, then most of the adjustment will have to take place through increased commitment of the foreign creditors. Notice also why the foreign claim holders hold debt claims rather than equity. The increased expansions of the financial intermediary balance sheets are intended to raise leverage—that is, to increase assets to a level that once again equates total value-at-risk with market equity. Thus, it is debt, rather than equity that is raised by the financial intermediaries. This feature of our model explains the fact discussed by Balakrishnan, Bayoumi, and Tulin in this special issue that most of the financing of the U.S. current account deficit has been met with debt rather than equity.

Finally, we note one further consequence of our framework. Asset price booms (especially housing booms) and current account deficits go hand in hand.
hand. They are both reflections of the booming leverage of the financial intermediary sector. From now on, as the U.S. housing market declines, we would expect to see the accompanying reversal of the U.S. current account deficit.

II. Role of the Yen Carry Trade

We now turn to the role of the yen carry trade in the external adjustment described above. Before going to the key plots we describe some background. Consider first the total assets of foreign banks in Japan in Figure 6.

Total assets of foreign banks increased rapidly in the late 1990s, and have stayed high since. The composition of total assets (given in Figure 7) gives clues as to the reasons for the increase in the late 1990s.

The sharp increase in foreign bank assets in 1997 and 1998 is accounted for by the increase in “bills bought.” The Japan premium ruling at the time meant that non-Japanese banks had a considerable pricing advantage over local Japanese rivals, and managed to exploit this advantage.

Even as the “bills bought” amount falls in 1999 and 2000, the slack is taken up by holdings of Japanese securities in 2000 and 2001. Lately, the item “due from banks” has taken up the slack left by falls in other categories. This period coincides with the period of quantitative easing by the Bank of Japan, and suggests that even foreign banks had surplus balances at the Bank of Japan.

We now focus on the key series for the yen carry trade. Figures 8 and 9 plot, respectively, the aggregate interbank assets of foreign banks in Japan (“call loan”) and the aggregate interbank liabilities of foreign banks in Japan (“call money”). Call loans have fluctuated over the years, and were low in the early part of the decade when U.S. interest rates were exceptionally low. Call

Figure 6. Total Assets of Foreign Banks in Japan
money (yen liabilities) have fluctuated even more, with a surge in the period after 2004, when the U.S. interbank rate was rising. Note that the scale is different in the two series, so that the surge in yen liabilities is larger than at first meets the eye.

As a result of the surge in yen liabilities, the net interbank position of foreign banks becomes sharply negative in the most recent period leading up
to the credit crisis (see Figure 10) but has subsequently fallen back with the onset of the crisis. However, the important piece of evidence is the stance on the interoffice account. In order to conclude that the surge in yen liabilities is associated with the carry trade, we need to verify that the increased yen liabilities have been channeled out of Japan to other offices of the banks concerned. The crucial piece of evidence is therefore the net interoffice accounts, as presented in Figure 11.

As previously discussed, the net interoffice accounts of foreign banks have normally been negative, implying that foreign banks have held a net long position in Japanese assets. In the period of the “Japan premium” (roughly 1997 to 1998) foreign banks held large net long positions in Japanese assets, given their funding advantage over Japanese rivals handicapped by the Japan premium.5

However, the most noteworthy feature of Figure 11 is the surge in net interoffice accounts in the most recent period, dating from around 2005. The increase in the net interoffice account is so large that the usual sign of the net interoffice account was reversed in the period leading up to the crisis of 2007. The implication is that yen funding had been channeled out of Japan immediately prior to the credit crisis of 2007. The surge has subsequently been reversed as the 2007 credit crisis has progressed.

---

5 The Japan premium explains the very sharp spike upward in the “bills bought” component of foreign banks’ assets, as shown in Figure 7.
Figure 12 is a scatter chart of the monthly change in the interoffice accounts of foreign banks against the monthly change in the net interbank assets (call loan minus call money) of foreign banks from 1999. If our hypothesis is correct that the fluctuations in yen liabilities reflect the broad yen carry trade, then the points on the scatter chart should be negatively sloped. The slope of the relationship would depend on the degree to which the yen liabilities of the foreign banks’ Japan office merely reflects the channeling of yen to uses outside Japan. If the slope is −1, then there is a one-for-one relationship between increases in yen interbank liabilities and yen interoffice accounts, suggesting that changes in yen liabilities reflect the broad yen carry trade. If the slope has a lower absolute value, then the fluctuations in yen interbank liabilities would reflect other motives for borrowing yen (such as funding the purchase of Japanese securities).

In the scatter chart, we see, indeed, that the relationship is strongly negative. The slope of the ordinary least squares (OLS) regression is close to −1 at −0.89.6 We take this to be evidence consistent with the hypothesis that the Japan offices of the foreign banks play the role of channeling yen liquidity out of Japan in the broad yen carry trade.7

The evidence focuses attention on the question of how such yen funding has been used by the headquarters offices of the foreign banks. At this point,

---

6 The t-statistic is -7.15 and the $R^2$ is 0.34.

7 There is some evidence that some of the funds captured in the interoffice accounts are used to purchase Japanese securities on the books of the headquarters bank. Thus, not all of the interoffice accounts will reflect funds channeled out of Japan for use overseas.
the trail becomes murkier, but it would be a reasonable conjecture (to be verified through other evidence) that the increased yen funding has either been recycled for use by the customers of the foreign banks in their home markets (for example, hedge funds), or have funded the mortgage-backed securities and other assets on the banks’ own balance sheets.
We have focused on the yen interbank for evidence of the carry trade, but there are other means through which foreign institutions can raise funding in Japan, such as the issuance of “Samurai bonds”—that is, yen-denominated bonds issued by nonresidents, especially when the issuer is a foreign bank. A more comprehensive study of the carry trade would need to take account of such alternative funding sources.

**Carry Trades and Balance Sheet Size**

We turn now to the final piece in the jigsaw. If the close comovement of net interoffice accounts and the net interbank assets of foreign banks in Tokyo is an indication that yen funding is being channeled for use outside Japan, then the increased incidence of the carry trade should show up on the balance sheets of financial intermediaries outside Japan, especially for the period in which the yen carry trade is expected to have played a key role in the funding of financial intermediaries outside Japan.

We examine data for the aggregate security broker dealer sector for the United States, as given by the Flow of Funds accounts for the United States. Adrian and Shin (2007) have shown that the security broker dealer sector (which includes the major U.S. investment banks) respond sensitively to shifts in measured risks and other market conditions by active adjustment of their balance sheets. Also, given the importance of the market-based funding of residential mortgages in the United States (with two thirds now being held by mortgage pools rather than banks), the security broker dealer balance sheets provide a timely window on the market-based banking system.

The flow of funds is a quarterly series, but our net interoffice account is monthly. Therefore we took quarterly snapshots of the interoffice accounts. In order that we minimize the influence of short-term noise in the series and focus on the long-run trends, we take longer-term growth rates, but measured at quarterly intervals. Figure 13 plots the two-year growth rate of the U.S. security dealer sector total assets together with the two-year change in the net interoffice accounts. Thus, the first observation for the security dealer series is the growth from March 1, 1999 to March 1, 2001, the next is the growth from June 1, 1999 to June 1, 2001, and so on.

For the period from 2001 to 2008, the two series track each other closely. The dip in the early years of the decade coincides with the period of low U.S. short-term interest rates, when the carry element was small. Later in the decade, when the interest rate differential starts to widen, both series move up. In particular, the boom in U.S. housing markets and the associated period of rapid growth in broker dealer assets coincide in the interval from

---

8The reason why we take changes rather than growth rates for the net interoffice accounts is that the series changes sign frequently, with some observations close to zero.

9We will see later some independent confirmation of the role of the interest rate differential.
2005 to early 2007. Then, with the onset of the credit crisis of 2007, both series move down sharply.

The scatter chart given in Figure 14 confirms the close comovement in the two series. A linear regression yields an $R^2$ of 57 percent, and a $t$-statistic on the regressor of 6.0.

III. Carry Trade and Risk Appetite

We now examine the wider implications of the carry trade. Our focus is on the implications of expansions of balance sheets for the appetite for risk. In a financial system where balance sheets are continuously marked to market, changes in asset prices show up immediately on the balance sheet, and so have an immediate impact on the net worth of all constituents of the financial system. The reactions of financial intermediaries to such changes in net worth are a critical influence on overall market risk appetite.

If financial intermediaries were passive and did not adjust their balance sheets to changes in net worth, then leverage would fall when total assets rise. Change in leverage and change in balance sheet size would then be negatively related. However, as documented by Adrian and Shin (2007), the evidence points to a strongly positive relationship between changes in leverage and changes in balance sheet size. Far from being passive, financial intermediaries...
adjust their balance sheets actively, and doing so in such a way that leverage is high during booms and low during busts.

As we have seen in our sketch of the stylized financial system, procyclical leverage can be seen as a consequence of the active management of balance sheets by financial intermediaries who respond to changes in prices and measured risk. For financial intermediaries, their models of risk and economic capital dictate active management of their overall value-at-risk through adjustments of their balance sheets. Credit ratings are a key determinant of their cost of funding, and they will attempt to manage key financial ratios so as to hit their credit rating targets.

From the point of view of each financial intermediary, decision rules that result in procyclical leverage are readily understandable. However, there are aggregate consequences of such behavior for the financial system as a whole that are not taken into consideration by an individual financial intermediary. Such behavior has aggregate consequences on overall financial conditions, risk appetite, and the amplification of financial cycles.

For these reasons, it would be important to draw a distinction between the capital outflows from Japan due to the carry trades by financial intermediaries and the outflows due to the household sector’s purchase of foreign assets, or the diversification of the portfolios of institutions such as

![Figure 14. Carry Trade and Balance Sheet Growth (Scatter)](image)

Note: This figure is a scatter chart of the two-year growth in U.S. security dealer assets and the two-year change in the net interoffice accounts. There is a positive relationship between them, suggesting that yen funding is associated with balance sheet expansions of U.S. intermediaries.
mutual funds and life insurance companies that are not leveraged, or have minimal leverage. Indeed, the purchase of foreign currency assets for these entities should not be seen as part of the yen carry trade we have discussed so far. In contrast, the most important marginal players are the financial intermediaries whose fluctuating balance sheets determine overall financial market liquidity conditions.

Aggregate liquidity can be understood as the rate of growth of aggregate balance sheets. When financial intermediaries’ balance sheets are generally strong, their leverage is too low. The financial intermediaries hold surplus capital, and they will attempt to find ways in which they can employ their surplus capital. In a loose analogy with manufacturing firms, we may see the financial system as having “surplus capacity.” For such surplus capacity to be utilized, the intermediaries must expand their balance sheets. On the liabilities side, they take on more short-term debt. On the asset side, they search for potential borrowers that they can lend to. It is in this context that the broad yen carry trade comes into sharper focus. By allowing intermediaries to expand their balance sheets at lower cost, the broad carry trade fuels the financial boom. Aggregate liquidity is intimately tied to how hard the financial intermediaries search for borrowers. In the subprime mortgage market in the United States we have seen that when balance sheets are expanding fast enough, even borrowers that do not have the means to repay are granted credit—so intense is the urge to employ surplus capital. The seeds of the subsequent downturn in the credit cycle are thus sown.

Jimenez and Saurina (2006) show from their study of Spanish banks that the loans granted during booms have higher default rates than those granted during leaner times.

Adrian and Shin (2007) have shown that balance sheet changes are closely related to the overall market risk appetite, as measured by the VIX index of implied volatility of stocks. In the context of the broad yen carry trade, it would be reasonable to conjecture that something similar holds, too.

Figure 15 is a scatter chart of the VIX index against the net interoffice account of foreign banks in Japan. There is a striking negative relation, where large net interoffice accounts are associated with lower implied volatility—that is, large balance sheets with greater risk appetite. We know from the period immediately preceding the 2007 credit crisis that implied volatility had plumbed historical lows. As we have seen earlier, this was precisely the period when the net interoffice accounts became positive—also an unprecedented event. More worryingly, the unwinding of these large net interbank assets to return the system to its historical norm will undoubtedly have adverse aggregate consequences.

IV. Carry Trades and Monetary Policy

Given the importance of balance sheet fluctuations for overall risk appetite and their spillover effects for the economy as a whole, the role of the carry trade in facilitating or amplifying the balance sheet fluctuations make it a
prime concern for monetary authorities. We examine the determinants of the size of the yen carry trade, especially the role of the short-term interest rate.

The important role played by the overnight rate can be gleaned from the relationship between the extent of the broad yen carry trade and the interest rate differential between Japan and other developed countries.

Figure 16 charts the net interoffice accounts with the difference between the overnight rates in Japan and a simple average of the policy rates in the United States, Eurozone, and Australia. The chart suggests that since 1999, we have a negative relationship between the two. The larger is the difference in short-term rates between Japan and the group of countries we consider (United States, Eurozone, and Australia), the greater is the broad yen carry trade. It is notable, especially, that in the period 2002–04 when U.S. interest rates were low, and hence close to that of Japan’s, the net interoffice account shows little evidence of large-scale carry trades. In contrast, the period from 2005 onward shows a surge in net interoffice accounts coming at the time when U.S. interest rates were moving back up to historically more normal levels.

The same information can be represented as a timed scatter chart as in Figure 17. There is a strongly negative relationship in the two series. The first and last data points (January 1999 and August 2007) are indicated with the red dots. An OLS regression has a $t$-statistic of $-7.8$.

The importance of the interest rate differential for the carry trade is also apparent in the skewness of returns, as shown by Brunnermeier, Nagel, and Pedersen (2009), and Gagnon and Chaboud (2007) as the unwinding of the

Note: This figure is the scatter chart of the VIX index of implied volatility derived from options on the U.S. stock market against the net interoffice account. There is a negative relationship between the two, suggesting that the yen carry trade is associated with periods of greater risk appetite.
carrying trade is likely to be more abrupt than the build up of positions.\footnote{See also Burnside and others (2007) on the excess returns on the carry trade. See Gyntelberg and Remolona (2007) for the evidence of carry trades in other Asian currencies.} Interest rate differentials also figure in theoretical models of the carry trade (see Plantin and Shin, 2006). The carry element combined with a procyclical leverage ratio (illustrated in the previous section) serve to increase the spillover effects of one currency speculator’s actions on others, making speculative trading strategic complements. The carry element turns out to be crucial in this regard. Without the carry element, speculators’ actions are strategic substitutes.

Combining Information from VIX and Interest Rate Differential

So far, we have discussed the role of the changes in the VIX index and the interest rate differential separately, and shown that they individually have some explanatory power as determinants of the net interoffice accounts. Both

Note: This figure charts the net interoffice accounts and interest rate differential between Japan and simple average of the U.S. dollar, the euro, and the Australian dollar. There is a negative relationship between the two series, suggesting that the yen carry trade is most active when interest rate differentials are large.
VIX and the interest rate differential continue to have explanatory power when combined, as seen in Table 1. The $P$-values are in parentheses.

As seen from column (1) of the table, in a linear regression where both series are included, both VIX and the interest rate differential term are highly significant. Indeed, we see that the $R^2$ rises to 59.5 percent, from 37.7 percent when only the interest rate differential is used as the regressor, and from 19.6 percent when only VIX is used.

### Table 1. Determinants of Net Interoffice Accounts

<table>
<thead>
<tr>
<th>Explanatory Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate differential</td>
<td>-37.349</td>
<td>-36.299</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>VIX</td>
<td>-3.679</td>
<td></td>
<td>-3.490</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td></td>
<td>(0.000)</td>
</tr>
<tr>
<td>Constant</td>
<td>-134.380</td>
<td>-204.850</td>
<td>8.083</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.568)</td>
</tr>
<tr>
<td>$R^2$-squared</td>
<td>0.595</td>
<td>0.377</td>
<td>0.196</td>
</tr>
</tbody>
</table>

VIX and the interest rate differential continue to have explanatory power when combined, as seen in Table 1. The $P$-values are in parentheses.

As seen from column (1) of the table, in a linear regression where both series are included, both VIX and the interest rate differential term are highly significant. Indeed, we see that the $R^2$ rises to 59.5 percent, from 37.7 percent when only the interest rate differential is used as the regressor, and from 19.6 percent when only VIX is used.

### Implications for Monetary Policy

Our empirical findings suggest that the overnight rate set by central banks may have an important role in influencing the scale of the carry trade, but more broadly in determining balance sheet size in the financial sector as a...
whole. Our results are in line with the results of Adrian and Shin (2008a), who show that the residuals from a Taylor rule regression is closely (negatively) related to the growth of financial sector balance sheets in the United States. These results suggest that overnight rates may have some importance in their own right when conducting monetary policy, not merely as an instrument to signal the central bank’s intentions of future actions.

Our conclusions run counter to some key tenets of central bank thinking in recent years, especially at those central banks that practice inflation-targeting. Under this alternative view, the overnight rate is important only as a means of communicating with the market on future central bank actions, and thereby managing market expectations (see, for instance, Blinder, 1988; and Bernanke, 2004a and 2004b). However, to the extent that financial stability concerns should impinge on monetary policy, the insignificance of the overnight rate may have been somewhat overdone. On the contrary, short-term rates could be conjectured to play an important role in their own right, as it is the short-term rate that determines the cost of rolling over liabilities.

In addition, although monetary policy is conducted primarily with domestic macroeconomic conditions in mind, there are undoubted international spillover effects. The experience of the 2007 credit crisis is a lesson in the importance of financial stability in the conduct of monetary policy.

V. Carry Trade and Subprime Crisis

The main theme of our paper has been that the external adjustment of the U.S. current account deficit should be viewed in terms of the deleveraging of the U.S. financial intermediary sector. The fate of the yen carry trade is tied up with this overall process. Although sometimes the yen carry trade is viewed narrowly simply as a trade in the foreign exchange market, we have seen that the phenomenon should be viewed within the larger context of the waxing and waning of the balance sheets of the financial intermediary sector as a whole.

We illustrate the way in which the unwinding of the leverage has been proceeding during the current credit crisis. Figure 18 is a scatter chart that plots the monthly change in the net interoffice accounts against the AA tranche of the ABX index (the vintage being the first half of 2007), compiled by the London firm Markit. The ABX index summarizes the information from polls taken from dealers who quote prices for credit default swaps (CDSs) on various tranches of collateralized debt obligations built on subprime residential mortgages. To the extent that the CDS prices reflect underlying prices, the ABX index is a reflection of the prices of the underlying subprime mortgage assets. The qualification is that the ABX index may also reflect liquidity effects arising from balance sheet constraints, and so the index should be seen as a composite of the underlying “true” values in a nondistressed market, together with a liquidity premium that increases during periods of distress.
The scatter chart reveals that the subprime crisis has been intimately linked with the unwinding of the yen carry trade in terms of the reversal of the net interoffice account positions of foreign banks. The scatter chart shows the monthly changes in the net interoffice accounts from the beginning of 2007.

In the early months of 2007, the ABX index is trading at very close to par, as befits a credit rating of AA. Even the minor ripple that occurred in the foreign exchange market in February and early March of 2007 barely registers on the chart.

However, the picture changes radically from the end of June 2007. Thereafter, there is a rapid fall in the ABX index, accompanied by the unwinding of the net interoffice accounts. The sharpest movement occurs in August, when (beginning on August 9) the subprime crisis took hold in the interbank credit market resulting in the drying up of liquidity in the interbank credit market. We see that August saw a sharp adjustment of the net interoffice account, consistent with the rapid unwinding of the yen carry trade positions of the foreign banks in Japan.

As the crisis has unfolded in the subsequent months, the net interoffice account has once again become negative—back to the historically normal position in which foreign banks hold a net positive position in Japanese assets. In doing so, it would be reasonable to conjecture that the funding for repayment of the yen debt to the Japanese banks has been obtained through

Note: This figure is the scatter chart of monthly change in net interoffice account and the ABX AA 07-1 index of implied subprime mortgage security prices. There is a negative relationship between the two, suggesting that the carry trade is being unwound as the price of subprime mortgage securities fall.
the deleveraging process of foreign banks, and in particular through the sale of assets previously held on the balance sheets of the banks. Mortgage assets and related fixed income securities would have been a key component of such asset sales.

VI. Concluding Remarks

In the lead-up to the credit crisis of 2007–08, purchases of mortgage assets and related securities by hedge funds and their intermediaries was financed (at least in part) by money that was ultimately borrowed in Japan. With the bursting of the credit bubble and the gathering pace of the deleveraging, the hedge funds and their intermediaries have had to unwind such bets by selling mortgage assets and repaying their Japanese creditors. Thus, we saw in the early stages of the crisis the conjunction of a fall in asset prices and a fall in the U.S. dollar.

More broadly, we have examined the broader implications of the yen carry trade for risk appetite and financial cycles. Although the yen carry trade has traditionally been viewed in narrow terms purely as a foreign exchange transaction, we have argued that they hold broader implications for the workings of the financial system and for monetary policy. The evidence from the waxing and waning of balance sheets of foreign banks operating in Japan points to a broader notion of the carry trade. Yen liabilities fund not only pure currency carry trades, but also fund the general increase in balance sheets of hedge funds and financial intermediaries. Finally, we have shown that the difference in overnight rates across countries is a crucial determinant of balance sheet changes. Therefore, the short-term interest rate may be more important as a gauge of the stance of monetary policy than is given credit for by current monetary thinking. Domestic monetary policy has a global dimension through the workings of the global financial system.

REFERENCES


Rhyme or Reason: What Explains the Easy Financing of the U.S. Current Account Deficit?

RAVI BALAKRISHNAN, TAMIM BAYOUMI, and VOLODYMYR TULIN

This paper examines the roles of U.S. financial innovation, financial globalization, and the savings glut hypothesis in explaining the rise in U.S. external debt, first in a portfolio balance model, and then empirically. Perhaps surprisingly, financial deepening and falling home bias in industrialized countries explain a large share of external financing. The savings glut hypothesis (including difficult-to-track petrodollar recycling) and U.S. financial innovation also play a role, in part as a cause of declining home bias in industrialized countries. The latter underscores the importance of not looking at these factors in isolation, but rather as a constellation of forces that can be self-reinforcing. [JEL F32, F34, G11, G12, G15]


Notwithstanding the shrinking of the U.S. current account deficit in 2007–08, global imbalances remain one of the most striking trends in the international economy. The substantial rise in the U.S. current account deficit as a ratio to GDP over the last decade, counterbalanced by surpluses in Asia and, more recently, oil exporters, has been the focus of significant concern and controversy. For example, global imbalances have been seen as a...
key risk in the International Monetary Fund’s commentary on the global economy in its *World Economic Outlook* since at least the late 1990s.

On the one hand, many macroeconomic analysts have pointed out that an extremely large exchange rate adjustment would be needed to slow or stabilize U.S. international debt (Obstfeld and Rogoff, 2005; Krugman, 2006). Markets could also rapidly reassess the need for a “risk premium” to compensate for this depreciation, suggesting a risk of a rapid and disruptive correction in global financial markets and growth.

On the other hand, the seeming ease with which the current account deficit has been funded has led others to hypothesize that the deficit reflects the underlying strengths of the U.S. economy, in terms of productivity and financial market structure. In this view, financial instruments are correctly priced, and risks of a disorderly adjustment are limited. Indeed, rising U.S. net borrowing has occurred despite market forecasts of dollar depreciation that imply a negative risk premium on the dollar (Balakrishnan and Tulin, 2006). Supporting this, Kamin, Reeve, and Sheets (2007) find that the results of large trade balance adjustments in the United States and other industrialized countries have generally been benign.

Some have suggested that the strength of the U.S. economy is a key factor. For example, a higher level of productivity growth may have made U.S. assets more attractive (Caballero, Farhi, and Gourinchas, 2006). However, the fact that the rise in U.S. indebtedness has been almost exclusively financed through fixed-income instruments as opposed to equity, and that equity valuations (as measured by price-earnings ratios) are modest, suggests that other explanations are needed (Figures 1 and 2). In particular, bonds usually have a fixed nominal interest rate, and so relative growth prospects should not affect their demand significantly.

Indeed, the real question is why greater net U.S. borrowing has not put upward pressure on U.S. bond rates and spreads. Various explanations have been offered. The first is that demand and supply conditions in global bond markets have lowered borrowing costs. For example, increased saving from rapidly growing emerging markets that has not been matched by additional creation of liquid financial instruments has created a “global savings glut.”

This could be possibly allied with a preference for Asian countries to maintain competitiveness in goods markets. Indeed, Dooley, Folkerts-Landau, and Garber (2003) argue that the economic emergence of a fixed exchange rate periphery in Asia has reestablished the United States as the center country in a Bretton Woods style international monetary system. This periphery has a development strategy of export-led growth supported by

---

1 Some have also expressed these underlying strengths in terms of the existence of “dark matter” that supports the U.S. income position (Hausmann and Sturzenegger, 2006).

2 Bernanke (2005) discusses the global saving glut.
undervalued exchange rates, capital controls, and official capital outflows in the form of accumulation of reserve asset claims on the United States.

Other potential factors include limited business investment and regulatory changes that have increased demand for fixed-income instruments (IMF, 2006a and 2006b). Alternatively, at a time of rapid financial globalization and declining home bias, the depth of U.S. financial
markets and reserve currency role of the dollar may have favored dollar instruments. Finally, the potential role of innovative U.S. financial markets can not be ignored, both its positive impacts until the financial crisis which started in 2007 and that led to U.S. securitized asset markets becoming frozen, and its likely negative effect subsequently.\footnote{Evidence that U.S. markets are innovating faster than competitors is provided in IMF (2006c).}

This paper provides a framework for evaluating these explanations. First, it sketches a simple international capital asset pricing model (ICAPM) of portfolio balance that illustrates the likely impact of these explanations on government bond yields/corporate spreads as well as the global allocation of U.S. and foreign bonds. Particular emphasis is put on the potential role of U.S. financial innovation—in the form of new instruments with different risk characteristics—in explaining the relative attractiveness of U.S. bonds for international investors. Second, the paper constructs a comprehensive global data set on bond yields, capital flows, overall foreign asset and liability positions, and size of bond markets from a variety of sources. Using this data set, the paper then studies a variety of bonds yields across industrialized countries to see if they are consistent with any of the channels traced out in the portfolio balance model. The paper also looks at asset allocation, using an extension of the ICAPM model to decompose the deterioration in the U.S. net foreign asset (NFA) position. Finally, using these results as background, the paper discusses the likely impact of the financial crisis of 2007–08 on the outlook for U.S. current account financing.

I. Portfolio Balance

This section sketches a highly stylized ICAPM model of portfolio balance which allows us to examine the impact of the global savings glut, declining home bias, and financial innovation. As shall be seen in Section III, it is very difficult to take such a model to the data. Indeed, we will have to extend the model to construct a decomposition that specifically allows us to quantify the impact of the aforementioned factors on the U.S. NFA position. That said, the purpose of the model is to illustrate the likely impact of the different explanations on government bond yields/corporate spreads and the allocation of U.S. and foreign bonds in all regions.\footnote{Further details of the model are provided in Appendix I of the differently titled working paper version of this paper (Balakrishnan, Bayoumi, and Tulin, 2007).}

The Basic Model

Consider a model in which bond yields are characterized by a market-determined promised return ($r$) and risks factors ($\epsilon$) which (for simplicity) are assumed to be normally distributed and uncorrelated. More concretely, let us assume there are two types of bonds—a government security that has a “country-specific” risk factor and a corporate bond that also includes a
“corporate” risk factor—and two countries—labeled the U.S. and EA (for the euro area). Hence, there are four bonds: U.S. government, euro area government, U.S. corporate, and euro area corporate. In addition to “country-specific” U.S. and euro area shocks, we assume a single corporate shock common to both areas. Although this is clearly a simplification, and adding factors that represent U.S.- and euro area-specific corporate shocks might be more realistic, this adds complications without changing the underlying conclusions from the model.

The yields on the four instruments are thus:

\[ r_{US}^G = f(r, \varepsilon_{US}), \]
\[ r_{US}^C = f(r, \varepsilon_{US}, \varepsilon_C), \]
\[ r_{EA}^G = f(r, \varepsilon_{EA}), \]
\[ r_{EA}^C = f(r, \varepsilon_{EA}, \varepsilon_C), \]

where \( r \) is the risk-free real rate, \( r \) with superscripts/subscripts \( G, C, US, \) and \( EA \) refer to yields on government, corporate, United States, and euro area bonds, and \( \varepsilon_{US}, \varepsilon_{EA}, \) and \( \varepsilon_C \) refer to the risk factors associated with U.S., euro area, and corporate assets, respectively.

There are two identical investors—in the United States and the euro area—with unlimited access to capital at the risk-free real rate (assumed to be zero) and identical mean-variance preferences:

\[ U = \mu - \frac{\sigma^2}{2}. \] (2)

Assuming outstanding balances for each instrument (using obvious notation) of \( 2\sigma_{US}^G, 2\sigma_{EA}^G, 2\sigma_{EA}^C, \) and \( 2\sigma_{US}^C, \) and observing that because investors are identical they each hold half of the market, the investor’s problem is to maximize utility by selecting optimal amounts of each instrument:

\[
\begin{align*}
Max & \quad \alpha_G^{US} r_G^{US} + \alpha_G^{EA} r_G^{EA} + \alpha_C^{US} r_C^{US} + \alpha_C^{EA} r_C^{EA} \\
& \quad - \left( (\alpha_G^{US} + \alpha_C^{US})^2 \sigma_{US}^2 - (\alpha_G^{EA} + \alpha_C^{EA})^2 \sigma_{EA}^2 \right) \\
& \quad - \left( \alpha_G^{US} + \alpha_C^{EA} \right)^2 \sigma_C^2 / 2.
\end{align*}
\] (3)

The resulting yields on government bonds and the spread on corporate loans from this maximization problem are:

\[
\begin{align*}
& r_G^{US} = (\alpha_G^{US} + \alpha_C^{US}) \sigma_{US}^2, \\
& r_G^{EA} = (\alpha_G^{EA} + \alpha_C^{EA}) \sigma_{EA}^2, \\
& r_C^{US} - r_G^{US} = r_C^{EA} - r_G^{EA} = (\alpha_G^{US} + \alpha_C^{EA}) \sigma_C^2.
\end{align*}
\] (4)

Yields on government bonds depend on borrowing by that country in the market and the underlying uncertainty associated with that country, but the spread on corporate bonds depends on the size of overall corporate borrowing and associated risks.
As investors hold identical portfolios, U.S. net international debt is:

\[ \text{Net Debt} = 2((\alpha^{US}_G + \alpha^{US}_C) - (\alpha^{EA}_G + \alpha^{EA}_C)). \]  

(5)

Additional international borrowing involves either more borrowing by the U.S. government or corporates. Such an increase in U.S. borrowing raises interest costs for U.S. and (possibly) foreign corporate borrowers. For example, if the U.S. government borrows an additional \( \delta^{US}_G \), this will raise the required yield on U.S. government/corporate bonds by \( \delta^{US}_G \sigma^{2}_{US} \). If the additional borrowing comes from the U.S. private sector, there is also a rise in spreads on both U.S. and euro area corporate spreads of \( \delta^{US}_C \sigma^{2}_{C} \). Hence, higher U.S. international debt comes at the price of higher borrowing costs.

To summarize, we have the following relationships for U.S. borrowing on spreads and net debt:

\[ \Delta r^{US}_G = (\delta^{US}_G + \delta^{US}_C)\sigma^{2}_{US}, \]

\[ \Delta(r^{US}_C - r^{US}_G) = \delta^{US}_C \sigma^{2}_{C}, \]

\[ \Delta \text{US net debt} = 2(\delta^{US}_G + \delta^{US}_C). \]  

(6)

Rising Financial Globalization and Declining Home Bias

One type of explanation for why higher U.S. international debt has not led to higher borrowing costs is that it has been accompanied by a generalized erosion in home bias, which has naturally increased the indebtedness of countries that were initial debtors. In our framework, this can be modeled as a reduction in the disutility of foreign borrowing. This reduction in disutility lowers costs to borrowers while expanding the proportion of assets held by foreigners, thereby increasing net borrowing and net lending (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix I).

Global Savings Glut

A global savings glut can be modeled in this framework by assuming that a new investor is added to the model but the supply of securities remains the same. Reverting to the baseline model, if the new “emerging Asia” investor is identical to the other two, then the portfolios of the other two investors each shrink by one-third to accommodate the new region. As a result, all interest rates and spreads are also lowered by one-third. Furthermore, net foreign borrowing by the United States rises by one-half as the emerging Asia investor now holds one-third of the global portfolio of securities.

The analysis can be made more interesting and realistic by assuming that the emerging Asia investor is more concerned about corporate risks (that is, is more risk averse) and about euro area risks than its U.S. and euro area counterparts—implying a preference for U.S. government instruments, possibly reflecting intervention to stabilize the dollar exchange rate. In this
case, it is easy to show that—compared with the case of adding an identical investor—the addition of this emerging Asia investor reduces U.S. government bond yields by the same amount, but puts less downward pressure on yields on the other three bonds. Reflecting these investor preferences, there is a larger rise in U.S. net international debt than in euro area net debt (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix I).

Some analysts have also posited that the downward pressure on yields has come less from a global saving glut than from a dearth of global investment opportunities. In this model, such a situation can be modeled as a reduction in issuance of debt by the United States and the euro area. For this to raise U.S. net international borrowing, the fall must be larger in the euro area than in the United States, implying greater downward pressure on euro area than U.S. borrowing costs.

Financial Innovation

Innovation Through New Products

Now consider a situation in which the U.S. private sector starts issuing a new bond which is linked to household risk \( (H) \) rather than its corporate counterpart \( (C) \), and these risks \( (\varepsilon_C \text{ and } \varepsilon_H) \) are assumed uncorrelated. The new bond has the following yield:

\[
r_{US}^H = f(r, \varepsilon_{US}, \varepsilon_H).
\]

The equations for the rates of return are now:

\[
\begin{align*}
r_{US}^G &= (\alpha_{US}^G + \alpha_C^US + \alpha_H^US)\sigma_{US}^2 \\
r_{EA}^G &= (\alpha_{EA}^G + \alpha_C^EA)\sigma_{EA}^2 \\
r_{US}^C &= (\alpha_{US}^C + \alpha_C^US + \alpha_H^US)\sigma_{US}^2 \\
r_{EA}^C &= (\alpha_{EA}^C + \alpha_C^EA)\sigma_{EA}^2 \\
r_{US}^H &= \alpha_{US}^H\sigma_H^2.
\end{align*}
\]

(7)

As investors continue to hold identical portfolios, higher U.S. borrowing will raise U.S. net debt. The difference in this case is that while this additional borrowing raises the return on government bonds as in the base case, diversification into new products unambiguously reduces upward pressures on private spreads, and can even lower the cost of private sector borrowing, particularly for the United States.

To see this, compare the impact of issuing an additional \( \delta_C^{US} \) of “traditional” corporate bonds discussed above with the impact of borrowing the same amount of “new” household bonds on spreads. If the money is borrowed using the “new” instruments, there is now no upward pressure on global corporate bond spreads. Indeed, as the household bond is scarce and hence in high demand its spread remains lower than that for corporates under the not very stringent condition that \( \alpha_{H}^{US} \) is less than \( (\alpha_C^{US} + \alpha_C^{EA})\sigma_C^2/\sigma_H^2 \). Hence, the average spread on U.S. private sector borrowing falls as
long as the additional borrowing in household bonds is lower than the risk-adjusted aggregate size of the corporate bond market. Moreover, to the extent that additional issuance in the new $H$ market partly substitutes for borrowing in the $C$ market—and hence the aggregate amount of U.S. corporate borrowing ($z_{US}^C$) is reduced—these “new” instruments will lead to a fall in global corporate spreads.

In addition to the reduction in the level of spreads as a result of introducing the new bond, it can also be easily shown that additional borrowing now puts less upward pressure on spreads than in the case when there are only corporate bonds (this assumes that the additional borrowing comes in part from both types of bonds). Although the formulas get increasingly cumbersome, it is clear that under some conditions this model of financial innovation implies a fall in the cost of borrowing in the United States and elsewhere even if the United States increases its overall issuance of bonds and hence incurs higher net debt. Many argue, however, that financial innovation, rather than leading to a new product that creates new risks, leads to a new product that splits existing risks. It can be easily shown that this does not matter, as increased lending with limited impact on borrowing costs generalizes to the case of financial innovation splitting risk.

**Autonomous Rise in Demand for U.S. Assets**

Financial innovation could also cause an autonomous rise in demand for U.S. assets. In our two country model, this shows up as a decline in home bias (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix I). In a multicountry model, however, it could also show up as an autonomous rise in portfolio demand. In particular, foreign investors could divert more of the capital they allocate to investments abroad to the United States, without a decline in home bias.

In sum, even in the face of an increase in U.S. borrowing and some increase in rates on government bonds, U.S. financial innovation can lead to lower overall borrowing costs through lower spreads on private borrowing, particularly in the United States.

Table 1 summarizes the impact of different factors, using the portfolio balance model, on borrowing costs and the allocation of bonds.

**II. Impact on Borrowing Costs**

Analyzing yields across assets and countries to discriminate between the different explanations documented in Table 1 is a formidable task given the many factors that affect interest rates, and the difficulty of getting comparable yield data across countries—particularly with respect to corporate bonds. Nonetheless, Figures 3 and 4 make such an attempt, plotting yields/spreads for a variety of industrialized country government bonds, as well as investment grade and speculative grade corporate bonds for the United States and euro area.
In general, low long-term government bond yields have been common to many industrialized countries. On the corporate side, spreads fell in both the United States and euro area until mid-2007, since when they have widened considerably. Until mid-2007, investment grade corporate spreads tightened a little more in the United States than in the euro area, with the reverse true

<table>
<thead>
<tr>
<th>Change in Financial Structure</th>
<th>Impact on Borrowing Costs</th>
<th>Impact on Asset Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None U.S. issues more traditional government and private sector bonds.</td>
<td>Upward pressure on U.S. government bond yields and on private sector spreads.</td>
<td>Rise in U.S. debt being held by other industrialized countries.</td>
</tr>
<tr>
<td>Rising globalization Financial innovation lowers home bias across industrialized countries.</td>
<td>Some downward pressure on all borrowing costs and spreads, and less upward pressure from additional private sector borrowing.</td>
<td>Rise in proportion of industrialized country assets held by other industrialized countries.</td>
</tr>
<tr>
<td>Autonomous rise in demand for U.S. assets The rest of the world increases its demand for U.S. securities (could be caused by financial innovation).</td>
<td>U.S. yields fall while those on foreign securities do not, and less upward pressure on U.S. government yields from additional U.S. borrowing.</td>
<td>U.S. bonds become a larger part of foreign portfolios with no equivalent change in U.S. portfolios. Could result in a fall in home bias of foreign investors or simply a reallocation of their existing foreign asset portfolios.</td>
</tr>
<tr>
<td>Savings glut Financial innovation, rapid economic growth, and reserve build-ups widen the amount of industrialized country assets held by emerging markets.</td>
<td>Downward pressure on all borrowing yields and spreads, particularly U.S. government bonds, and less upward pressure from additional borrowing.</td>
<td>Expansion in proportion of U.S. and other industrialized country assets held by emerging markets.</td>
</tr>
<tr>
<td>Financial innovation United States issues a large amount of financial instruments that split/reconfigure risk.</td>
<td>Some upward pressure on U.S. government bond yields. A possible fall in private sector spreads, and less upward pressure from additional private sector borrowing.</td>
<td>Rise in U.S. bonds held by other industrialized countries, with much of the increase in new instruments, and potentially, a fall in industrialized country home bias.</td>
</tr>
</tbody>
</table>
for speculative grade corporate spreads. Overall, although such trends give a mixed picture—and could reflect other factors such as declining macroeconomic and financial volatility—the general pre-crisis decline in yields appears to be consistent with the savings glut and financial globalization hypotheses.
III. Impact on Asset Allocation: Considerations in Decomposing the Rise in U.S. External Debt

In this section, we set out a framework to analyze asset allocation and determine which explanations in Table 1 are consistent with recent trends. There are, of course, limits to what analysis can be done on asset allocation. As alluded to earlier, it is very difficult to take the ICAPM portfolio balance model sketched in Section I to the data. That model suggests different global asset allocations for the savings glut, declining home bias in industrialized countries, and financial innovation. But existing data sets do not allow one to track the proportion of industrialized country assets held by other industrialized countries or emerging markets for a reasonable time span.5

Detailed data on country-level U.S. assets and liabilities flows, however, are available from the Treasury international capital (TIC) system, which records monthly transactions involving U.S. residents and foreigners, mainly reported by brokers and dealers. We use such data to decompose the deterioration of the U.S. NFA position by extending the ICAPM model sketched in Section I. Given that most of the external financing has been through the bond market, as noted at the beginning of this paper, we concentrate on the NFA position of the United States with respect to bonds. We make one important correction to the gross bond flows into the United States for principal repayments on asset-backed securities (ABS). The monthly TIC system does not track such payments. Since 2002, however, the TIC website has started publishing data on repayment flows associated with foreign holdings of ABSs, which have grown substantially in recent years.6

We focus on flows between the United States and four major zones, industrialized countries, emerging market countries (including some large oil exporters), Middle Eastern oil-exporting nations, and Caribbean offshore centers.7 We group the countries as such because we want to discriminate between industrialized country financial globalization and the savings glut hypothesis—the latter which we view as manifested in flows of the “new players” or emerging market countries.8 We consider Middle Eastern

---

5 Coordinated Portfolio Investment Surveys conducted annually under the auspices of the IMF do have some bilateral data of industrialized country holdings in other industrialized countries. For many countries, however, the surveys are not particularly comprehensive, and generally only start in 2001.

6 Principal repayments on asset-backed corporate and agency bonds are taken out in proportion to their regional holdings, with the latter taken from estimates published in the annual TIC surveys of U.S. liabilities.

7 See Appendix I for the countries that make up the emerging market countries, Caribbean offshore centers, Middle Eastern oil-exporting nations, and industrialized countries.

8 As Bernanke (2005) notes, while population aging in other industrialized countries could also lead to a savings glut, the fact that their aggregate current account surplus has improved only marginally over the last decade suggests that other developments have been more important.
oil-exporting nations separately as many analysts have argued that their capital flows are substantial but particularly difficult to track given the lack of information of some of the large sovereign wealth funds in this zone. Caribbean offshore centers are also considered separately, as it has been argued that they act as an important conduit for financing flows to and from the United States.

The sample includes 2007–08, allowing us to see the initial impact of the financial crisis that started in mid-2007. The crisis initially only encompassed the subprime segment of the mortgage market, but soon spread, causing many U.S. securitized markets to freeze up and interbank markets to become impaired. In many ways, this episode provides a great natural experiment into how a loss of confidence in sophisticated financial assets impacts U.S. current account financing, something we will discuss in more detail in Section V.

**Regional Picture**

Figure 5 shows that while net flows from emerging markets to the United States have increased in recent years (constituting around 40 percent of total net flows in the last five years), the bulk of the financing has come from the industrialized countries during the last decade (about 55 percent). Middle Eastern oil exporter flows are surprisingly low and Caribbean offshore centers do not appear to be a major source of financing. Looking at which regions have contributed to bond financing at the margin paints a more nuanced picture (Figure 6). In particular, during 2005–07, increased financing from emerging markets partially offset reduced funding from industrialized

**Figure 5. Regional Composition of Net Bond Flows into the United States**

(In billions of U.S. dollars)

![Diagram showing regional composition of net bond flows into the United States from 1990 to 2008.]

Source: Treasury International Capital System.
countries, although in 2008 financing from emerging markets also fell. The impact of the financial crisis appears significant—net bond flows fell by nearly 60 percent from 2006 to 2008.

At first glance, the relative importance of industrialized country flows compared with those of emerging market and Middle Eastern oil exporter flows sits oddly with the fact that most of the deterioration in the U.S. current account position is mirrored by an improvement in the current account position of emerging market countries and Middle Eastern oil exporters (Table 2). Explaining this apparent dichotomy is key to the whole analysis of current account financing, and we will analyze it in detail in

![Figure 6. Regional Composition of Marginal Bond Financing of U.S. Current Account Deficit (in billions of U.S. dollars)](image)

Source: Treasury International Capital System.

| Table 2. Global Current Account Balances (in billions of U.S. dollars) |
|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| United States               | −114 | −417 | −461 | −788 | −731 | −673 |
| Euro area                   | 42   | −34  | 50   | 38   | 29   | −81  |
| Japan                       | 111  | 120  | 113  | 170  | 211  | 156  |
| Other industrialized countries | −1  | 34   | 34   | 51   | 21   | 92   |
| Emerging Asia excluding China | −34 | 58   | 83   | 125  | 152  | 84   |
| China                       | 2    | 21   | 35   | 253  | 372  | 440  |
| Middle Eastern oil exporters | 0   | 62   | 29   | 238  | 246  | 332  |
| Other major emerging markets | −36 | −22  | 5    | 69   | 0    | −25  |

Note: See Table A1 for the list of countries included in the aggregated categories. Source: IMF, *World Economic Outlook*. 

©International Monetary Fund. Not for Redistribution
Section IV. Likely explanations include financial center biases in the TIC data and the importance of indirect financing of the U.S. current account deficit.

**Portfolio Balance between U.S. and Foreign Investors**

Given the evidence in Figures 5 and 6 that industrialized country and emerging market flows are the biggest source of financing, we focus on decomposing these flows further. We build on the approach outlined in Section I, emphasizing the ICAPM aspect (see also Bertaut and Grievers, 2004). This implies that in equilibrium, each investor will hold exactly the same portfolio, which resembles the structure of the world market. Consequently, the allocation of the foreign assets should mirror the market structure of the rest of the world. In this subsection, we sketch a decomposition to demonstrate the main effects for industrialized countries. The same decomposition holds for emerging market countries, but, of course, most of the superscripts and subscripts change. For a full derivation for industrialized countries, see Appendix III of Balakrishnan, Bayoumi, and Tulin (2007).

Defining $a$ as the size of U.S. bond markets, $a^{ic}$ as the size of other industrialized country bond markets, $a^{em}$ as the size of emerging market country bond markets, $fa^{ic}$ as total foreign bond assets of other industrialized countries, $fli$ as total foreign bond liabilities of other industrialized countries, and $fli$ as industrialized country assets in the United States, if industrialized country investors place assets in the United States in accordance with the U.S. share in a “borderless” global bond portfolio:

$$fli = \frac{a}{a + a^{ic} + a^{em}} fa^{ic}. \tag{8}$$

Totally differentiating equation (8):

$$\Delta fli = \frac{a}{a + a^{ic} + a^{em}} fa^{ic} \left(\frac{\Delta a}{a} - \frac{\Delta(a + a^{ic} + a^{em})}{a + a^{ic} + a^{em}}\right)$$

$$+ \frac{a}{a + a^{ic} + a^{em}} fa^{ic} \frac{\Delta fa^{ic}}{fa^{ic}}. \tag{9}$$

We call the first term in equation (9) the U.S. market effect, as it shows that even with industrialized country foreign assets staying constant, if U.S financial markets are growing quicker than global markets, there should be a rebalancing within a representative industrialized country investor’s international portfolio, causing a flow into U.S. bonds.9 The second term shows that if industrialized country foreign assets expand, then there should

---

9This can be further decomposed into a larger market effect for U.S. private and government bonds, and a compositional effect allowing for a switch between government and private bonds (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix III).
be a flow into U.S. bonds which is equal to the product of the share of U.S bond markets in global markets and the increase in industrialized country foreign assets.

To get further insights, we decompose the second term of equation (9) using the concept of home bias. It is well documented that investors strongly favor their domestic markets, or, display home bias. To consider the impact of this, we follow Swiston (2005) and use a measure of home bias that accounts for the size of the domestic financial market relative to the rest of the world:10

\[ \text{Home Bias} = \frac{A^*}{A} \left( \frac{W - D}{W} \right), \]  

(10)

where \( A^* \) represents domestic holdings of foreign assets, \( A \) is domestic holdings of all assets, \( D \) is the size of the domestic market, and \( W \) is the size of the world financial market. The numerator measures the actual share of foreign assets in the portfolio, but the denominator measures what this ratio would be in a fully diversified world according to an ICAPM. A value of zero indicates no holdings of foreign assets, but a value of one indicates that the country’s portfolio is perfectly diversified from a geographic perspective. This implies that U.S. investors would be expected to hold a lower share of foreign assets and a higher share of domestic assets, reflecting the country’s greater weight in the global financial universe.

We can rewrite equation (10) to give:

\[ A^* = \left( A \frac{W - D}{W} \right) HB, \]  

(11)

where \( HB \) is home bias.

Totally differentiating equation (11):

\[ \Delta A^* = A^* \left( \Delta HB \frac{HB}{A} + \frac{\Delta A}{A} + \frac{\Delta (W - D)}{W - D} - \frac{\Delta W}{W} \right). \]  

(12)

The first term of equation (12) represents the increase in foreign assets because of a decline in home bias (\( \Delta HB > 0 \)). The next three terms show notwithstanding constant home bias, because of increasing total assets—which we call financial deepening—or a decrease in the size of the domestic markets relative to world financial markets, a rebalancing of portfolios leads to higher demand for foreign assets.

---

10This is sometimes referred to as the foreign asset acceptance ratio (FAAR).
If we insert equation (12) into equation (9), we have a predicted value for industrialized country gross flows, which is a function of three effects:

\[
\Delta f\hat{l}_i = (\text{U.S. large market effect}) \\
+ (\text{declining home bias effect}) \\
+ (\text{financial deepening effect}).
\] (13)

As noted earlier, Appendix II of Balakrishnan, Bayoumi, and Tulin (2007) has the full derivation of this decomposition and we will discuss in more detail each effect in Section IV. In this framework, interest rates will be endogenously determined given the shifts in bond market size, home bias, and financial deepening.

We make one final adjustment to equation (13) to take into account that actual stocks differ from the ICAPM benchmarks. In equation (13), the predicted value for inflows is essentially a function of changes in market size, home bias, and total assets; and a weighting factor—the ICAPM benchmarks. As Figure 7 shows, however, according to this criteria, foreign investors have been persistently underweight in U.S. assets (and U.S. investors have been persistently underweight in industrialized country assets). This suggests that we may be overestimating the impact of changes in market size, home bias, and total assets on financing. To adjust for this, we add a term called the stock adjustment effect, which is:

\[
stock_{adj} = \left( f\hat{l}_i - \frac{a}{a + a^{ic} + a^{em}f^{ic}} \right) \frac{\Delta f^{ic}}{f^{ic}}. \] (14)

Thus, as industrialized country investors have been persistently underweight in U.S. assets, the sign of this adjustment is generally

Figure 7. ICAPM-Implied and Actual Bond Holdings of United States vis-à-vis Industrialized Countries (In trillions of U.S. dollars)

<table>
<thead>
<tr>
<th>U.S. Liabilities</th>
<th>U.S. Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IMF staff estimates.
Note: ICAPM = international capital asset pricing model.
negative, reducing the magnitude of the flows predicted by the model:

\[
\Delta f_{i_{adj}} = (U.S. \text{ market effect}) \\
+ (\text{declining home bias effect}) \\
+ (\text{financial deepening effect}) + \text{stock}_{adj} 
\]

(15)

and

\[
\Delta f_i = \Delta f_{i_{adj}} + \text{residual}_{us}. 
\]

(16)

We derive a similar expression to equation (16) for U.S. gross capital flows to industrialized countries (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix III):

\[
\Delta f_{ai} = \Delta f_{ai_{adj}} + \text{residual}_{ic}, 
\]

(17)

where \( f_{ai} \) are U.S. assets in industrialized countries. Equations (16) and (17) are the decompositions we take to the data.

For emerging market countries, as Figure 8 shows, the degree to which they are underweight or overweight in U.S. assets depends on the amount of official reserves which are in long-term foreign bonds. This is because, unsurprisingly, emerging market countries—such as China—have large official reserves relative to private foreign asset holdings. Thus the amount of official reserves in long-term foreign bonds has a large impact on their overall NFA position with respect to bonds, which is not the case for industrialized countries. Annual benchmark surveys of foreign holdings of U.S. assets suggest that around 85 percent of U.S. portfolio debt securities

Figure 8. ICAPM-Implied and Actual Emerging Markets’ Holdings of U.S. Bonds (in trillions of U.S. dollars)

Source: IMF staff estimates.
Note: ICAPM = international capital asset pricing model.
held by foreigners are in long-term bonds and IMF Coordinated Portfolio Investment Surveys suggest that, globally, around 75 percent of foreign portfolio debt holdings are in long-term bonds.

Given this, and assuming a significant share of official reserves will also be in bank deposits, our baseline assumption is that 60 percent of official reserves are in long-term bonds. This assumption suggests that emerging markets have oscillated around being appropriately weighted in U.S. assets according to an ICAPM model. Currently, they are overweight in U.S. assets, something which actually increased in the run-up to the crisis. Thus, as opposed to the case with industrialized countries, the stock adjustment should not be as a significant factor.\textsuperscript{11}

IV. Empirical Decomposition of The Rise in U.S. External Debt

Overview of the Main Factors in the Decomposition

To summarize what we have learnt so far, Section III shows that looking at raw TIC flows suggests that industrial country inflows have been the largest source of financing of the U.S. current account deficit over the last decade, although emerging market flows have gained prominence in the last few years. Given this, we also derive a decomposition of the U.S. NFA position with respect to bonds against industrialized countries and emerging market countries. This decomposition allows us to trace the impact of four key components on both inflows to and outflows from the United States:

- **Bond market size:** This effect captures a desired rebalancing within a representative foreign country investor’s international portfolio as the relative share of regional bond markets change. As equation (9) shows, for flows into the United States, this is made up of two components: (1) the growth rate of U.S. bond markets relative to that of the global bond markets; and (2) a weighting factor, which is the share of the United States in the global bond market (also the expected level of bond holdings in the United States according to ICAPM). We have a similar equation for flows out of the United States to foreign countries.

- **Declining home bias:** This leads to more capital being invested abroad. For foreign countries, given the share of the United States in the global market, such a decline leads to significant outflows to the United States. A similar effect applies for U.S. bond outflows to foreign countries.

- **Financial deepening:** As equation (12) illustrates, if the total assets a country holds expands, this can lead to a further demand for foreign assets even if home bias has not changed. There are two components to

\textsuperscript{11}For industrialized countries, we make the same assumption that 60 percent of official reserves are invested in long-term bonds. Of course, given the dominance of private capital flows, the results for industrialized countries are not sensitive to this assumption.
increasing total assets or financial deepening: growing domestic bond markets and an improving NFA position.

- Residual: If the residual is positive, this would reflect a “pure” preference for U.S. assets. In the case of industrialized countries, part of it could be linked to “catching-up” to ICAPM predicted holdings given that we make an adjustment to the flows predicted by expanding bond markets, declining home bias, and financial deepening for the fact that industrialized country investors have been persistently underweight in U.S. assets (the stock effect). We will discuss further what else could explain a pure preference later in Section IV.

Of course, apart from declining home bias, these four key components do not map one-to-one into the explanations highlighted in Table 1. Given this, we will discuss the mapping between the two of them in detail once we report the results. Indeed, we will show that financial innovation can be linked to more than just bond market size, and that the global savings glut could be a factor behind a decline in home bias of industrialized countries. Before getting to the results, however, we briefly discuss the data set put together to estimate the decomposition.

Further Data Considerations

Apart from the TIC data discussed at the beginning of Section III, we also need annual data on the size of bond markets for the United States, industrialized countries, and emerging markets, as well as gross foreign asset positions of emerging market countries, industrialized countries, and the United States. For bond market size, we use Bank for International Settlements (BIS) data, with changes in market size adjusted for valuation effects caused by exchange rate movements. For asset positions, we update the data set used in Swiston (2005)—which uses a combination of IIP data, estimates based on balance of payments, and various official sources—and add to it long-term bond assets which are part of official reserves (see Balakrishnan, Bayoumi, and Tulin, 2007, for more details). Although our decomposition is at an annual frequency, bond market size data are only available up to the third quarter of 2008. However, especially in light of the financial crisis, it would be illuminating to have some analysis for 2008. To this end, we report the results of the decomposition for the first three quarters of 2008, with the added caveat that such results are not directly comparable to the rest of the sample as they do not capture a full year. Overall net flows from the various regions are available for all of 2008.

Results of the Decomposition

Figures 9–12 plot the results from estimating equations (16) and (17) for industrialized countries. Figure 9 shows that the trend of deterioration is dominated by liability flows, which for the period 1994–2008 have been around eight times the size of asset flows. Decomposing overall net flows
suggests that financial deepening and declines in home bias have been key drivers over the last decade (Figure 10). There is also, as expected, a negative effect from the stock adjustment; and, in general, a positive residual. As noted in Section III, these two effects are related. Indeed, in some years (for example, 2005–06), the stock adjustment more than offsets the residual. This illustrates that if industrial country investors were using ICAPM to determine their purchases of U.S. assets at the margin, in some years we could more than fully account for net industrial country flows to the United States.

Interestingly, net flows from industrialized countries fell by nearly 40 percent in 2007 and the residual turned negative. The latter was largely
driven by both a substantial positive residual for U.S. flows to industrialized countries, and a falling negative residual for industrialized country purchases of U.S. bonds (Figures 11 and 12). These trends probably illustrate a couple of key developments: (i) a flow out of risky U.S. assets; (ii) safe haven flows into U.S. treasuries; and (iii) a massive increase of U.S. home bias (see section V for details).

Drilling down further on the gross flows between regions, on the liability side (Figure 11), the effect from the expansion of foreign assets of
industrialized countries ($fa^{fc}$) dominates (financial deepening), with a negligible U.S. market effect. Figure 12 decomposes the increase in gross U.S. assets in industrialized countries, illustrating that U.S. home bias, if anything, has been increasing in recent years. Indeed, in 2008, an unprecedented increase in U.S. home bias led to an actual repatriation from industrialized countries after a significant build up of U.S. assets in previous years (Figures 9 and 12). Financial deepening in the United States, in contrast, is the main contributor to outflows over the whole period.

Figures 13–16 plot the results of the decomposition for emerging market countries. As is the case for industrialized countries, Figure 13 shows that the trend of deterioration is dominated by liability flows. Interestingly, asset flows have been negative since the late 1990s, with the repatriation again being especially strong in 2008. Figure 16 suggests that this is because of a sizable negative residual, which could be related to U.S. investors having less appetite for emerging market debt after the Asian crisis. Figures 14 and 15 show that the key driver of liability flows has been financial deepening in emerging market countries, although there is an important positive residual. The stock adjustment, as expected is smaller than for industrial countries. Perhaps surprisingly, declining home bias is only a positive contributor to flows in 2006 and 2007.

Despite the financial turmoil, net flows from emerging markets to the United States increased in 2007, although they declined significantly in 2008 (Figure 13). Moreover, since 2006, the residual associated with emerging market purchases of U.S. bonds has turned negative. This may support the view that while less developed emerging markets previously invested in the United States partly because their own financial markets are underdeveloped (Forbes, 2008), concerns about the quality of U.S. assets and the dollar are
starting to offset this. Next, we map these results into the explanations outlined in Table 1.

**Home Bias and Financial Deepening in Industrialized Countries**

As shown in Figure 17, according to our definition (with an inverted scale), home bias has been falling in industrialized countries in recent years. The level of gross foreign assets and liabilities at the country level has also
expanded significantly, often referred to as financial globalization. Factors driving financial globalization and declining home bias include reductions in the costs of cross-border financial transactions, increasing investor sophistication, and financial deregulation (IMF, 2005a and 2005b). For the euro area, the impact of the introduction of the euro cannot be ignored. In particular, it has allowed member countries to take on foreign assets without currency risk, and consequently led to a major reduction in home bias.
In light of such trends, it is perhaps not surprising that declining home bias can explain a significant portion of expansion of industrialized country assets in the United States. Indeed, it is consistent with the views of former Federal Reserve Chairman Alan Greenspan (2005), who believes that such trends have allowed individual countries to run large deficits for sustained periods. On the U.S. asset side, home bias has remained high. Indeed, it has even increased in some years (especially in 2008), and consequently made a negative contribution to U.S. outflows (as seen in Figure 10). This may be consistent with U.S. bond markets already being highly liquid, deep, and innovative, allowing U.S. investors to structure highly diversified portfolios with ease and likely reducing their interest in foreign fixed-income securities. It is also consistent with the view that in troubled times—no matter whether the troubles originate in the United States or abroad—U.S. investors repatriate their funds.

Financial deepening has been the other key factor. For the other industrialized countries, this has mainly come about by a rapid increase in the size of domestic bond markets, rather than an increase in NFA, as their current account surpluses have not changed much over the last decade (Figure 18). As noted earlier, on the U.S. asset side, the biggest contribution to purchases of industrialized country assets comes from financial deepening. Again, this is fully explained by rapid growth of U.S. fixed-income markets, as the U.S. NFA position has deteriorated.

Global Savings Glut: Emerging Market Country and Petrodollar Financing

We noted in this section that while net flows from emerging markets increased significantly in recent years, the bulk of the financing had come...
from the industrialized countries. We also suggested that this sits oddly with the pattern of recent current account imbalances as shown in Table 2. This puzzle is confirmed when we look at the pattern of official and private inflows, with official flows largely thought to come from nonindustrialized countries. As Figure 19 shows, the share of official inflows has increased since the late 1990s: it reached around 40 percent during 2005–07, and an incredible 75 percent in 2008. Explaining this puzzle is what we turn to next.

As is well known, monthly TIC transactions have significant financial center bias.12 Indeed, it could be that significant emerging market and petrodollar flows are showing up as industrialized country flows and, thus, explaining part of the residual. To test for the importance of such a bias, we performed some robustness checks using TIC flow data corrected using custodial data—which are considered more accurate and comprehensive—as reported in infrequent benchmark surveys of U.S. assets and liabilities for the industrialized countries, emerging markets, and offshore centers.13

---

12 For example, if the Bank of China instructed a private bank in London to buy U.S. treasury bonds from a U.S. resident, this would show up in the TIC system as a treasury bond flow from the United States to the United Kingdom. For further details see Warnock and Cleaver (2002).

13 The authors thank Frank Warnock for providing the benchmark consistent TIC data, and readers interested in further details are referred to Thomas, Warnock, and Wongswan (2006) and Chinn, Rogers, and Warnock (2006).
Although liability data from the benchmark surveys in theory still suffer from custodial bias, it does not appear to be strong for the big emerging market countries.\footnote{Warnock and Cleaver (2002) argue that while benchmark surveys of U.S. assets should not suffer from custodial bias, surveys of U.S. liabilities probably do. This is because the identifier on a U.S. security only provides information on the custodian, which is not necessarily in the country of the actual owner of the security. Nonetheless, the bias is significantly less than in the raw monthly TIC data.} For example, the latest annual benchmark liability survey suggested that of the estimated $1 trillion of reserves that China held at end-June 2006, around 70 percent were in U.S. dollars (assuming that virtually all holdings are official). Various commentators have suggested that this demonstrates that the annual surveys do not significantly undercount Chinese holdings of U.S. assets (Setser, 2007), with an ICAPM suggesting that China should be holding around 40 percent of its foreign assets in U.S. securities. Overall, emerging market country flows do not change materially when using the corrected TIC data. Indeed, it appears that financial center bias largely affects country assignation within the industrialized countries; in particular, euro area flows are underestimated and U.K. flows are overestimated.

For the Middle Eastern oil exporters, financial center and custodial center biases could be more of a problem, likely explaining why their measured flows are so low. Indeed, as Setser (2007) argues, U.S. asset holdings of the Middle Eastern oil exporters recorded in the annual surveys are low relative to most estimates of total portfolios of the respective central banks and investment authorities. This may reflect the difficulty of tracking purchases of some of the major investment authorities in the Middle East, who rarely report their activities, in sharp contrast to the Norwegian Government Pension Fund. An example of a potentially significant channel for undercounting would be if large purchases are made through private fund managers in London. This would show up as a flow from the industrialized countries to the United States and, thus, explain part of the residual.

However, the trends in Table 2 could also be consistent with another theory—even if the emerging markets countries and Middle Eastern oil exporters have not been providing direct financing of the U.S. current account deficit, they have been providing \textit{indirect financing} (Higgins, Klitgaard, and Lerman, 2006). As a recent McKinsey Global Institute (2007a) report notes, it does not matter whether such funds are invested in Europe or Asia rather than being invested directly in the United States; by increasing the capital available in the global financial system, they still contribute to the funding of the U.S. current account deficit.

For example, petrodollars may have been used to purchase assets in Japan. Since Japan is running a balance of payments surplus, this would lead to overfinancing, which, in turn, would lead to Japanese investments elsewhere. In other words, both the gross foreign assets and liabilities of the industrialized countries would expand equally. According to equation (16),
this would show up as a decline in home bias of the industrialized countries as their total assets would remain unchanged. Under our decomposition, this would be part of the “declining home bias” component of the financing, but not financial deepening.

In sum, the global savings glut has likely played a bigger role in providing external financing than a first glance at Figures 5 and 6 would suggest. This is partly through misclassified emerging market/petrodollar purchases and its contribution to declining home bias of the industrialized countries, which our results suggest has been a key factor explaining current account financing.

Financial Innovation

Financial innovation can show up in various forms. It can be consistent with the U.S. market effect if innovation has led to the rapid expansion of U.S. private bond markets relative to other countries. Indeed, it can be shown that the U.S. market effect splits into a market effect for U.S. private and government bonds, and a compositional effect allowing for a switch between government and private bonds (see Balakrishnan, Bayoumi, and Tulin, 2007, Appendix IV).

As Figure 12 shows, however, the U.S. market effect has not contributed much to inflows from industrialized countries to the United States. This may seem surprising given the global preeminence of U.S. private fixed-income markets. But it reflects the fact that while U.S. fixed-income markets have grown rapidly, so have such markets in the rest of the world. Thus, the dominance in terms of size of U.S. fixed-income markets has not really changed in the last decade, and the U.S. market effect—which depends on changes—is small. It is worth underscoring, however, that although rapid expansion of bond markets both in the United States and abroad tend to offset each other in terms of the bond market size effect, they still lead to a substantial financial deepening effect on both flows into and out of the United States. Financial innovation can also show up as a decline in home bias or as a portfolio rebalancing—with foreign investors diverting more of the capital they allocate to investments abroad to the United States—if it leads to an autonomous rise in demand for U.S. assets. While declining home bias caused by financial innovation will be picked up by our decomposition, any resulting portfolio rebalancing would not be tracked and would show up in the residual.

Until the onset of the financial crisis in mid-2007, it is quite plausible that investors may have autonomously raised their demand for U.S. fixed-income instruments. Simply put, they may have perceived U.S. financial markets to be producing assets to help create diversified portfolios. For example, U.S. corporates certainly issue more speculative grade bonds than European corporates. Furthermore, at least until 2007, U.S. financial markets securitized vastly more assets than markets in other regions. Investors may have viewed such assets as allowing them to expose themselves to a wide variety of risks and embedded leverage. Moreover, regarding securitized
assets, the majority of subprime ABSs were rated AAA, which allowed many investors to hold them in their portfolios. However, as investors lost faith in the quality of securitized assets in late 2007, this effect may have reversed, something which would be consistent with the precipitous drop off in gross industrialized country flows in 2007 and 2008, and gross emerging market country flows in 2008 and which we will return to in Section V.

Other Factors Explaining the Residuals

The fact that the industrialized country residual fell despite oil prices continuing to increase during 2005–07 suggests that difficult-to-track petrodollar recycling is only part of the explanation. As noted earlier in this section, inflows associated with financial innovation could also be showing up in the residual. Other explanations for the positive, and often sizable, residual include the reserve currency role of the dollar and the level of investor protection that U.S. financial markets offer.

Does the stock adjustment also help explain the residual? As discussed earlier in this section, for industrialized countries, the stock adjustment effect is negative over the horizon considered, consistent with industrialized country investors being persistently underweight in U.S. assets. Clearly, an ICAPM is a simplification as it implies that investors’ relative holdings in equilibrium should depend only on the relative size of bond markets. The world economy, however, has faced many structural changes in recent years—including persistently elevated commodity prices, rapid financial development, and a secular decline in macroeconomic volatility. Given that the impact of such developments on desired portfolios may take time to process, investors may still be in a state of transition toward a new equilibrium, and different equilibriums given that they are unlikely to have identical preferences.

Mechanically, a negative stock adjustment reduces the size of the predicted flows from increasing bond market size, declining home bias, and financing deepening. This, in turn, increases the size of the residual. Does this imply that part of the industrialized country residual could be “catch-up” associated with the stock adjustment effect? Possibly. Certainly, the decomposition does not capture flows associated with industrialized country investors attempting to “catch-up,” because they were initially underweight in U.S. assets, as defined using an ICAPM approach. Although how large this affect could be is debatable as, if anything, the degree to which industrial country investors are underweight in U.S. assets has increased (Figure 6). The later, however, could reflect valuation effects.

V. The Impact of the Financial Crisis

As noted in previous sections, overall net portfolio flows were significantly lower in 2007–08, even being negative from Caribbean offshore centers (Figures 5 and 6). Industrialized country flows fell considerably in 2007, while those from emerging market countries dropped off in 2008. The pattern of
the flows over the 2007–08 makes the link with the financial crisis clear. Foreign net purchases of U.S. assets were about $150 billion higher during the first half of 2007 than during the same period in 2006. However, during the second half of 2007, net flows were close to $200 billion lower than in the second half of 2006. And late July 2007 was when financial strains started to escalate, with the subprime crisis blowing up, interbank markets becoming impaired, and the asset-backed commercial paper market freezing shortly afterwards in August 2007. During 2008, net inflows continued to fall precipitously, and in the second half of the year were even negative.

The composition of the flows also tells an interesting story. Perhaps unsurprisingly given their riskier nature, as Figure 20 shows, there has been a big switch out of corporate bonds and equities. Such purchases were higher in the first half of 2007 when compared with 2006, but lower in the second half. The drop off in the second half of 2007 is particularly severe for corporate bonds. The drop off in corporate bonds and equity purchases continued in 2008, with flows into the former even turning negative in the second half of 2008. Moreover, even agency bond purchases started dropping off in the second half of 2007. Likely reflecting the troubles at the housing GSEs, which eventually ended up with them being bailed out by the U.S. government in October 2008, agency bond purchases actually turned negative in the second half of 2008.

In contrast, and not surprisingly given their status as a flight to quality assets, treasury purchases remained robust in the second half of 2007 when compared with 2006, and they also increased significantly in 2008.

In sum, the evidence so far suggests that financial turmoil has impacted U.S. current account financing. Not only was the level of portfolio inflows...
substantially lower in the second half of 2007 and all of 2008, but the composition dramatically changed. In particular, corporate bond purchases declined substantially. As subprime ABS and collateralized debt obligations are classified as corporate bonds, this trend is consistent with foreign investors fleeing from U.S. securitized assets as they lost faith in their quality and how to value them. This could represent the financial innovation channel reversing somewhat. More recently, even agency bonds, which were previously considered relatively safe, have seemingly lost their luster. The ramifications of this for the future are discussed in the next section.

VI. Conclusions and Policy Implications

This paper develops a portfolio balance model to help evaluate to what extent the global savings glut hypothesis, financial globalization and declining home bias, and financial innovation can explain the easy financing of the U.S. current account deficit. One important explanation that we reject is that it reflects high expected U.S. productivity growth. This appears inconsistent with the fact that funding has occurred almost exclusively through fixed-income markets and U.S. equity prices are moderate. Rather, globally low long-term interest rates on government debt and tightening spreads on a variety of corporate bonds suggest that the global savings glut and declining home bias in industrialized countries have been important drivers.

This is largely confirmed when looking at a detailed decomposition of the deterioration in the U.S. NFA position with respect to bonds. At a first pass, the decomposition suggests that the majority of financing over the last decade can be explained by declining home bias and financial deepening in industrialized countries, although financial deepening in emerging countries has become increasingly important in recent years. Interestingly, U.S. flows to emerging markets have largely been negative since late 1990s, perhaps consistent with U.S. investors reevaluating the attractiveness of emerging market assets in the aftermath of the Asian crisis.

The decomposition also throws up a not insubstantial positive residual in the financing that foreign investors have provided to the United States for much of the last decade. For industrialized countries, this could be consistent with foreign investors having been persistently underweight in U.S. bonds according to an ICAPM model or having a preference for the wide array of bonds that deep and innovative U.S. financial markets issue, as well as difficult-to-track petrodollar recycling. For emerging market countries, the depth of U.S. financial markets and the level of investor protection they provide, as well as the reserve currency role of the dollar, have probably been the key factors.

At a second pass, there are some important nuances to the decomposition. In particular, in many ways, the different factors are
intertwined. For example, apart from showing up in the residual, the global savings glut and financial innovation could also be factors behind the decline in home bias in other industrialized countries. This underscores the importance of not looking at these factors in isolation, but rather as a constellation of forces that can be self-reinforcing.

With most analysts forecasting continued large U.S. current account deficits over the medium term, what are the implications from the conclusions above for the financing of such deficits? To the extent that financial deepening and declining home bias continue in industrialized countries, it would appear that substantial financing will likely continue, consistent with the views expressed in McKinsey Global Institute (2007a).

Regarding financial deepening, while the current financial crisis has clearly been a major negative shock, we continue to see a long-run upward trend for structural reasons. Similarly, regarding home bias, while we have argued that the global savings glut may have supported the trend fall in industrialized country home bias so far, there are other reasons why we may expect such a trend to continue in the long-run after the financial crisis abates. In particular, IMF (2005a) suggests that out of the G-3, Japan still has much to gain from further international diversification. Cooper (2005) also argues that large current account surpluses are likely to persist in industrialized countries, such as Japan and Germany, that have aging populations. Moreover, industrialized country investors are still underweight in U.S. assets using an ICAPM model.

Some would argue that the subprime-related financial crisis will leave a permanent scar on the attractiveness of U.S. assets. Certainly, the evidence presented earlier suggests that the financial turmoil did have a major impact on portfolio flows to the United States from industrialized countries and Caribbean offshore centers (which are seen as a conduit for sophisticated investor flows to and from the United States). Looking ahead, it is probably likely that some sophisticated investors who previously bought corporate ABS will be wary of buying such assets (including nonagency subprime mortgage-backed securities) in the short term. However, like the junk bond market of the late 1980s, securitized asset markets will likely survive, but in a simpler form. Moreover, demand for Treasuries and non-ABS should remain strong given the depth and liquidity for such markets in the United States, and the robust investor protection offered. Overall, while the innovativeness of U.S. financial markets may be less attractive to investors, at least for the immediate future, the likely trends in industrialized country home bias and financial deepening suggest that significant funds will continue to be directed toward the United States.

Some have also argued that easy financing will no longer come from the big emerging market countries and oil exporters, despite their increasingly important role in providing capital. In particular, as emerging market countries have accumulated significant reserve assets in recent years, it is argued that their sovereign wealth funds (often recently created) will start...
diversifying away from U.S. treasuries driving dollar depreciation as well as increases in relative interest rates in the United States. Moreover, as fixed-income markets in emerging market countries continue the process of “catch up,” this will reduce the share of the United States in the global bond market, causing investors to rebalance their portfolios away from U.S. assets.

Certainly, emerging market portfolio flows dropped off dramatically in 2008, which may be the first sign of this. However, looking beyond the near-term impact of the financial crisis, financial deregulation and increasing investor sophistication in emerging markets are likely to continue to reduce home bias. Combined with financial deepening, this will provide a large pool of funds to be invested globally. For the same reasons as outlined for industrialized countries, and given the reserve currency role of the dollar, a substantial portion of such funds, while maybe not directed to U.S. treasuries, will likely be invested in U.S. assets. Indeed, as shown by the TIC benchmark surveys, the share of treasury bonds in emerging markets’ U.S. bond portfolios has already been falling for a number of years. More fundamentally perhaps, significant diversification away from dollar assets will only come about if dollar pegs become less prevalent among emerging market countries.

Regarding sovereign wealth funds, as McKinsey (2007b) notes, many act like private investors and often have a stronger preference for equity and alternative investments than traditional investors. As an example, many sovereign wealth funds injected capital into U.S banks in late 2007 and early 2008. Moreover, 40 percent of total petrodollar assets are owned by wealthy private individuals rather than large funds. This suggests, given the size and depth of U.S. equity and debt markets, sovereign wealth funds will continue to direct a sizable share of their portfolio to U.S. assets.

To be sure, risks to continued easy financing of large U.S. current account deficits remain. Already, U.S. home bias regarding equities has fallen considerably in recent years (IMF, 2005b). It still remains high though and home bias with respect to bonds is even higher. Undoubtedly the depth, liquidity, and perceived innovativeness of U.S. fixed-income markets is one of the reasons why U.S. home bias with respect to bonds has remained so high. If the edge that the United States has had regarding financial markets is being lost—through innovation elsewhere and/or the loss of attractiveness of securitized assets—it could lead not just to reduced inflows, but rising outflows as U.S. investors increasingly look abroad to structure their portfolios. Although this has not happened during the current crisis, which has so far seen a major repatriation of funds back to the United States, it remains a risk over the medium term.

In sum, one of the great unknowns facing U.S. current account financing is the future behavior of U.S. investors and their degree of home bias. In particular, to what extent the financial crisis of 2007–08 will lead them to diversify out of U.S. bonds, resulting in a sharp rise in U.S. interest rates and a potential dollar collapse.
Table A1. List of Countries

<table>
<thead>
<tr>
<th>Industrial Countries</th>
<th>Emerging Markets</th>
<th>Offshore Centers</th>
<th>Middle Eastern Oil Exporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Argentina</td>
<td>Bahamas</td>
<td>Bahrain</td>
</tr>
<tr>
<td>Australia</td>
<td>Brazil</td>
<td>Bermuda</td>
<td>Iran</td>
</tr>
<tr>
<td>Belgium</td>
<td>China, P.R.: Hong Kong</td>
<td>Cayman Islands</td>
<td>Iraq</td>
</tr>
<tr>
<td>Canada</td>
<td>China, P.R.: Mainland</td>
<td>Netherlands Antilles</td>
<td>Kuwait</td>
</tr>
<tr>
<td>Denmark</td>
<td>Chile</td>
<td></td>
<td>Oman</td>
</tr>
<tr>
<td>Finland</td>
<td>Colombia</td>
<td></td>
<td>Qatar</td>
</tr>
<tr>
<td>France</td>
<td>Czech Republic</td>
<td></td>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Germany</td>
<td>Hungary</td>
<td></td>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>Greece</td>
<td>India</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Indonesia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>Korea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>Malaysia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>Mexico</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>Peru</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>Philippines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>Poland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Russia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>Singapore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>Slovakia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United Kingdom</td>
<td>South Africa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taiwan Province of China</td>
<td>Thailand</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Turkey</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Venezuela</td>
</tr>
</tbody>
</table>

APPENDIX I. DATA

Table A1 provides the list of countries included in industrialized countries, emerging markets, and Caribbean offshore centers.

Debt securities outstanding: From the Quarterly Review of the Bank for International Settlements, Tables 12A, 12B, 12C, 12D, 16A, and 16B. Bond market size corresponds to the stock of outstanding domestic and international debt securities, but market size change is the sum of net issues of international debt securities and changes in stocks of domestic debt securities adjusted for exchange rate valuations as calculated by BIS.

Foreign assets position: Data on international bond holdings and liabilities were kindly provided by Lane and Milesi-Ferretti (2006), which we update for 2005, 2006 and 2007. These combine official data on international investment position with estimates based on balance of payments and various official sources. International bond flows data are from IMF, Balance of Payments Statistical Yearbook, and other official sources. Stocks of foreign exchange international reserves are from the IMF, International Financial Statistics, but flows are from the IMF, Balance of Payments Statistical Yearbook. We add 60 percent of foreign exchange reserves to foreign portfolio debt holdings and 60 percent of the change in international reserves to bond purchases. While for the industrial countries, inclusion of reserve assets leads to a 2 to 4 percent increase in foreign bond holdings for 2000–05, for emerging markets 60 percent of international reserves are about 2 to 2.5 times larger than foreign portfolio bond holdings.
REFERENCES


———, 2006a, World Economic Outlook, World Economic and Financial Surveys (Washington, International Monetary Fund, April).


INTERNATIONAL MONETARY FUND SERIES

Arranged and edited by IMF experts, this series showcases important new work and directions in economic and financial issues. With contributions from leading academics and policy advisors from across the world, the volumes in this series explore research in a wide range of areas including finance and banking. The series also focuses on regional developments, using data from the IMF’s worldwide surveillance projects. Drawing on the vast knowledge and reach of the IMF, these books present the very latest thinking on economic and financial issues worldwide, and are crucial companions for practitioners and academics alike.

COMING SOON

CENTRAL BANK INDEPENDENCE, ACCOUNTABILITY AND TRANSPARENCY
A GLOBAL PERSPECTIVE
Edited by Bernard J. Laurens, Marco Arnone and Jean-Francois Segalotto
978-0-230-20107-1 • £60.00
Hardback • July 2009
Do you want regular access to this journal?

Subscribing is easy online...

Go to www.palgrave-journals.com/pal/subscribe/index.html

Alternatively...

Contact our Subscriptions Department:

By e-mail: subscriptions@palgrave.com
By phone: +44 (0)1256 357893
By fax: +44 (0)1256 812358
By post: Subscriptions Department
        Palgrave Macmillan Journals,
        Houndmills, Basingstoke,
        Hampshire RG21 6XS, UK

In North America:

Palgrave Macmillan Journals Subscriptions,
175 Fifth Avenue,
New York, NY 10010, USA
Telephone: 1-800-747-3187

www.palgrave-journals.com